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Impacts of Assistive Technology Applications in Higher Education for Students With and Without Disabilities

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by

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Abstract

Current trends in higher education include an increased enrollment of students who have a disability and a rising trend of technology use within the classroom. Assistive technology (AT) has been shown to enhance academic success and influence learning strategies. Furthermore, the combination of AT and individualized support has the potential to promote and enhance engagement in meaningful occupations, such as participation in school, for individuals with and without disabilities. However, the procurement of AT alone can often have less impact than AT combined with individualized support. Occupational therapists (OT) can play a significant role in HE providing training and individualized support for the use of AT. The purpose of this study was to investigate the impact and lived experience of students with and without disabilities and AT use in combination with individualized support to address occupational engagement in HE. Participants of this study received two types of AT software, Notability© and BEST Suite©, and were randomized into groups with or without additional individualized support. The research questions were: (1) How do the AT apps Notability© and BEST Suite© impact performance and satisfaction for students with and without disabilities? (2) How do the AT apps Notability© and BEST Suite© with and without individualized support impact occupational performance and satisfaction for undergraduate students? (3) What AT features impact undergraduates with and without disabilities? and (4) What is the lived experience of undergraduate students given AT with and without individualized support? Results indicated that use of a universally designed AT support promoted clinically meaningful change among participants' performance and satisfaction in their self-reported academic areas of challenge. In addition, the importance of individualized support was identified as valuable among participants and may diminish the likelihood of AT abandonment. Researchers highlight the role of OT for AT in HE.

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Introduction

Historically, assistive technology (AT) research in higher education (HE) has focused on the particular skills that the specific AT features support (e.g. increased spelling, increased typing speed, etc.) (Madaus, 2011). However, research has begun to evolve to include the involvement of an occupation-based lens in examining the impact of AT on the end user (Gamueda, Grant, Ortega, Song & Morris, 2018; Malcolm & Roll, 2017). For example, Gamueda et. al., (2017) explored managing fatigue through the utilization of AT among a small group of adults with multiple sclerosis. Malcolm and Roll (2017) are also pioneers of this research, as their study included a larger group of college students using AT. However, further research is still needed to examine the effects of AT on occupations in HE, in addition to the academic skills supported by specific AT software (e.g. in this study the BEST Suite© apps and Notability©). Further, there is a lack of research examining the individualized supports necessary for successful AT intervention in comparison to simply receiving the AT itself. Finally, there is limited qualitative research capturing the lived experiences of the AT end user in their own voice.

Literature Review

Universal Design

Universal Design (UD) is a framework that arose from the field of architecture with the intent of designing products and the environment to meet the needs of all individuals (McGuire, Scott, & Shaw, 2006). Since its conception, UD has been applied to the field of education as an approach to creating an inclusive environment in which all students are able to learn, known as Universal Design for Learning (UDL) (Black, Weinberg, & Brodwin, 2015).

UDL is an approach to learning that focuses on the student (Black et al., 2015). In an effort to enhance student learning by providing a flexible learning environment, UDL is governed by three principles: multiple means of representation, multiple means of engagement, and multiple means of expression (Black et al., 2015). The intent of multiple means of representation is to provide a variety of ways for students to acquire instructional material (e.g. lectures, videos, and guest speakers). The intent of multiple means of engagement is to provide a variety of ways for students to interact with instructional material (e.g. in-class activities and discussions). The intent of multiple means of expression is to provide a variety of ways for students to demonstrate their learning of the instructional material (e.g. papers, exams, and projects) (Black et al., 2015; Izzo, 2012; Schelley, Davis, & Spooner, 2011).

While research has largely focused on UDL in a K-12 setting, a UDL presence is increasing in institutions of HE (Rose, Harbor, Johnston, Daley, & Abarbanell, 2006; Chodock & Dolinger, 2009; Davies, Schelly, & Spooner, 2013). Studies highlight the potential of UDL to be effective in HE and encourage the implementation of UDL principles in colleges and universities (Black et al., 2015; Davies et al., 2013; Gradel & Edson, 2010). However, most research in HE focus on the instructors' point of view when implementing UDL rather than the impact of UDL

on student outcomes (Davies et al., 2013). The limited research on UDL and student performance in HE shows students with and without disabilities benefit when UDL principles are implemented by faculty, as indicated by increases in self-motivation, focus, and success in their learning (Black et al., 2015; Garrison-Wade, 2012). More research is needed regarding the effects of UDL implementation in institutions of HE on student performance, such as time management, self-regulation, and academic skills. While UDL aims to promote learning for all students, students with disabilities largely benefit from UDL (Davies et al., 2013)

Disabilities and Higher Education (HE)

Common disabilities. Over the past 50 years, the number of students attending institutions of HE has been rising; therefore, subsequently, the number of students with disabilities enrolled in HE has also increased (Snyder, de Brey, & Dillow, 2016). Sources, including the most updated data provided by the National Center for Education Statistics, found that 11% of undergraduates reported a disability, which under represents the national percentage of adults with disabilities at 26% (Centers for Disease Control and Prevention, 2018; Madaus, 2011; Snyder, de Brey, & Dillow, 2016). Nonetheless, a variety of reported disabilities exist in institutions of HE, as demonstrated by California State University's (CSU) Fall 2016 report of students with disabilities enrolled in their 23 campuses. The three most reported disabilities on CSU campuses were learning disabilities (LD) (22.5%), psychological and psychiatric disabilities (19%), and attention deficit disorder (ADD) and attention deficit hyperactive disorder (ADHD) (17%). Other reported disabilities were mobility limitations, temporary disabilities, autism spectrum disorder, hearing impairments, visual limitations, acquired brain injuries, and communication disabilities (The California State University, 2016). While these statistics are specific to CSU, Lisa Haydon, the interim manager of the Accessibility and Disability Services

Office at Dominican University of California (DUC), confirmed that the makeup of students with disabilities at DUC is comparable to that of most colleges and universities in the United States (personal communication, September 19, 2018). Students with disabilities are expected to navigate living with their self-reported disability and adjust to participating in occupations, including the specific academic demands of HE.

Higher Education learning and demands. Entering HE and obtaining a college degree is often seen as the gateway to a financially secure future. Within the United States, degree completion is predictive of stable employment and higher earnings (Fleming, Edwin, Hayes, Locke & Lockard, 2018). As the number of students entering college rises, the number of students graduating from college also rises (U.S. Department of Education, National Center for Education Statistics, 2003a, 2004, 2005). Nettles (2017) found that unemployment rates in turn decrease with each level of degree completion. For example, a group ranging from 25 to 34-years-old dropped from having an unemployment rate of eight percent for those with a high school diploma to three percent for those with a bachelor's degree or higher (Nettles, 2017). In order to graduate from college, students must learn to transition and successfully adapt to the demands and expectations that is required of a college student. Factors that influence student retention and graduation rates in college include average class size, student academic preparation, and finances (Millea et al., 2018). Students must not only learn to adapt to an increase in the student to faculty ratio, challenging courses, and rising tuition costs, but also learn to cope with being away from home and the pressures of becoming an adult. While the transition to college may be difficult for students, it has been found to be an even greater challenge for students with disabilities (Adams & Proctor, 2010). In a study comparing students without disabilities to students with disabilities, those without disabilities scored higher for their overall

adaptation to college including their social adjustment, institutional attachment, and semester GPA (Adams & Proctor, 2010). For students with disabilities, further factors have been found to influence their college adaptation, such as adjustment to disability, self-regulation, and self-advocacy (Adams & Proctor, 2010).

Within HE, students are also faced with the expectation of highly autonomous learning (Maydosz & Raver, 2010). Although differentiation of instruction is an expected practice in K-12, the same expectation does not exist in HE (Maydosz & Raver, 2010). As a result, lectures continue to be the primary method for communicating class content. The act of note taking during lectures is an academic task which presents a hurdle for students both with and without disabilities. A typical student takes notes on only 11-70% of the information provided in lecture, and students with disabilities may record even less (Maydosz & Raver, 2010). Specifically, academic hurdles for students with disabilities may include: not writing/typing fast enough, deciding what to record, paying attention, and understanding the notes taken (Maydosz & Raver, 2010). As an academic skill, note taking requires both self-regulation and cognitive processing. Self-regulation is a self-directed learning process which occurs in three phases: forecast, execution control, and self-reflection (Yot-Dominguez & Marcelo, 2017). Because the ability to review lecture notes is essential to preparing for exams, note taking is often considered essential to academic success (Maydosz & Raver, 2010). The barriers to academic success in HE are many, and are even more pronounced for students with disabilities.

Barriers to academic success. Additional barriers for students with disabilities in HE include difficulties with managing both personal and academic responsibilities. At the personal level, psychosocial factors such as academic self-efficacy, stress and time management, organization and attention to study, and emotional satisfaction with academics can impact

success in HE settings (Fleming et. al., 2018). Furthermore, under the Individuals with Disabilities Education Improvement Act (IDEIA 2004), students experienced high levels of parent advocacy and student-teacher contact during K-12. However, upon entering HE, those same students are expected to become self-advocates without necessarily understanding the process. In order to receive accommodations, students are first required to disclose that they have a disability to the disability services office (Squires, Burnell, McCarty, & Schnackenberg, 2018). This transition from K-12 to HE can be confusing and challenging (Squires et. al., 2018). For some students, the reduced level of parent/teacher support in HE can impact their ability to function academically (Fleming et. al., 2018). Other students may choose not to disclose their disability status for various reasons including stigma and the attempt to assert their independence (Squires et. al., 2018). As a result, these students do not receive the services and accommodations which could support their academic success (Squires et. al., 2018). This could lead to academic distress, defined as a student's concerns with their perception of academic functioning and performance (Fleming et. al., 2018). High academic distress is one barrier in HE which results in interference with learning, performance, retention, and graduation (Fleming et. al., 2018). Additional barriers include a lack of awareness of institutional support, financial distress, perceived stigma, and a lack of understanding of faculty and staff (Squires et. al., 2018). These barriers in turn may lead to a rise in academic distress and could result in increased attrition rates for students with disabilities (Fleming et. al., 2018). While quantitative research on these specific barriers for students with disabilities exists (Fleming et. al., 2018), our study aims to fill the gap in qualitative research by focusing on the lived experience of the students themselves (e.g. their voice and contexts) via an occupation centered lens. In order to provide

context, we need to first understand the current supports which are available in HE for students with disabilities.

Support Services for Learning in Higher Education: Then and Now

History of supports in Higher Education. The field of HE and disability services has been in place since the late nineteenth century (Madaus, 2011). The earliest efforts date back to 1864, with President Lincoln's work to sign into law a bill that "authorized the establishment of a college division at the Columbia Institution for the Deaf and Dumb", resulting in the first graduating class in 1869, including both men and women (Madaus, 2011, p.5). Following into the early to mid-twentieth century, the Vocational Rehabilitation Act of 1918 was passed after World War I to provide educational assistance for veterans with disabilities. This influx of veterans over the years paved the way for a large increase in students with disabilities enrolling in college, and generated disability services like transportation facilities (e.g. special elevator privileges, parking privileges, etc.), housing facilities (e.g. first-floor rooms, homes close to campus), and classroom facilities (e.g. priority seating and registration, provision of readers and note takers) (Madaus, 2011). Prior to the 1960's, these efforts focused primarily in physical disabilities. After the civil rights movement, in conjunction with a myriad of educational legislation, the term *learning disability* became designated by the federal government, and heralded the Vocational Rehabilitation Act of 1973. Section E of Section 504 of this piece of legislation is arguably one of the most important components in relation to postsecondary education, requiring institutions, both public and private, to consider the applications of qualified students with disabilities to implement necessary accommodations and auxiliary aids for students with disabilities (Madaus, 2011). It had an incredible impact on the access to postsecondary education for students with disabilities, and addressed discrimination on the basis of a disability,

ending the practice of counseling students with disabilities into more restrictive majors and careers. Today, the field of postsecondary education and global disabilities now serves an estimated 11% of all students in HE (Madaus, 2011).

Current HE Supports and Ongoing Challenges

With this rapid expansion, the current landscape of the field has begun to take shape with the growing number of students with disabilities and the types of services that have evolved. Institutions have embraced new demands, in addition to new considerations related to service delivery and policy. Based on a qualitative study looking at factors impacting outcomes in HE, Garrison-Wade (2012) identified the following supports: "self-awareness, self-determination and advocacy, self-management, adequate preparation for college, and assistive technology", as some of the foundational benefits for students with disabilities in HE (p. 114). In order to meet the academic needs of students with disabilities, many universities host programs and groups on campus that provide extra services like note-taking, tutoring, and/or special accommodations for test-taking. However, in order to qualify for such services, students must choose to report their disability to the university in the form of documentation from a medical professional, leaving many students with unidentified troubles and frustrations to fall through the cracks where services are not provided. While initial acceptance, enrollment, and attendance for students with disabilities is on the rise, only 12% of these students go on to graduate in HE (Garrison-Wade, 2012). Thus, while strides have been made regarding accommodations for students with disabilities in HE, the reality is that students with disabilities still face frustration in postsecondary education, and are at greater risk of leaving college before they graduate (Ferguson, 2017).

One of the difficulties proposed with the current support services in HE is the heavy dependence on students' ability to self-advocate and initiate their own access to services at the start of their collegiate career (Ferguson, 2017). This can be a large adjustment from grades K-12, when students were supported by the 504 and IEP process, often with marked parental involvement. In contrast, a college student, now a legal adult, must feel confident, secure, and/or welcomed to consult with an accessibility advisor to discuss a disability and appropriate classroom accommodations; yet, not all students with disabilities who need support are seeking out these services (Ferguson, 2017). One survey showed 93% of students with disabilities polled indicated feeling "stupid", "embarrassed", or "ashamed" of their learning challenges (Ferguson, 2017). Furthermore, surveyed students identified common barriers that existed in HE. These included accessibility issues, negative attitudes expressed towards students by both faculty and peers alike, and an identified need to address disability awareness (Ferguson, 2017). This leaves a large amount of students with disabilities struggling to bridge the gap between adjusting to college life while simultaneously identifying and accommodating to their new, college level academic needs. For example, attempts have been made to provide accessible content through electronic course delivery, yet the primary method continues to be class lectures. Although note taking is used to record information presented in lectures, this practice serves as a challenge for students with disabilities who do not qualify for note taking accommodations or who have trouble seeking out such services. Thus, note taking as a critical component to success can be a limiting factor for students with disabilities. More research is needed on UDL solutions that promote an inclusive learning environment for the success of all students, including those with disabilities.

Individualized support services. Other on-campus resources include university counseling centers, which are available to assist students in addressing personal concerns and promoting academic success (Fleming et. al., 2018). Zeng et al. (2018) sought to evaluate the effectiveness of such comprehensive support group programs that offer individualized or group intervention designed to address each student's needs. These programs not only improved students' academic skills, but also improved self-awareness, self-efficacy, and self-advocacy (Zeng et al., 2018). Students with learning disabilities who received student-centered interventions improved their academic success and developed strategies such as self-regulation, self-determination, and time management. Zeng et al. (2018) conducted a comprehensive literature review to investigate academic interventions designed to improve academic success, and discovered that programs which focused on students' personal strengths and creating individualized strategies allowed students to generalize learned skills to other courses and challenges. Overall, Zeng et al. (2018) found that comprehensive support programs that utilize student-centered support are shown to promote long lasting academic success. Thus, because the IDEIA does not cover individualized supports for post-secondary education, we believe HE students would benefit from student-centered designed services. This study aims to support student-centered services and enhance academic satisfaction by taking a personal approach through one-on-one interactions which include providing expertise on AT application use in conjunction with AT application that supports UDL. This study aims to expand upon Zeng et al. (2018) findings on the benefits providing individualized support to promote and maintain self-perceived academic success and performance by incorporating AT and individualized supports. Therefore, in this research, personalized support and one-on-one interactions with students in

combination with AT applications were utilized to support academic success and satisfaction among all students in HE.

Assistive technology used for learning strategies. The IDEIA is the most current legislature that defines AT. IDEIA defines AT as "any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of a child with a disability" (IDEIA 2004, section 300.5). AT in HE has been shown to enhance academic success and increase the effectiveness of learning strategies (Malcolm & Roll 2017; Heiman & Shemesh, 2012; Heiman, Fichten, Olenik-Shemesh, Keshet & Jorsensen, 2017; Yot-Dominguez & Mercelo, 2017). According to the National Center for Education Statistics report (2013), 70% of degree granting postsecondary institutions report AT as a core support to meet the needs of students with a disability (National Center for Education Statistics, 2013). Beyond this, faculty are delivering content in electronic formats, which is increasing the demands among students with disabilities to have access to AT learning tools that allow them to successfully interact with digital content (Malcolm & Roll, 2017). Other studies have shown that between 30 and 50% of students with disabilities required some form of adaptive software or hardware to enable them to use e-learning and other information and communication technologies effectively (Fichten et al., 2006). Weis, Dean, and Osborne (2016) reported that almost 70% of clinicians recommended that students with LD use AT, such as recorded books, text-to-speech, speech-to-text, calculators, spell-checkers, etc. Despite this increasing reliance upon AT as a method to support learning of college students with and without a disability, there is a limited amount of research published describing the use of AT, the user experience, and the impact of AT on specific academic tasks and learning strategies. This research study was designed to address some of those gaps.

Mainstream technology. Heiman and Shemesh (2012) revealed students with disabilities access mainstream education technologies to a greater extent than their non-disabled peers. Mainstream education technologies encompass information and communication technologies (ICTs) which are computers, software, firmware, and services that are used to transmit, receive, and provide information (Heiman & Shemesh, 2012). Heiman and Shemesh discussed the utilization of ICTs as AT, and discovered that when ICTs were employed in this assistive manner, these technologies supported academic tasks such as writing, spelling, planning, organizing, editing, and calculation; in turn, users were able to study and express their needs (2012). It was also determined that ICTs provided "students with adaptive ways to compensate for their disabilities, enabling them to utilize compensatory academic skills" (Heiman & Shemesh, 2012, p. 2729). Therefore, AT, including mainstream technologies and ICTs, has been a vital part in helping students enhance academic achievement, regardless of a diagnosis (Heiman, Fichten, Olenik-Shemesh, Keshet & Jorsensen, 2017).

Digital technologies provided in HE. Success in HE relies heavily on a student's self-sufficient ability both inside and outside of the classroom (Kingsbury, 2015). Therefore, to nurture successful students, it is the institution's duty to develop independent learners inside and outside of the classroom (Yot-Dominguez & Mercelo, 2017). Due to the different demands of the HE system, students need to be provided with a variety of strategies to regulate cognitive, motivational, and behavioral aspects to reach the optimal level of student learning (Yot-Dominguez & Mercelo, 2017).

Interestingly, upon entrance to college, students have limited knowledge regarding the use of technology, mainstream, or otherwise for learning. Despite this, it was found that students selectively use a variety of technologies to self-regulate their learning on their own (Yot-

Dominguez & Mercelo, 2017). Yot-Dominguez and Mercelo (2017) found when digital technologies were provided and supported in a HE setting, learner's engagement with instructional experiences and constructing knowledge about self-regulation with study skills increased (2017). Despite such evidence, there has been no research found on the effectiveness of training or follow up provided by universities on digital technologies. Additionally, no research was found on individual student abilities to organize and manage their learning using digital technologies. This research aimed to fill in the gaps of providing individualized digital technology training and ongoing support integrated with capturing the lived experience of the students from their own voice and contexts of their AT use.

AT has been shown to increase a student's ability to enhance academic success and influence learning strategies. However, it has also been shown that university instructors neither require nor encourage AT use by students with or without disabilities (Yot-Dominguez & Mercelo, 2017). The aim of the study was to increase the evidence behind the importance of universities supporting all students to enhance their learning with AT to provide the best experience in college and their future careers. Student use of AT could be further enhanced by the support of OT within the HE setting.

Role of Occupational Therapy

Occupational therapy and assistive technology. AT interventions fall within the scope of practice, training, and expertise of occupational therapy (American Occupational Therapy Association, 2014). AT has been used by occupational therapists (OTs) with clients across the lifespan in various settings to enhance occupational performance. Specifically, OTs have training and expertise in activity analysis, environmental modifications, and universal design. Additionally, OTs have training in individualized assessment to determine the client-to-AT

match based on the client's unique needs and occupations. The Accreditation Council for Occupational Therapy Education (2012) has mandated that entry-level OTs have educational training in the use of AT to enhance occupational performance. OTs can use AT as both a means and an end to occupations, using technology as an aid to occupational performance, and to establish essential alternative options for occupational engagement (AOTA, 2016).

Occupational therapy and assistive technology in K-12 school settings. The use of AT in K-12 settings increases the participation and independence of students by providing them with access to school occupations including curriculum learning, classroom mobility, and communication strategies (Schoonover, 2014). OTs create and implement an AT plan that is specific to the needs of each student as part of an interdisciplinary team. The full continuum of AT is used in schools to support educationally based occupations including low tech devices, such as pencil grips and visual supports, to high tech devices such as augmentative and alternative communication devices, specific learning software, and mobile applications (apps). Considering the rapid advancements of app software, further research is needed to determine the effectiveness of app use in maintaining and enhancing occupations.

Occupational therapy, assistive technology use, & occupational engagement. Research has shown that both occupational therapy and AT supports are beneficial in the participation of daily tasks and maintenance of quality of life. In a study of participants with multiple sclerosis (MS), Gamueda et al. (2017) found the use of a mobile health app was effective in reinforcing the use of energy conservation management techniques taught by the occupational therapy student researchers. Use of the app resulted in reduced levels of fatigue and increased self-perceived performance and satisfaction in completing daily tasks. The study had significant results showing the combined use of occupational therapy and AT support in

conjunction with one another was an effective intervention. Further research needs to be done to analyze the use of high tech AT, such as apps, in combination with occupational therapy services and to determine if this method of service delivery would also produce positive results for other populations, such as students with disabilities in HE.

Advocacy in Higher Education. Currently, the IDEIA does not cover AT services or transition support for student accommodations in HE (Asselin, 2014). Rather, HE students are expected to seek out their own individualized support on campus such as through disability services. Students with disabilities in HE have reported limited access and decreased use of AT with 39% stating this deficiency is due to inadequate support services and evaluations (Asselin, 2014). In addition, students in HE report academic and disability support services focus more on a student's diagnosis rather than a student's contextual and functional needs to succeed academically in HE (Zeng et al., 2018). These findings suggest a need for holistic transition services and supports for students with disabilities and academic challenges, especially undergraduates who have recently entered HE. In order to support all students in HE, this study aims to promote advocacy efforts and need of individualized AT support through occupational therapy services in HE.

Occupational therapy, assistive technology, and Higher Education. OTs are concerned with the participation and engagement in everyday meaningful activities, known as occupations, to promote well-being and enhance individuals' quality of life (AOTA, 2014). Occupations occur and are influenced within a context that provide meaning, purpose, or utility that are unique to each individual (AOTA, 2014). We believe occupational therapy can address the support and service needs for students who face academic challenges in HE through their expertise in advocacy and promotion of self-advocacy (AOTA, 2014). Self-advocacy is the

ability to understand the nature of one's disability and to speak up for actions and needs to overcome individual barriers (Evers, 2012). Furthermore, OTs use AT as a preparatory method to promote successful intervention with their clients (AOTA, 2014). Because OTs are experts in occupation and AT has been shown to enhance engagement within occupation, especially for students, OTs are the perfect fit to facilitate AT use. With the expertise and collaborative support of an OT, we believe students with and without disabilities may be more informed on how to receive accommodations for academic supports and AT to promote academic success in postsecondary settings.

Summary and Conclusions

Based on the current evidence available regarding AT in HE for students both with and without disabilities, it is clear that strides have been made in developing access and considerations to service delivery and policy in order to meet the diverse academic needs of students. However, review of current research also reveals gaps in examining the effect of one-on-one support of students in combination with accessible AT applications on self-perceived academic satisfaction and performance. Finally, there is limited research from an occupation centered lens and few occupational therapy in HE supports despite AT being under the purview and expertise of occupational therapy as a profession. Therefore, the purpose of this study was to utilize an occupation based lens to examine the implication of specific AT within students' individual context in HE to foster effective self-regulation and time management in order to enhance satisfaction and performance in their chosen area of academia like note taking, writing essays, etc. Therefore, we implemented two separate apps. First, the BEST Suite© app which consists of three apps in one: Pace My Day, Reach My Goals, and Strategize My Life, which are designed to organize and prioritize an individual's goals and daily routine. Originally, this app

was designed to aid goal setting and self-regulation for individuals with traumatic brain injuries, therefore the implementation of this app in HE explores its use in other populations who may also benefit from these uses. BEST Suite© identifies goal related successes and challenges to assist users in developing strategies for success, which may be beneficial for undergraduate students and their academics. Second, Notability© was also implemented, and is a multi-modal note taking app which allows users to import audio, documents, and any combination of text, handwriting, or photos to annotate the document. This generates more ways for users to organize and take notes than other standard note taking platforms.

By combining individualized support sessions and AT apps, BEST Suite© and Notability©, as an intervention tool for students with and without disabilities, we examined how HE learning can be optimized to the needs of all students in a manner that supports their independence, yet still meets their individualized needs.

Statement of Purpose

Research Questions

How can Assistive Technology (AT) apps and individualized support impact college students' performance and satisfaction in an academic area of their choosing?

Sub-questions.

1. How do the AT apps Notability© and BEST Suite© impact performance and satisfaction for students with and without disabilities?
2. How do the AT apps Notability© and BEST Suite© with and without individualized support impact occupational performance and satisfaction for undergraduate students?
3. What AT features impact undergraduates with and without disabilities?
4. What is the lived experience of undergraduate students given AT with and without individualized support?

Theoretical Frameworks: Person – Environment – Occupation (PEO) and Andragogy – Adult Learning Theory

Person – Environment – Occupation (PEO)

The Person-Environment-Occupation (PEO) model, developed by Law, Cooper, Stewart, Letts, Rigby, and Strong (1996), explores the dynamic interaction between persons, their environments, and their occupations, and how the transactional relationship between these three components affect occupational performance. The model emphasizes the notion that when the fit between person, environment, and occupation is achieved, the outcome is the quality of a person's experience in regards to their level of satisfaction and functioning. According to the American Occupational Therapy Association (AOTA) (2014), the successful transaction between these three components is known as occupational performance. Essentially, the greater the degree of overlap of these dimensions (person, environment, occupation), the greater the degree of harmony or fit. Conversely, when there is a shift in one component of the model, the other components are thus affected and areas of occupational performance are negatively impacted. Therefore, the model considers this transactional relationship occurs over the lifespan in congruence with changes in a person's age and health, and as the person moves through life cycles and developmental phases. Using the PEO theoretical framework to address the specific variables of a person, their environments, and their occupations, this research study explored the effectiveness of using the Notability© and BEST Suite© apps with undergraduate college students to help achieve optimal occupational performance and satisfaction. These AT interventions along with our outcome measures will consider the participants' roles as students, their individual attributes, skill sets, values and beliefs, and the specific environments in which they engage in HE occupations.

The first component of the PEO model is P- person and considers the person a distinct and holistic being, while assuming multiple roles varying in degree of importance. The person provides the context with a set of attributes, skills, knowledge, and experience. The use of BEST Suite© can enhance a person's self-regulation skill set and the ability to manage task loads more efficiently, thus furthering personal satisfaction with completing daily tasks and fulfilling their roles as students. This could include time managing homework, organizing work and school schedules, managing overwhelming feelings during exam times, and prioritizing workload. Additionally, Notability© can serve as a useful tool to cater to the individual needs of the unique student's learning style when partaking in the occupation of note taking. In turn, this individualization may increase the chance of self-satisfaction and performance of school-related occupations.

The second component, E - environment, includes the context within which occupational performance takes place (Law et al., 1996). It is important to consider the cultural, institutional, physical and social factors present when considering an individual's environment, and in what regard each factor may be hindering or enhancing one's occupational performance. The BEST Suite© app allows users to create strategies for optimal task completion, reminding the user to employ these modifications within their environment in order to avoid fatigue and frustration when completing a task. Additionally, the availability of the apps on personal devices allows for the user to employ these apps in their preferred environment, creating more opportunities for innovative ways to complete school work within an array of contexts. Notability© can impact the environment of a student by changing the way they interact with their device during class time or studying. Notability© can influence a student's environment in similar ways as BEST Suite©

because it is available on an individual's personal device and therefore available when and wherever the individual prefers.

The third component, O - occupation, refers to meaningful activities and tasks in which people engage in throughout the lifespan while carrying out various roles in multiple environments. Occupations satisfy an intrinsic need for self-maintenance, expression, and life satisfaction, and are carried out within an individual's multiple contexts (Law et al., 1996). Examples of occupations include activities of daily living (grooming, feeding, etc.), instrumental activities of daily living (such as cooking, cleaning, and driving), leisure activities and work. Using the BEST Suite© app, an individual can gain skills, such as time management, to better engage in an area of occupation(s) of their choosing. By employing and documenting self-regulation and time management strategies, individuals complete occupations of their choice at optimal performance and efficiency. This can allow for more time and energy for engagement in occupations such as leisure activities and work, which in return allows for a well-balanced lifestyle. For students specifically, BEST Suite© has the potential to improve engagement in school-based occupations (e.g., test taking, studying, reading, writing, group work, assignment completion, etc.), socialization (e.g., clubs, organizations, friends, volunteer work, employment, religious affiliations, etc.), and household management. Additionally, for college students, discovering and using a tool like Notability© can increase the likelihood to meet the demands of note taking by individualizing the occupations of studying and learning in order to enhance performance and satisfaction in these areas. Due to the large correlation between success in the classroom and note taking (Maydosz & Raver, 2010), Notability© may be able to increase perceived satisfaction and performance as a student. This may produce an increase in self-efficacy and ability to engage in preferred occupations.

Andragogy – Adult Learning Theory

Andragogy, also known as adult learning theory, supports this research. Developed by Malcolm Knowles, it refers to the art and science of adult learning and is used as a framework to teach adults (Bastable, 2011; Knowles, Swanson, & Holton, 2012). Andragogy places more focus on the participation of the adult learner and less focus on the facilitation of the teacher. As learners mature throughout adulthood, there are several basic assumptions of andragogy. The primary assumptions state that as an individual matures, their self-concept develops from being a dependent personality to an independent personality that is self-directed. With maturity comes exposure, which can be used as a resource for learning. These experiences can shift an adult's application of knowledge to being problem-centered instead of subject-centered (Bastable, 2011).

Based off of the aforementioned assumptions, adult learning theory states that adults need to be involved and play an active role in the planning, implementing, and evaluating of their learning as opposed to having a teacher-centered method (Bastable, 2011). Unlike the child learner who mostly depends on an instructor for learning, the adult learner is more independent and self-directed in seeking out new knowledge and information. Because undergraduate students are transitioning from childhood to adulthood, their self-directedness is still developing and maturing. By using AT, such as the Notability© and BEST Suite© apps, students will have the appropriate tools to take an active role in their learning and utilize various features of the apps to plan, implement, and evaluate their learning. The Notability© app can increase independence in learning by providing a variety of unique note taking features that can be tailored to different learning styles, such as tools for handwriting, drawing, audio, and pictures. The BEST Suite© can enable self-directed learning by giving the student a tool to set reminders

for time management, utilize strategies for self-regulation throughout a task, and set goals towards academics such as reading and assignment completion. Because both apps offer numerous features, students are able to choose, utilize, and evaluate the features that are most beneficial for their learning.

Andragogy also states that as adults mature, they use the information learned from their own personal experiences as the basis for additional learning (Bastable, 2011). As both Notability© and BEST Suite© apps provide a method of task-oriented learning, students will have the opportunity to learn from their experiences and mistakes as they develop time management, self-regulation, and other academic skills. By utilizing Notability© for note taking, students will learn from their experiences and mistakes to determine a note taking strategy and which unique features is most beneficial for their unique learning. By utilizing BEST Suite©, the students may not only be able to utilize the app to learn which strategies work best for them, but also be able to monitor and track their progress by utilizing the chart feature that shows their progress with tasks throughout each day.

Because adult learning is problem-centered, one of the prime motivators to learning is having the knowledge and skills necessary to solve immediate problems (Bastable, 2011). Adults are motivated to learn, develop new behaviors, or change old behaviors when they are aware of how relevant the effort will be to their lives and what benefits they will receive as a result. Each student who transitions into both adulthood and HE has a different background, experience, and motivation for learning. The Notability© and BEST Suite© apps can provide a vehicle for problem solving as there are a multitude of tools available to the user. The diverse features of Notability© may promote identification of which note taking and study techniques are problematic for the student. BEST Suite© promotes self-identification of strategies towards goal

achievement, such as academic-related goals. By prioritizing goals, each student will be aware of what tasks are most relevant and beneficial to their lives. By including methods that specifically utilize qualitative interviewing and a self-reported measurement on satisfaction and performance, as well as utilizing the Higher Education Learning Performance and Satisfaction Scale (HELPSS), this research examined how students identified the occupations they desire to improve on and how AT can assist them in achieving those goals.

Ethical Legal Considerations

Student researchers obtained approval to conduct this study from the DUC Institutional Review Board for the Protection of Human Participants (IRBPHP #10706) on November 7, 2018 (Appendix I). This study followed full board IRB review guidelines, due to the inclusion of a vulnerable population, set by the IRBPHP and student researchers followed the American Occupational Therapy Association (AOTA) Code of Ethics, upholding the principles of beneficence, nonmaleficence, autonomy, confidentiality, and social justice during implementation and design.

The principles of beneficence and nonmaleficence requires researchers to ensure and protect the wellbeing of participants, eliminate any potential harm, and inform participants of any potential risk and benefit while conducting this study and dissemination of research (AOTA, 2015). To observe these ethics student researchers informed participants of all potential risks, costs, and benefits in the Consent Form and Bill of Rights (Appendix B) prior to the start of the study. Potential risks included potential distress when discussing topics of personal nature and potential discomfort when using the provided apps. Researchers addressed these risks by informing participants of their right to choose to not disclose any personal information and their ability to withdraw from the study at any time without any repercussions. Additionally, researchers provided participants with online and in-person training to optimize access, proficiency, and reduce potential frustration from using novel apps. Furthermore, student researchers conducted themselves in a professional and ethical manner during on-campus meetings and online support for participants.

The principle of autonomy and confidentiality require student researchers to observe and respect the rights, beliefs, privacy, and consent of participants (AOTA, 2015). Student

researchers upheld these principles by assuring each participant's identifying information was kept confidential by using a participant ID on all forms and participant data was stored in a password protected computer in a faculty advisor's locked office. Only student researchers and a faculty advisor were provided access to the data. To ensure autonomy, all participants determined their top three academic challenges to program into the BEST Suite© during the HELPSS pre-test (Appendix E).

Under the principle of social justice student researchers are expected to promote fair and equitable treatment of all participants (AOTA, 2015). While this study was limited due to the exclusion of participants who did not own a MacBook, iPhone, or iPad (based on app compatibility limitations); student researchers made the BEST Suite© and Notability© apps complimentary for all participants. Further, to ensure all participants received support throughout the study both the ATIG and non-ATIG received on-line support and opportunity to collaborate with student researchers through the Weekly Check-in Forms (Appendix F).

To assure informed consent, participants were given a form to legally consent and sign (Appendix B), which included a description of the study's procedures and a copy of their Bill of Rights. Participants had all expectations explained clearly to them in person and were able to ask questions during the consenting process. Again, participants had the right to refuse participation and withdraw from the study at any time without any adverse consequences.

Methodology – Mixed Methods

Design

This research had a recruitment goal of 20 undergraduate students from DUC. Recruitment was completed using a convenience sample with dissemination of a recruitment flyer (Appendix A) on DUC campus. Eleven students were recruited (N=11), consented (Appendix B), and given both the BEST Suite© and Notability© apps free of charge, as funding for this research was supported by a Competitive Research Grant from the School of Health and Natural Sciences from DUC. In the pre-screening form (Appendix C), students self-identified whether or not they have a disability. Our total sample (N=11) was then divided into students self identifying with disabilities (n=4) and students who did not identify as having a disability (n=7). Further, a randomized control design was used to assign the students from each grouping, with disabilities and without disabilities, to either the AT intervention group or the non-intervention group (Table 1). All participants received the software in December 2018 to January 2019. The intent of this early distribution was to allow participants time over the winter break to become familiar with the AT. However, in order to achieve a larger sample of participants, recruitment rolled over into the beginning of spring semester, so several participants received the software after winter break. During Spring semester, specifically the first two weeks of February, all participants (N=11) received live, in-person training on the AT from the occupational therapy student research team to further support the participants on their use of the AT. As well, participants were provided with redemption codes to access additional training online, which included videos and detailed step-by-step guides of how to use the AT. Following training, participants underwent the eight week study during the Spring semester of 2019 (Table 1).

Research Design		
RCT N=11	Intervention Group: AT and Support	Control Group: AT Only
Self-Identifies with a Disability	n=2	n=2
Does not Self-Identify with a Disability	n=4	n=3

Table 1 Research Design

Quantitative Data

This study utilized a mixed-methods pretest-posttest design. The HELPSS was a baseline and outcome measure (Appendix E) designed specifically by the researchers for this study and was based on the Canadian Occupational Performance Measure (COPM) (Law et al., 1990). The COPM has successfully been adapted for occupational therapy and AT research in previous studies (Malcolm & Roll, 2017; Gameuda et al., 2017). Participants were asked to respond to the HELPPS at baseline and again post-AT intervention in order to examine whether undergraduate students with and without disabilities report improved performance and satisfaction academic occupations of their choosing after using BEST Suite© and Notability©. Over an eight week period, the participants were asked to use the Notability© app for a class of their choice. Participants were also asked to choose an area of improvement to track in the BEST Suite© app, such as tracking goals, time management strategies, organization skills, self regulating strategies, or pacing their day. Additional measures included weekly check-in forms (Appendix F) and BEST Suite© reports. In the final analysis, BEST Suite© reports were not used.

Qualitative Data

Qualitative data was utilized to examine the lived experience of participants. Semi-structured interviews were used upon completion of the eight week study (Appendix H). Grounded theory and the constant comparison method were the foundations for the qualitative analyses and coding (Dye, Schatz, Rosenberg, & Coleman, 2000; Saldana, 2009). Data analysis for qualitative data was conducted using Dedoose Version 8.0.35 (Dedoose Version 8.0.35, 2018). Coding rigor was established across six researchers for 18% of all data (two of 11 transcripts) was coded to 100% consensus. The remaining data (nine out of 11 transcripts) was coded to 100% consensus among reliable research pairs. There were multiple coding meetings to generate categories and themes among all student researchers and faculty. All disagreements were addressed through discussion ending in consensus to modify any changes to the coding scheme. Categories and themes were arrived upon via consensus across six researchers and the faculty mentor.

Participants and Recruitment Procedures

This study recruited undergraduate students from DUC from the distribution of a flyer (Appendix A). The flyer was emailed through the Dominican University Disability Services Office, the athletics department, and undergraduate student life. The flyer was also posted in undergraduate dorms, in classrooms, throughout different areas of campus and tabled in front of DUC's dining hall. Additionally, the research team shared the flyer and information through several DUC undergraduate classes, such as Positive Psychology and Introduction to Occupation.

DUC undergraduate students self-selected to participate in the research and replied to the recruitment flyer via email. Students who emailed for participation were provided with a Pre-

Screening form (Appendix C) to ensure they qualified for the study. Inclusion criteria included: A) 18 years of age or older, B) have personal access to an iPhone, iPad, and/or MacBook, C) have a self-reported ability to motorically use a touch screen and/or traditional keyboard, D) are enrolled as a full-time undergraduate student at DUC, and E) are able to follow step-by-step directions. Exclusion criteria included individuals with a motor access limitation or mobility disability that would prevent usage (per item C above), individuals who have previous experience using the BEST Suite© or Notability© apps, individuals who do not have access to Apple products with iOS compatibility necessary to run the apps, and part-time students. There were no restrictions based on major, gender, race, ethnicity, or socioeconomic status.

Recruited participants in this study were female undergraduate students (N=11), ages 18 to 22. The undergraduates were in their first (n=8), third (n=2), and fourth (n=1) year of college, with majors in nursing (n=6), occupational therapy (n=2), psychology (n=2), and international studies (n=1). Participants who self-identified with a disability reported a diagnosis/disability of learning disability (n=2), attention deficit disorder (ADD) (n=1), psychological/psychiatric (n=2), fibromyalgia (n=1), dyscalculia (n=1), and generalized anxiety disorder (GAD) (n=1). Two of the four participants who self-reported a disabling condition, reported more than one condition (Table 2).

Participants with a Disability	Diagnosis
A	Psychological/psychiatric-related
B	Fibromyalgia Psychological/psychiatric-related
C	Learning disability Dyscalculia Generalized Anxiety Disorder (GAD)
D	Attention Deficit Disorder (ADD)

Table 2 Participants with a Disability Note. n=4

Descriptions of Measures

This study utilized a pre-screening form (Appendix C), an intake form (Appendix D), the HELPSS pre- and post-AT intervention (Appendix E), weekly check-in forms (Appendix F), assistive technology intervention notes (ATIN) for those subjects randomized into the intervention group (Appendix G), and semi-structured exit interviews (Appendix H). Quantitative data included the HELPSS and weekly check-ins. Qualitative data included the pre-screening form, intake form, ATIN, and exit interviews. These extensive measures were utilized before, during and after the eight week intervention period (Table 3). The qualitative data from this study is intended to fill the gaps regarding lived experiences of AT in HE in current research. The pre-screening form, intake form, and HELPSS were taken prior to the intervention at baseline. The weekly check-in form and the ATIN were completed throughout the intervention phase of the study. The HELPSS and semi-structured exit interviews were completed post-intervention. (Table 3).

Timeline of Measures		
Data collected at baseline	Data collected throughout the intervention phase *(approx. 8 weeks)*	Data collected post-intervention
All Participants: ● Pre-screening form ● Intake form ● HELPSS	All Participants: ● Weekly check-in form Intervention Group: ● ATIN	All Participants: ● HELPSS ● Semi-structured exit interview Intervention Group: ● Additional questions in exit interview regarding intervention group experience

Table 3 Timeline of Measures

Pre-screening. Prior to consenting, all participants completed the pre-screening form to determine their eligibility to participate in the study (Appendix C).

Intake form. All participants completed an intake form (Appendix D) following the pre-screening and consent (Appendix B). In addition to garnering information about the participants' date of birth, gender, undergraduate year, expected graduation date, and major the intake form gained information about the participants' use of technology in education, use of services at DUC, and self-identification with any specific diagnosis(es). Participants had the opportunity to choose not to state any diagnoses.

Higher Education Learning Performance and Satisfaction Scale- HELPSS. All participants completed the HELPSS in order to obtain quantitative data on performance and satisfaction at baseline and post-intervention (Appendix E). As previously mentioned, the HELPSS was designed by researchers based on modification to the COPM as these types of modifications have successfully been used in previous AT research (Law et al, 1990; Malcolm &

Roll, 2017; Gameuda et al., 2017). The HELPSS, pre- and post-intervention, through a Google Form to measure self-perceived performance and satisfaction on areas of learning in the following areas: time management, self-regulation, organization, note taking, studying, test taking, reading, writing, assignment completion, group work, or another area of learning identified by the participant. Two scores were obtained from the HELPSS, one score indicating self-perceived performance and the other score indicating self-perceived satisfaction with performance. The scores ranged from one to ten, with one being the lowest level and ten being the highest level of self-rated performance and satisfaction. Clinically meaningful change scores in performance and satisfaction were analyzed using a study on the COPM by Eyssen et al. (2011), who identified that a mean change score of 0.9 in performance and 1.45 in satisfaction are each considered a clinically meaningful change.

Weekly check-in form. All participants completed the weekly check-in form (Appendix F) to gather qualitative and quantitative data of their ongoing use of BEST Suite© and Notability©. Weekly check-in forms were distributed via email each week and completed on a Google Form. Participants were asked which task or class they used the apps, what features of the apps they used, and how satisfied they were with the app on a ten-point scale ranging from "not satisfied at all" to "extremely satisfied". Participants were also offered an opportunity to ask questions and/or leave comments for the researchers as part of the weekly check-in form.

Assistive Technology Intervention Notes (ATIN). Participants who were randomized to the Assistive Technology Intervention Group (ATIG) received individualized AT support. ATIG participants had the option to receive support in person, over a video chat, or via a phone call in a non-public place. ATIG participants received support regarding the use of AT up to three times during the course of study and qualitative data was gathered for each meeting using the ATIN

(Appendix G). In order to provide individualized AT support, participants were asked questions based on their personal goals as identified by the HELPSS pre-test. Further information was gathered regarding participants' use of BEST Suite© and Notability©, the helpfulness of the apps, and participants concerns or needs for assistance regarding the apps. Our final analysis did not include the ATIN data, rather the ATIN information was used as a guide for the OT student researcher to customize the AT support as needed for those randomized to the ATIG.

Exit interview. Student researchers conducted in-person, semi-structured exit interviews (Appendix H) with all participants upon conclusion of the eight week intervention to obtain qualitative data regarding the lived experiences of the participants using the BEST Suite© and Notability© apps. Participants were asked questions, developed using the PEO and andragogy frameworks , regarding how they used the apps, what features of the app were most useful, and their suggested changes for the apps, if any (Law et al., 1996; Bastable, 2011). Participants who were part of the ATIG received additional interview questions focused on the impact of individualized AT support from OT graduate student researchers. Audio data from the exit interviews were recorded on researcher's personal devices (e.g. password protected laptop and password protected smartphone) and downloaded to a password protected Google Drive within 72 hours and then to non-identified USB drives in accordance with our IRB (#10706).

Study Process

Participants were recruited by a convenience sample of undergraduate students at DUC. Eligible students met with graduate occupational therapy student researchers on-campus and in-person to be informed of the study's purpose and procedures. Students were invited to sign an informed consent form and bill of rights (Appendix B). Once participants were consented, they were each randomly assigned an identification number to ensure confidentiality throughout the

eight weeks of the study, and given the Participant Intake Form (Appendix D), redemption codes for BEST Suite© and Notability© apps, and links to app training modules and videos. Participants attended an on-campus training session led by researchers. During the on-campus training, participants completed the HELPSS pre-test assessment (Appendix E).

All participants were given Notability© and BEST Suite© apps for use during eight weeks during the Spring semester of 2019. During this time, the target AT usage included use of Notability© for at least one academic course each week and the usage of BEST Suite© to track at least one academic task of their choosing. Participants completed weekly check-in forms (Appendix F) regarding Notability© and BEST Suite© usage via Google Forms. In addition, participants in the ATIG also received individualized AT support from OT graduate student researchers and focused on AT use for academic tasks. These participants were advised to meet with their assigned OT graduate student researcher three times (at approximately two weeks, four weeks, and six weeks into the study) either in-person, via video chat, or over the phone. These meetings were not held in public places and sessions were documented using an ATIN (Appendix G). Following the intervention phase, all 11 participants completed a post-test HELPSS (Appendix E) and an in-person exit interview (Appendix H). All exit interviews were audio recorded for transcription.

Data Collection

All data collection was completed in accordance with our IRB (IRBPHP #10706). Audio data was recorded on researcher's personal devices (e.g. password protected laptop and password protected smartphone) and downloaded within 72 hours to a password protected Google Drive, and then to non-identified USB drives. The USB drives were stored in a locked cabinet at DUC campus in the office of the faculty advisor in a locked closet that was only accessible through a

check out procedure by the research team. Participant data from intake forms, HELPSS (pre and posttest), and weekly check-ins were collected by Google forms. Qualitative data from participant experience in individualized support sessions was collected by ATIN (Appendix G) and facilitated by OT student researchers.

Data Analysis

Audio data from the exit interviews was transcribed using TRINT™ (2019). Qualitative data analysis was conducted via the constant comparison method (Corbin & Strauss, 2008) and were audio transcribed verbatim. Content coding was conducted via Dedoose® (Dedoose Version 8.0.35, 2018). In order to ensure rigor reliability, 18% data (two out of 11 transcripts) was coded to 100% consensus by six researchers. In addition, the remaining 82% (nine out of 11 transcripts) of data coded to 100% consensus in reliable research pairs. Categories and themes were discussed across several research meetings. Any disagreements or questions were resolved via discussion resulting in 100% consensus.

Results

To address the main research question, "How can AT apps and individualized support impact college students' performance and satisfaction in an academic area of their choosing?", four research questions were used to disseminate and further analyze the qualitative and quantitative data.

Research Question 1: How do the AT apps Notability© and BEST Suite© impact performance and satisfaction for students with and without disabilities?

All participants (N=11) completed the HELPSS to self-identify their top three most challenging academic areas and self-rate their satisfaction and performance in each area. Among the students with disabilities group (n=4), the reported challenging academic areas were time management (36.4%), test taking (18.2%), note taking (9.1%), reading (9.1%), group work (9.1%), self-regulation (9.1%), and assignment completion (9.1%) (Figure 1). Among the students without disabilities (n=7), the reported challenging academic areas were time management (26.1%), test taking (20.7%), note taking (15.2%), organization (10.9%), reading (10.9%), studying (10.9%), and self-regulation (5.4%) (Figure 4). The results of the pre-intervention and post-intervention HELPSS data was used to determine a mean change in self-reported performance and satisfaction scores over the course of eight weeks. In a separate study conducted on the COPM, researchers identified that a mean change score of 0.9 in performance and 1.45 in satisfaction is considered a clinically meaningful change (Eyssen et al., 2011). This metric was applied to this study.

Students with disabilities. Results indicate the students with disabilities reported clinically significant mean changes in performance (mean change score 0.9 or higher) for five out of seven challenging academic areas (Figure 2) - time management (*M*=1), note taking

(*M*=3), group work (*M*=2), self-regulation (*M*=2), and assignment completion (*M*=2) - as well as clinically significant mean changes in satisfaction (mean change score of 1.45 or higher) for four out of seven challenging areas (Figure 3) - note taking (*M*=2), group work (*M*=2), self-regulation (*M*=2), assignment completion (*M*=2).

Students without disabilities. Results indicate students without disabilities reported clinically significant mean changes in performance for six out of seven challenging academic areas (Figure 5) - time management (*M*=1.8), test taking (*M*=1.8), organization (*M*=1.3), note taking (*M*=1.7), reading (*M*=1), and studying (*M*=2) - as well as clinically significant mean changes in satisfaction for six out of seven challenging academic areas (Figure 6) - time management (*M*=2), test taking (*M*=2.5), organization (*M*=1.8), note taking (*M*=3), reading (*M*=2), and studying (*M*=2).

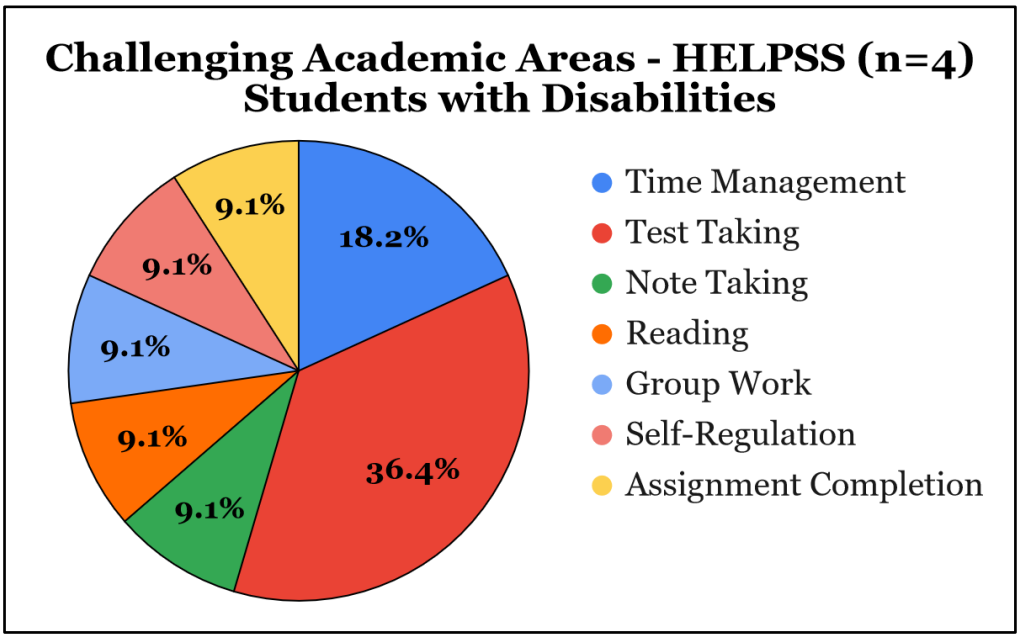

Figure 1 Challenging academic areas identified by the disability group

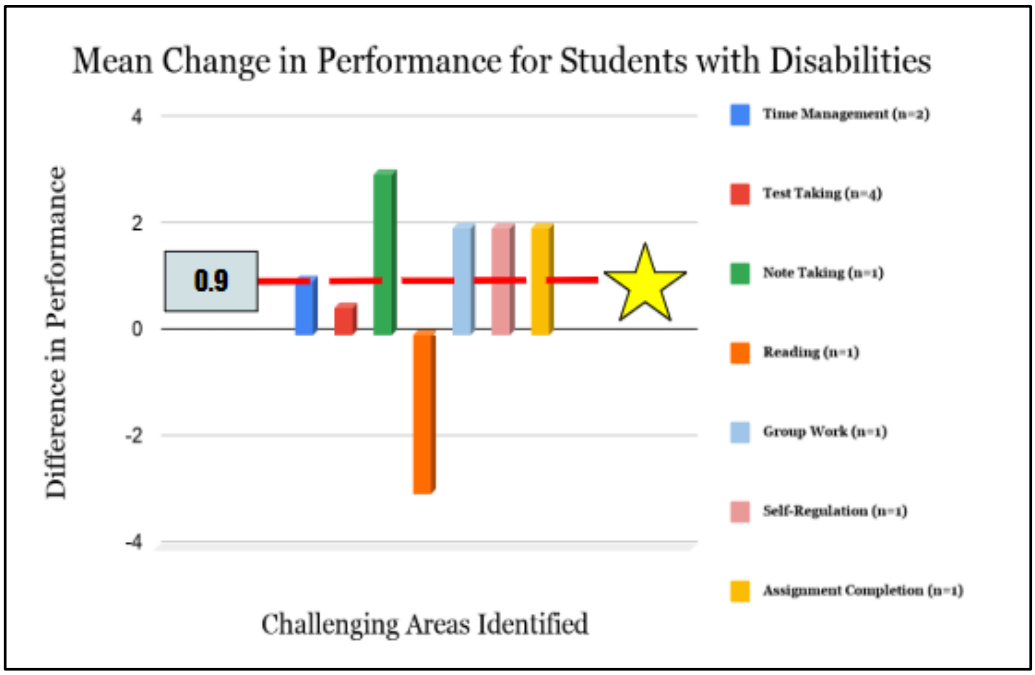

Figure 2 Mean change in performance based on pre/post-intervention HELPSS data for students with disabilities

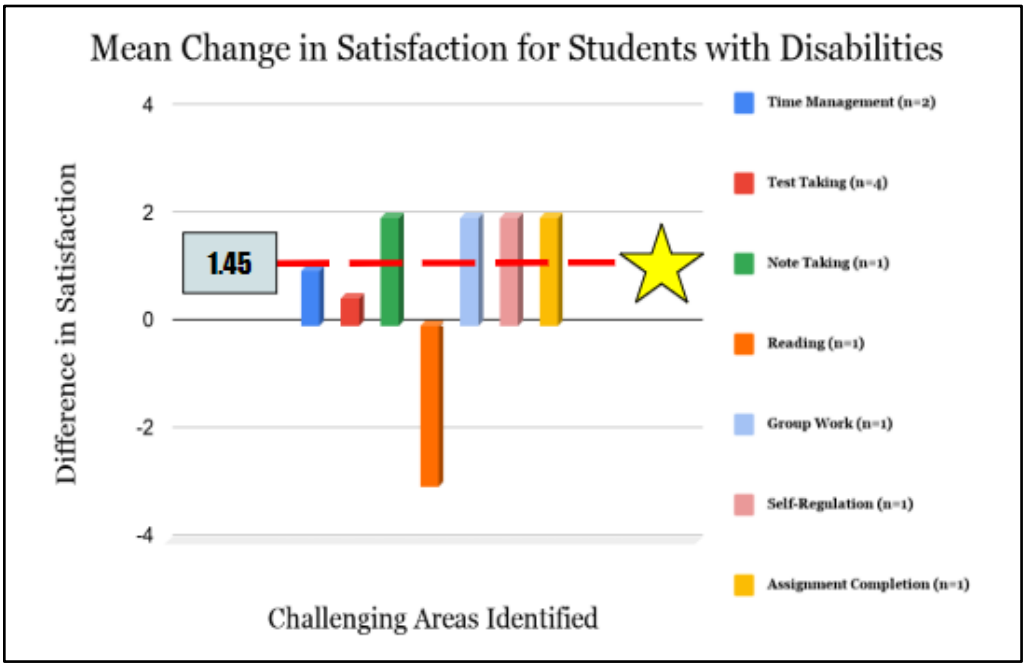

Figure 3 Mean change in satisfaction based on pre/post-intervention HELPSS data for students with disabilities

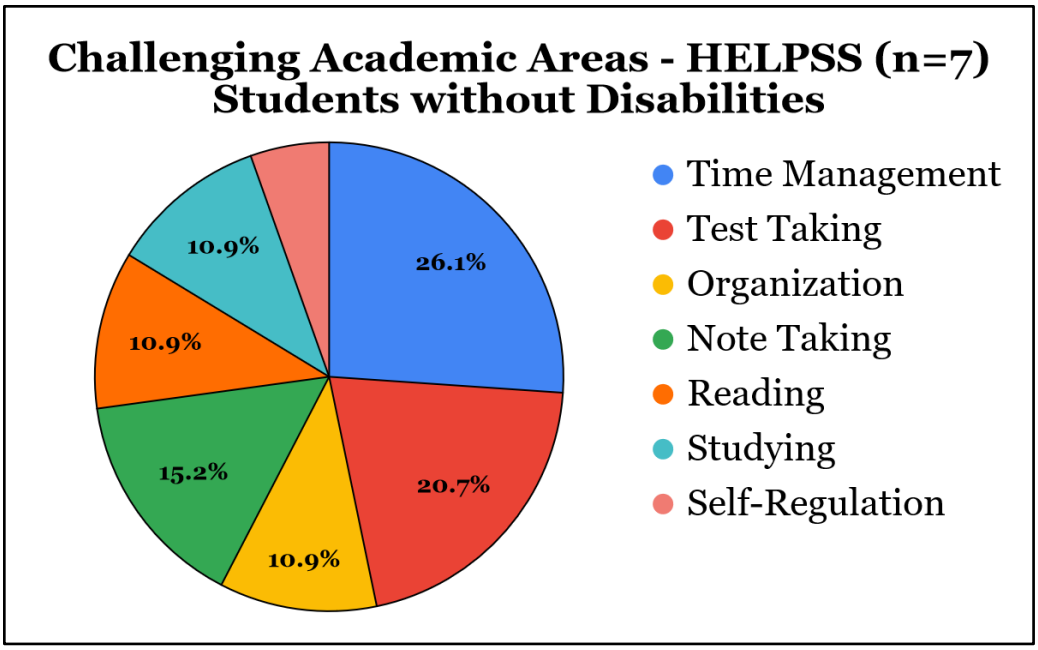

Figure 4 Challenging academic areas identified by students without disabilities

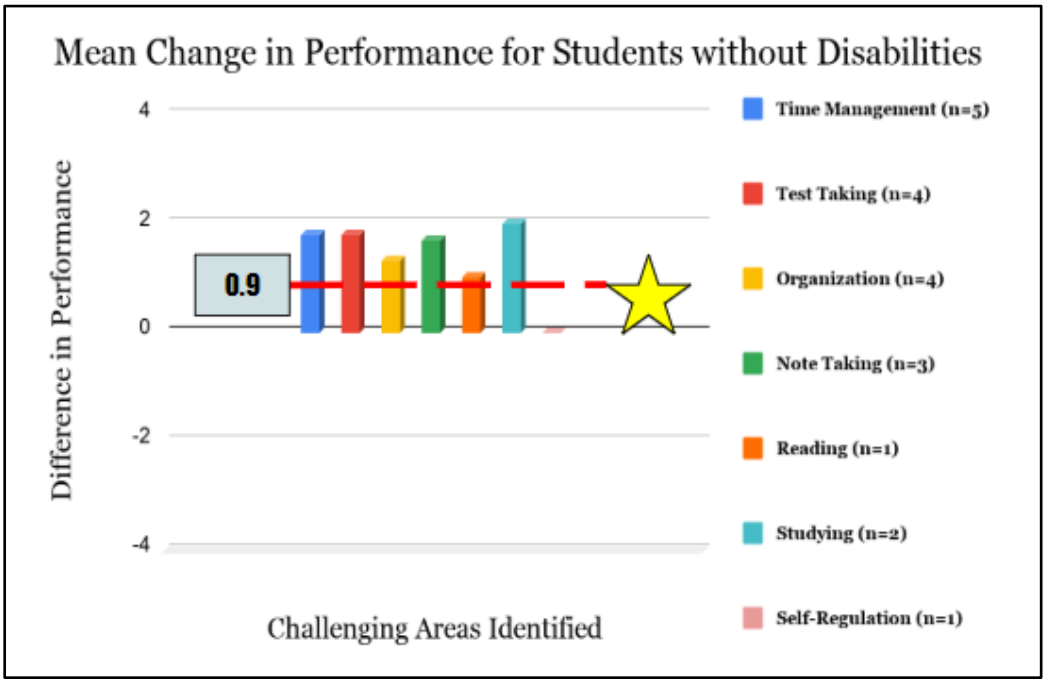

Figure 5 Mean change in performance based on pre/post-intervention HELPSS data for students without disabilities

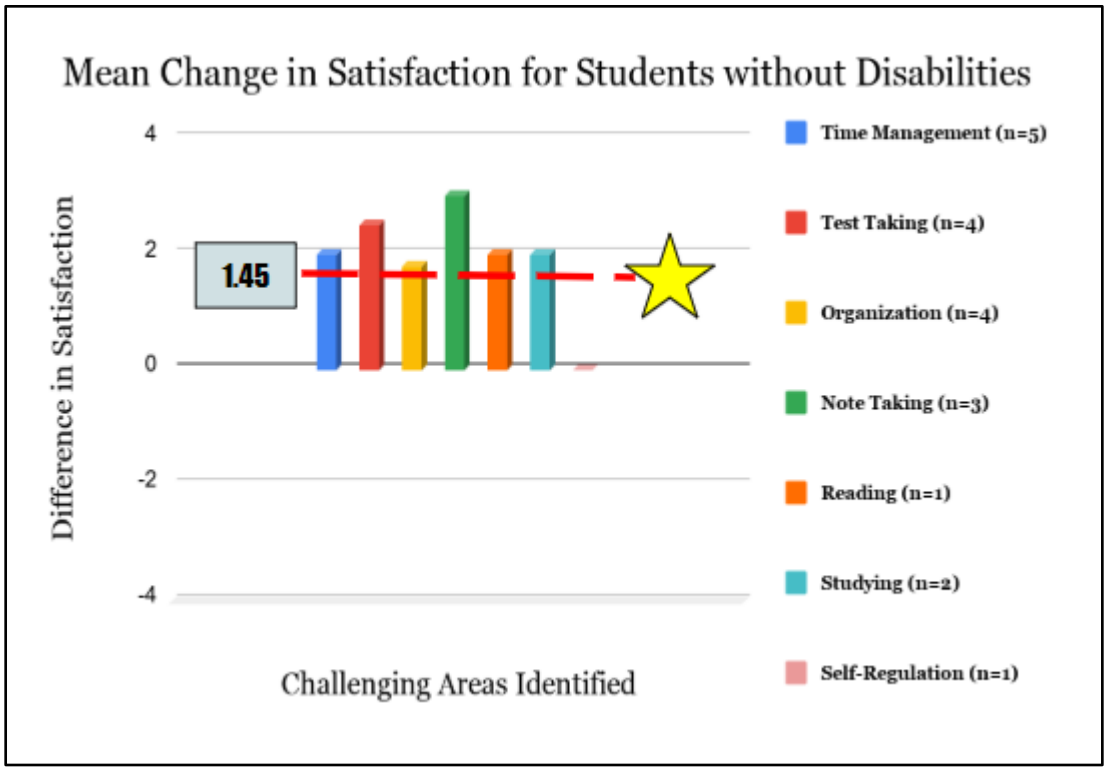

Figure 6 Mean change in satisfaction based on pre/post-intervention HELPSS data for students without disabilities

Research Question 2: How do the AT apps Notability© and BEST Suite© with and without individualized support impact occupational performance and satisfaction for undergraduate students?

All participants completed the HELPSS to self-identify their top three most challenging academic areas and self-rate their satisfaction and performance on each area. The control group's reported challenging academic areas were group work (n=1), note taking (n=2), organization (n=1), reading (n=1), self-regulation (n=1), studying (n=1), test taking (n=4), and time management (n=3). The intervention group's reported challenging academic areas were assignment completion (n=1), note taking (n=2), organization (n=3), reading (n=2), self-regulation (n=1), studying (n=1), test taking (n=1), and time management (n=4). The results of the pre-intervention and post-intervention HELPSS data were used to determine a mean change

in performance and satisfaction scores over the course of eight weeks (Figure 7). The mean change scores for 0.9 in performance (0.9) and satisfaction (1.45) were utilized to determine clinically meaningful change (Eyssen et al., 2011). When looking at the sample as a whole (N=11), clinically meaningful change scores were found for both performance and satisfaction among academic areas of their choosing (Figure 7).

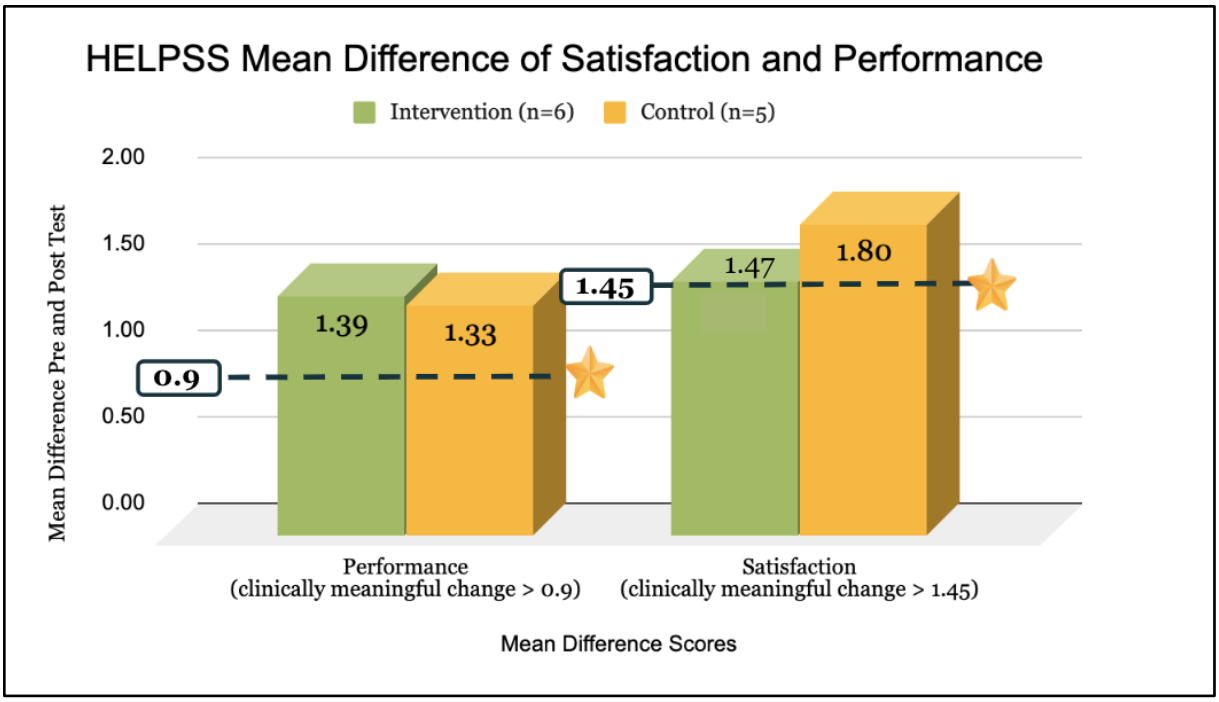

Figure 7 HELPSS mean change in satisfaction and performance

Control group. Results show overall clinically significant mean change scores in self-reported performance (*M*=1.33) and satisfaction (*M*=1.80) for the control group (Figure 7). Clinically significant mean change scores were found in performance for seven out of eight challenging academic areas and were group work (*M*= 2), note taking (*M*= 1), organization (*M*= 2), reading (*M*= 1), self-regulation (*M*= 2), studying (*M*= 2), and test taking (*M*= 1.75). For one out of eight challenging academic areas, time management had no mean change (*M*= 0) and was not found to be clinically significant in performance (Figure 8). Clinically significant mean change scores in satisfaction were found in seven out of eight challenging areas and were group

work (*M*= 2), note taking (*M*= 2), organization (*M*= 2), reading (*M*= 2), self-regulation (*M*= 2), test taking (*M*= 1.67), and time management (*M*= 2) For one out of eight challenging academic areas, studying had no mean change (*M*= 0) and was not found to be clinically significant for satisfaction (Figure 9).

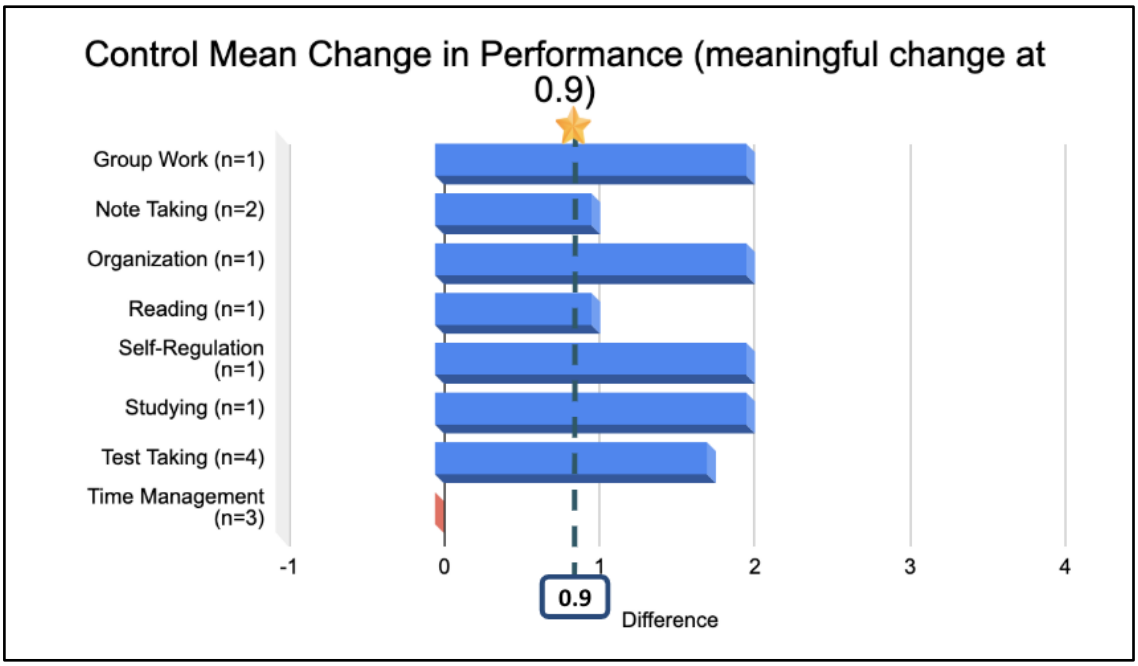

Figure 8 Control group's mean change in performance

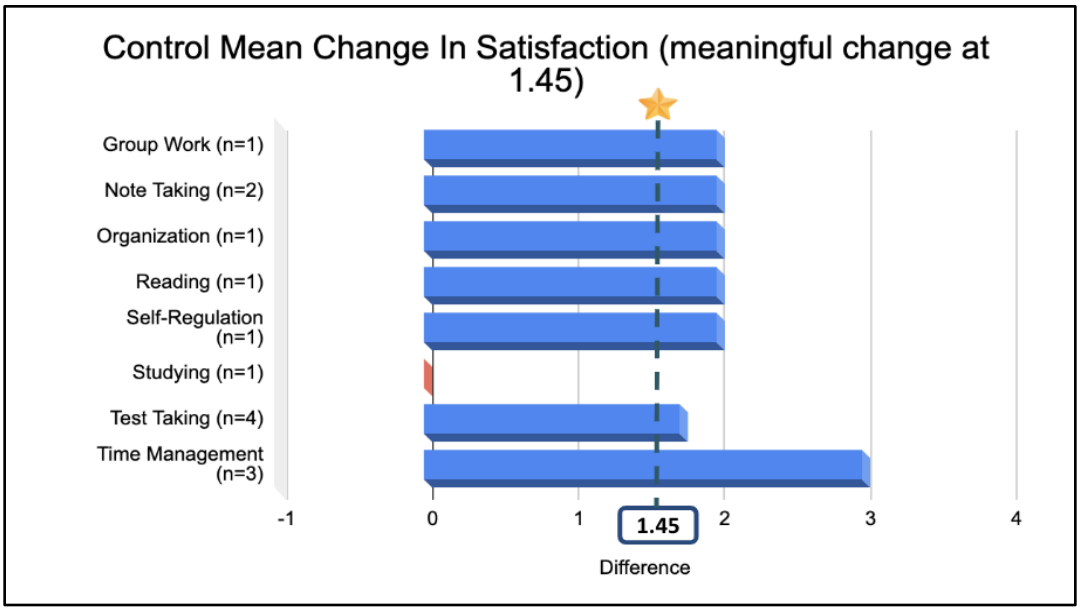

Figure 9 Control group's mean change in satisfaction

Intervention group. Results show overall clinically significant mean change scores in self-reported performance (*M*=1.39) and satisfaction (*M*=1.47) for the intervention group (Figure 7). Specifically, the intervention group reported clinically significant mean change scores in performance for five out of eight challenging academic areas - assignment completion (*M*= 2), note taking(*M*= 3), organization(*M*= 1), studying(*M*= 2), and time management (*M*= 2.75). Three out of the eight challenging academic areas did not reach the clinically meaningful change score, reading (*M*= -0.5), self regulation (*M*= 0), and test taking (*M*= 0.5) and was not found to be clinically significant for performance (Figure 10). Additionally, clinically significant mean change scores in satisfaction were found for four out of eight challenging academic areas - assignment completion (*M*= 2), note taking (*M*= 3.5), organization (*M*= 1.67), and time management (*M*= 1.5). Four out of eight challenging academic areas did not reach the clinically meaningful change score, reading (*M*= -1.0), self regulation (*M*= 1), studying (*M*= 1), and test taking (*M*= 1.25) and was not found to be clinically significant in satisfaction (Figure 11).

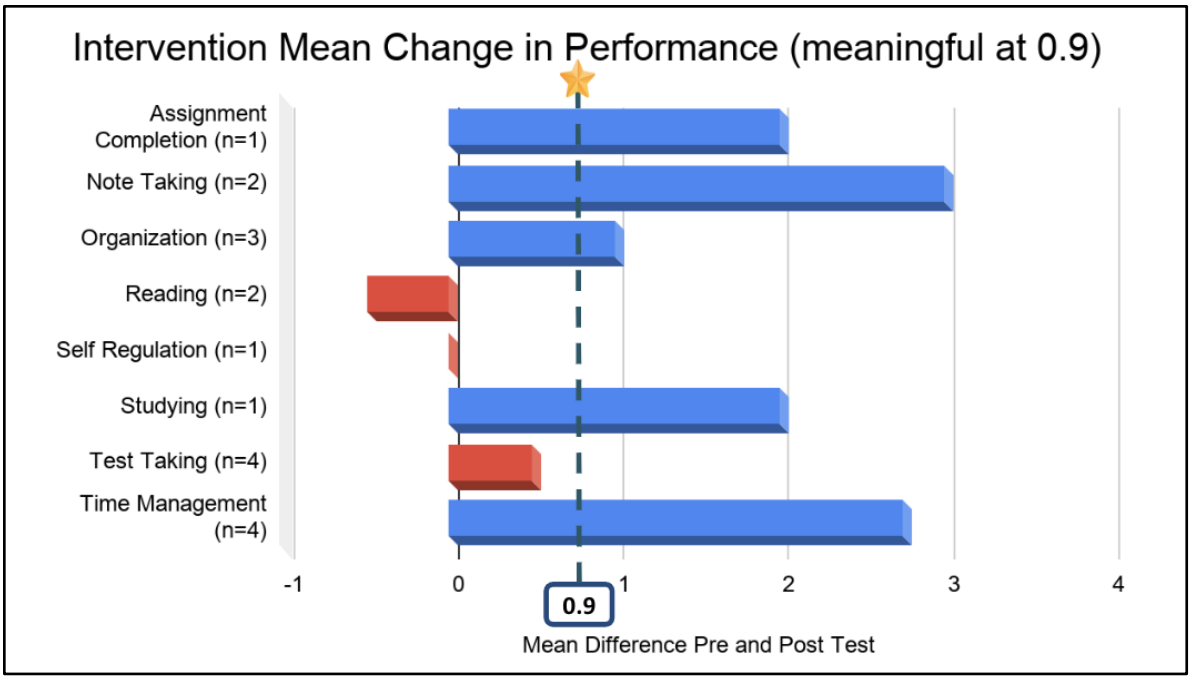

Figure 10 Intervention group's mean change in performance

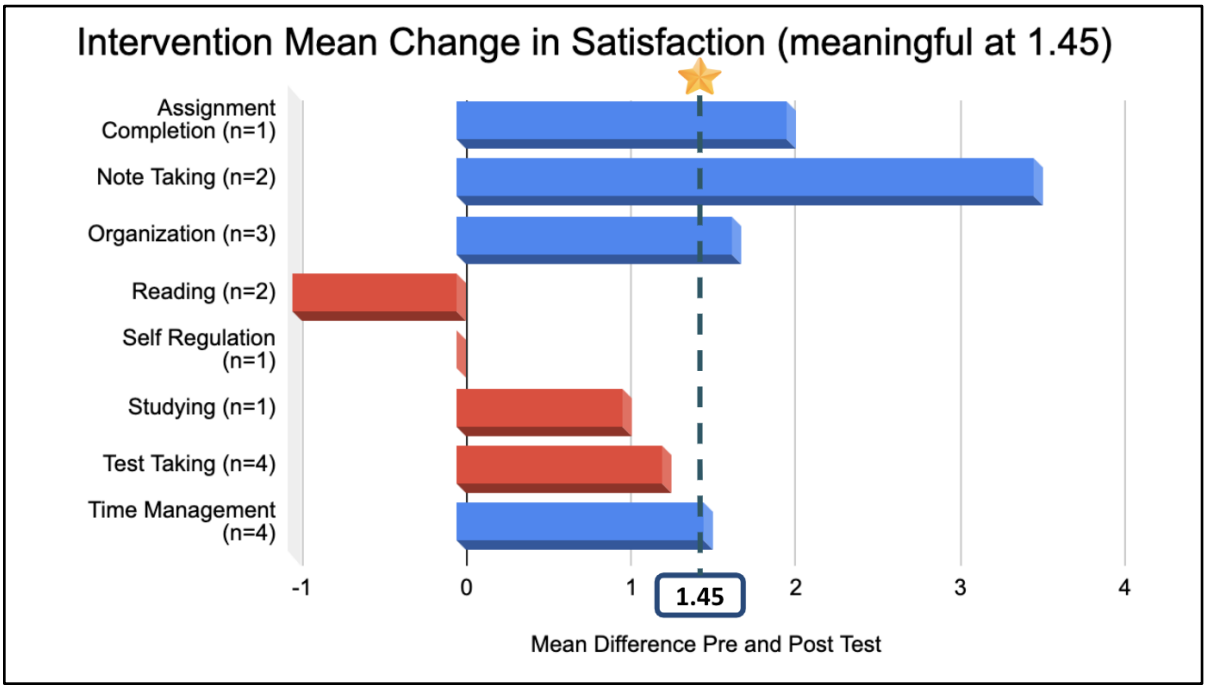

Figure 11 Intervention group's mean change in satisfaction

Research Question 3: What AT features impact undergraduates with and without disabilities?

Lived experience using BEST Suite©. Semi-structured interviews were conducted with all participants using a semi-structured exit interview questionnaires following conclusion of the study. The interviews were coded for themes to gather qualitative data on the lived experience of undergraduates use of the BEST Suite© app. Findings included overlapping themes between the students with disabilities group and the students without disabilities group, in terms of benefits, barriers, and key uses of BEST Suite©. Both groups were found to benefit from the app as it allowed the participants to focus on self-regulation (Table 6). Shared barriers between the groups included complicated navigation of the app, required time spent to learn how to use the app, and app abandonment, with six out of 11 participants abandoning use of BEST Suite© by the end of the study. Participants reported the need for additional support with the BEST Suite© app. Key uses of the app between the two groups included homework reminders and goal setting (Table 6).

Students with disabilities. Various themes were found for the *benefits*, *barriers*, and *key uses* of BEST Suite© used by the disability group.

Benefits. The themes found as the *benefits* of BEST Suite© included accountability, organization, and self-regulation (Table 4). When describing the benefits of accountability and organization, one participant stated, "definitely recommend them to...help...with the organization and staying on track with the goals throughout the semester." When describing the benefit of self-regulation, another participant reported the breaks provided by the app as useful. She described, "because it actually really helped with stamina going through them [goals]."

Barriers. The themes found as the *barriers* of the BEST Suite© included complicated navigation of the app, significant time needed to learn how to use the app, and abandonment of

the app (Table 4). One participant reported all three barriers in one statement, stating, “maybe when my schedule slows down a bit I can use it more...there is too much that needs to go into [it] and I don’t have time to...put that time into it.”

Key uses. The themes found for key uses of BEST Suite© by the disability group included homework reminders and goal setting (Table 4). One participant reported, “I would still like to use it in the future to reach small goals and long term goals.”

Students without disabilities. For students without disabilities, various themes were found for the *benefits*, *barriers*, and key uses of BEST Suite© used by this group.

Benefits. The themes found as the *benefits* of BEST Suite© included reminders, time management, and self-regulation (Table 5). One participant reported on using the reminders for coursework stating “it was telling me every day [to] do...pediatric homework”. A second participant reported on time management and self-regulation stating “it was nice to know...when I should be taking breaks.”

Barriers. The themes found as the *barriers* of the BEST Suite© included complicated navigation of the app, significant time needed to learn how to use the app, abandonment of the app, need of additional support in using the app, and the existence of too many apps in one platform (Table 5). One participant described complications of navigating the app due to having “too many prompts and a lot of things to click through.” Another participant reported abandonment of the BEST Suite© occurring after “the first couple days” and “never [adding] anything to it” after.

Key uses. The themes found as key uses of BEST Suite© by the non-disability group included homework and study reminders, goal setting, and task management. One participant

indicated using the BEST Suite© app features for setting goals and managing tasks to get desired grades on exams and assignments (Table 5).

Lived experience using Notability©. Semi-structured interviews were conducted with all participants using a post-interview questionnaire following the conclusion of the study. The interviews were coded for themes to gather qualitative data on the lived experience of undergraduates use of the Notability© app. Both groups were found to benefit from the app's ease of use (Table 6), and there were few to no shared barriers of the app between the groups. The key use of Notability© between the two groups included note taking (Table 6).

Students with disabilities. For students with disabilities, various themes were found for the *benefits*, *barriers*, and the *key uses* of Notability© by this group.

Benefits. The themes found as the benefits of Notability© were its ease of use and being a condensed tool, meaning that all study materials could be saved in one place (Table 4). Regarding the condensed benefit of Notability©, one participant reported, "compared to having used ... Google Docs and go to memos and then go into drawing apps and then audio apps. It's all in one".

Barriers. There were no themes found as barriers of Notability© for students with disabilities (Table 4).

Key uses. The themes found as key uses of Notability© by students with disabilities were note taking and audio recordings (Table 4). One participant reported on using the audio feature by stating,

> For me, since I have accommodations to audio record the classes and I use it for that couple of times and I usually recorded on voice memos on my phone but also used it on the app.

Another participant reported specifically on note-taking. This participant shared how Notability© was incorporated into notetaking in all of her classes. She shared, "I used it [Notability©] as a notebook for all of my classes... I took notes for all my classes on Notability. I really enjoyed using the app."

Students without disabilities. For students without disabilities, various themes were found for the *benefits*, *barriers*, and *key uses* of Notability© by this group.

Benefits. The themes found as the benefits of Notability© were ease of use, studying, and audio (Table 5). One participant reported on ease of use and audio features:

> I used that for everything...like note taking...and voice recording for lectures. And I was able to… upload slides from my other classes and keep it all in the same folder like next to my notes and everything. That was really nice. I liked that.

Barriers. The theme found as barriers to Notability© was drawing on a Macbook using the trackpad (Table 5). One participant reported on drawing using a Macbook stating,

> The one thing I really wish I had personally was the ability to write on it because I used it on the MacBook… It was hard because doesn't really pick up with your trackpad unless you click on it… I feel like it's more beneficial for something with, like, a touch screen.

Key uses. The themes found as key uses of Notability© by students without disabilities included note-taking, drawing, studying, and importing powerpoints (Table 5). Regarding studying, one participant reported, "I was able to get A's on my exams because it really helped with my studying".

	Unique Themes for Students With Disabilities		
	Benefits	Barriers	Key Uses
Notability©	• Ease of use • Condensed	• None	• Note taking • Audio
BEST Suite©	• Accountability • Organization • Self-regulation	• Complicated • Time • Abandonment	• Homework reminders • Goal setting

Table 4 Unique themes for the benefits, barriers, and key uses of Notability© and BEST Suite© for students with disabilities

	Unique Themes for Students Without Disabilities		
	Benefits	Barriers	Key Uses
Notability©	• Ease of use • Studying • Audio	• Drawing on a MacBook	• Note Taking • Drawing • Studying • Importing powerpoints
BEST Suite©	• Reminders • Time management • Self-regulation	• Complicated • Time • Abandonment • Needs support • Too many apps	• Homework and study reminders • Goal setting • Task management

Table 5 Unique themes for benefits, barriers, and key uses of Notability© and BEST Suite© for students without disabilities

	Common Themes for Students With and Without Disabilities		
	Benefits	Barriers	Key Uses
Notability©	● Ease of use	● Few to no barriers	● Note-taking
BEST Suite©	● Self-regulation	● Complicated ● Time ● Abandonment	● Homework reminders ● Setting goals

Table 6 Common themes for the benefits, barriers, and key uses of Notability© and BEST Suite© for students with and without disabilities

Research Question 4: What is the lived experience of undergraduate students given AT with and without individualized support?

Semi-structured exit interviews were conducted with both the control group and intervention group to ask about the lived experiences, benefits, and barriers of using AT with and without individualized support. As mentioned, content coding was conducted via Dedoose® (Dedoose Version 8.0.35, 2018). In order to ensure rigor for reliability across the researchers, 18% data (two out of 11 transcripts) was coded to 100% consensus by six researchers. In addition, the remaining 82% (nine out of 11 transcripts) of data were coded to 100% consensus in reliable research pairs. Categories and themes were discussed across several research meetings. Any disagreements or questions were resolved via discussion resulting in and coming to 100% consensus. Codes were developed to capture specific themes and reflect the participant's voice and context regarding AT support.

Control group. In the control group, there were several benefits and barriers discovered after data analysis. Researchers analyzed these findings and categorized them into two major themes. The first major theme found was a benefit theme - accountability. Participants in the control group felt a sense of accountability with their provided support throughout their eight week study. By having weekly check-ins and in-person training prior to the start of the study

participants in the control group felt held accountable to utilize the apps to support their academic occupations. The second major theme found was a barrier theme - lack of individualization. Individualization referred to app support that is customized to meet the needs of each individual. Participants expressed that individualized support would have enhanced their experience and ability to use apps more fully. The themes of accountability and individualization are exemplified with participant quotes in Table 7.

Control Group Themes: Accountability and Individualization		
	Themes	Quotes
Katelyn	Benefit: Accountability	"...I like how every week we have a check in to say how it's going and if we need any help. Just to track the progress, I really like that."
Rachel	Benefit: Accountability	"...the instruction at the beginning of the semester helped. And if we ever had any problems, we could email you guys and meet up if we needed to."
Chloe	Barrier: Individualization	"I think it would have been a little bit helpful [to get individual support] cause I struggled with the app [BEST Suite©]."

Table 7 Major themes for the control group's benefits and barriers given AT without individualized support. Note. Pseudonyms were utilized to ensure confidentiality

Intervention group. Data analysis of the intervention group exit interviews revealed various barriers and benefits. The largest benefit was surrounding client-centeredness (Table 8). Client-centeredness referred to the help and support that was individualized and customized for each participant during their one-on-one meetings with a student researcher. Through these individual meetings, the student researchers sought to customize the apps to meet the needs of each participant in the intervention group as well as to aid them in using the apps to support improvements in their identified challenging academic areas from the HELPSS. The largest

barrier reported was time (Table 8). Time referred to the need to plan and schedule the three 15 minute one-on-one meetings with a student researcher that participants in the intervention group were asked to participate in. These one-on-one meetings required the participant and student researcher to find and allocate a common time to meet in-person or via phone call or FaceTime. The themes of client-centered and time are exemplified with participant quotes in Table 8.

Intervention Group Themes: Client Centered and Time		
	Themes	Quotes
Zoe	Benefit: Client-Centered	"This is actually the first time I'm bringing my technology into the classroom and it was just it was really cool to have somebody to actually just sit down like, 'Hey, how are you doing?'"
Monica	Benefit: Client-Centered	"She [student researcher] kept trying to help me figure it out and she was really focused on helping make it work for me."
Gianna	Barrier: Time	"It was just timing...I was always really busy, so it was trying to figure out the right time, the perfect time to be able to meet."

Table 8 Major themes for the intervention group's benefits and barriers given AT with individualized support. *Note. Pseudonyms were utilized to ensure confidentiality*

Discussion

Research Question 1: How do the AT apps Notability© and BEST Suite© impact performance and satisfaction for students with and without disabilities?

Mean change scores for performance and satisfaction of students with and without disabilities were analyzed using the HELPSS data. The results indicate clinically meaningful changes in satisfaction and performance for students with disabilities (Figure 2 & 3) and without disabilities (Figure 5 & 6). This occurred in the majority of academically challenging areas for students with and without disabilities. Results indicate use of the apps increased performance and satisfaction for undergraduate students during their academic semester. These findings are consistent with previous studies noting AT in HE has been shown to enhance academic success and increase the effectiveness of learning strategies (Malcolm & Roll 2017; Heiman & Shemesh, 2012; Heiman, Fichten, Olenik-Shemesh, Keshet & Jorsensen, 2017; Yot-Dominguez & Mercelo, 2017). Whereas previous studies found that university instructors neither require nor encourage use of AT by students with and without disabilities (Yot-Dominguez & Mercelo, 2017), this study contributes evidence that app use can have marked performance and satisfaction impacts across many areas of academic engagement.

Research Question 2: How do the AT apps Notability© and BEST Suite© with and without individualized support impact occupational performance and satisfaction for undergraduate students?

Mean change scores for the intervention and control group's performance and satisfaction were analyzed using the HELPSS data. Figure 7 depicts the results of both the control and intervention group, noting clinically meaningful change scores in satisfaction and performance for both groups. This shows the significant impact of pairing individualized support with AT. It

is important to note, the control group was provided with an initial in person training, access to online training modules, weekly check-ins and baseline and exit interviews about their experiences with the AT. According to research, all of the aforementioned training and prompting, is above the norm for support that typical undergraduate students receive (Fleming et al., 2018). This illuminates that even minor support, cueing and discussion of goals and needs can be impactful in a student's academic occupations. This may be even as impactful as asking the students about areas they are working on and how the AT tools may be implemented, thus making the student aware of their tools and the relative impact to their individualized academic performance and satisfaction.

Research Question 3: What AT features impact undergraduates with and without disabilities?

Analysis of the lived experiences of participants with and without disabilities revealed the benefits, barriers, and key uses of Notability© and BEST Suite©.

Themes that emerged around benefits of the apps for both students with disabilities and without disabilities included ease of use with Notability© and self-regulation tools within BEST Suite© (Table 6). Because both groups found ease of use with Notability© and self-regulation with BEST Suite© as beneficial aspects of the apps, these are the qualities of the apps that promoted learning for students with and without disabilities and reinforced the need for UDL in HE. Taking the approach of utilizing AT that is inclusive in meeting the needs of all individuals is consistent with the UDL framework (Black et al., 2015). In addition, students with disabilities found the BEST Suite© app provided them with a tool to manage personal and academic responsibilities. By incorporating UDL into HE, not only does it provide support for all students,

but it bridges the gap between students with disabilities and being successful in the classroom (Black et al., 2015).

Themes that emerged for barriers of the apps were also similar between students with disabilities and students without disabilities. No shared themes for barriers for Notability© among students with and without disabilities emerged. Both groups found BEST Suite© to be complicated to learn and use, which led to abandonment of the app by the end of the study for six out of 11 participants (Table 6). These participants suggested additional support for navigating BEST Suite© would have been useful. While app training was provided at the beginning of the study, additional individualized support to find the best fit between the user and the app may have led to greater retention. College students have time-pressed schedules, making additional guidance with new AT vital to understanding AT and maximizing its use in their busy schedule. This aim to find the best fit between the person (i.e. participant), environment (i.e. HE), and occupation (i.e. AT use in academics) to achieve optimal occupational performance is consistent with the implications of the PEO model (Law et al., 1996).

Key uses of Notability© for students with and without disabilities included note-taking in the classroom (Table 6). Notability© provided multiple features to meet the needs of different learners, such as organizing notes all in one app, drawing, and audio-recording lectures. This demonstrated how AT may meet the needs of all users and supports the application of UDL principles in HE (Black et. al, 2015). For example, Notability© provides the user an opportunity to record lectures, which may allow the user to pay more attention to the teacher in class and less time focusing on typing fast enough to keep up with the lecture. It also affords multi-modal opportunities for learning including, auditory, visual and kinesthetic, which may benefit multiple learning styles of adult learners (Bastable, 2011). Key uses of BEST Suite© for both students

with and without disabilities included homework reminders and setting goals with the app (Table 6). Andragogy poses that adult learners play a role in the active planning, implementing, and evaluation of their learning (Bastable, 2011). By utilizing features to hold oneself accountable in completing academic tasks and working towards long-term goals, BEST Suite© allowed participants to play an active role in directing their attention to studying and to achieving academic success in short-term goals.

Research Question 4: What is the lived experience of undergraduate students given AT with and without individualized support?

Current research on AT in HE typically measures quantitative effects in specific academic performance skills and neglects to investigate the lived experience of self-reported performance and satisfaction. Therefore, the inclusion of this sub-research question was intended to address and analyze this gap in literature. Coding the qualitative exit interviews revealed that the control group reported themes of accountability as a benefit and lack of individualization as a barrier (Table 7). First, participants in the control group reported the benefit of being held accountable by the Weekly Check-In. While Andragogy assumes that learners become more self-directed as they mature, undergraduate students are still maturing and developing in their independence and self-directedness, as 72% were in their first year of college (Bastable, 2011). This demonstrates the significance of providing accountability and support for undergraduate students' AT use, especially during their transition into higher education. Second, the control group reported that lack of individualization was a barrier to AT use. The control group reported that receiving individualized support would have been helpful in aiding app use, which points to the need to provide customized support for undergraduates' use of AT (Table 7).

In addition, coding revealed that the intervention group reported themes of client-centeredness as a benefit and time as a barrier (Table 8). First, participants in the intervention group reported the benefit of client-centeredness, the individualized support in which the student researcher sought to customize the AT use (i.e., occupation) to meet the needs of the participant (i.e., person) in a higher education setting (i.e., environment). This demonstrated the significance of client-centeredness to find the right fit between the person, environment, and occupation such that optimal occupational performance can occur (Law et al., 1996). Second, participants in the intervention group reported the time as a barrier to receiving individualized report. As adult learners, institutional learning is often autonomous and schedules can be inconsistent among students and faculty. Therefore, consideration of the various nature and contexts of adult learning (i.e., time) support services should accommodate these factors when appropriate to best support student needs (Bastable, 2011).

Implication for OT Practice

Currently, there is a rise in the number of students with and without disabilities enrolling in HE (Snyder et al, 2016). As more undergraduates are attending institutions of HE, a need exists for AT combined with individualized supports to aid undergraduates in challenging academic areas, as demonstrated by the results of this study (Figure 12). As OTs, utilizing a PEO model when implementing AT and individualized support was found to have positive effects with AT use. This is important in order to cater to the unique needs of each student, especially as they transition into HE. Traditionally, OTs provide services for students in K-12 education and very rarely practice on college campuses. However, HE disability service offices or accessibility service offices can be a unique fit for OT, based on OT expertise and scope of practice including AT. OTs can have an extensive impact on college campuses, specifically by implementing AT within their practice. As the results of this study indicate, OTs have the potential to promote and enhance engagement in meaningful occupations, such as participation in HE academics, for undergraduates with and without disabilities (Figure 13).

From this study we observed, procuring AT alone can often have less impact than AT combined with individualized support. Occupational therapists can provide services in HE including pairing AT with individualized supports. As it states in the Occupational Therapy Practice Framework (OTPF), OTs have unique qualifications and skills to identify and use AT to support occupational engagement (American Occupational Therapy Association, 2014). The combination of AT and individualized support has the potential to promote and enhance engagement in meaningful occupations for students in HE. As a profession, OTs need to advocate for this role in HE to support and improve the quality of life of students, advancing AT support into the 21st century (Figure 13).

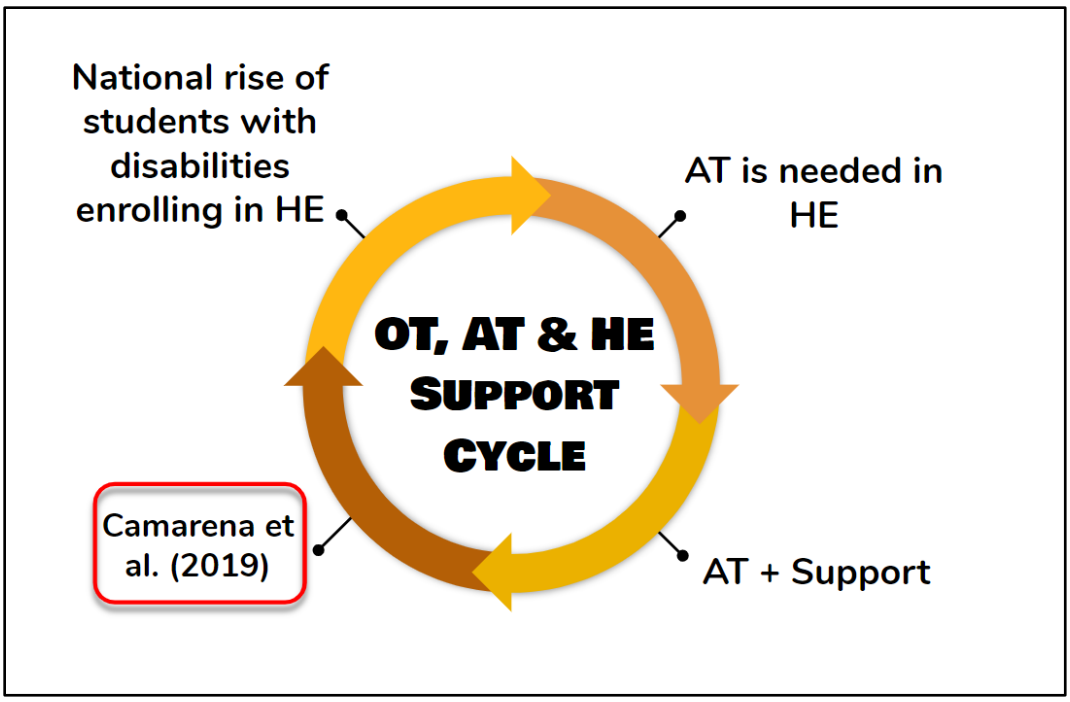

Figure 12 Diagram of the OT, AT and HE Support Cycle

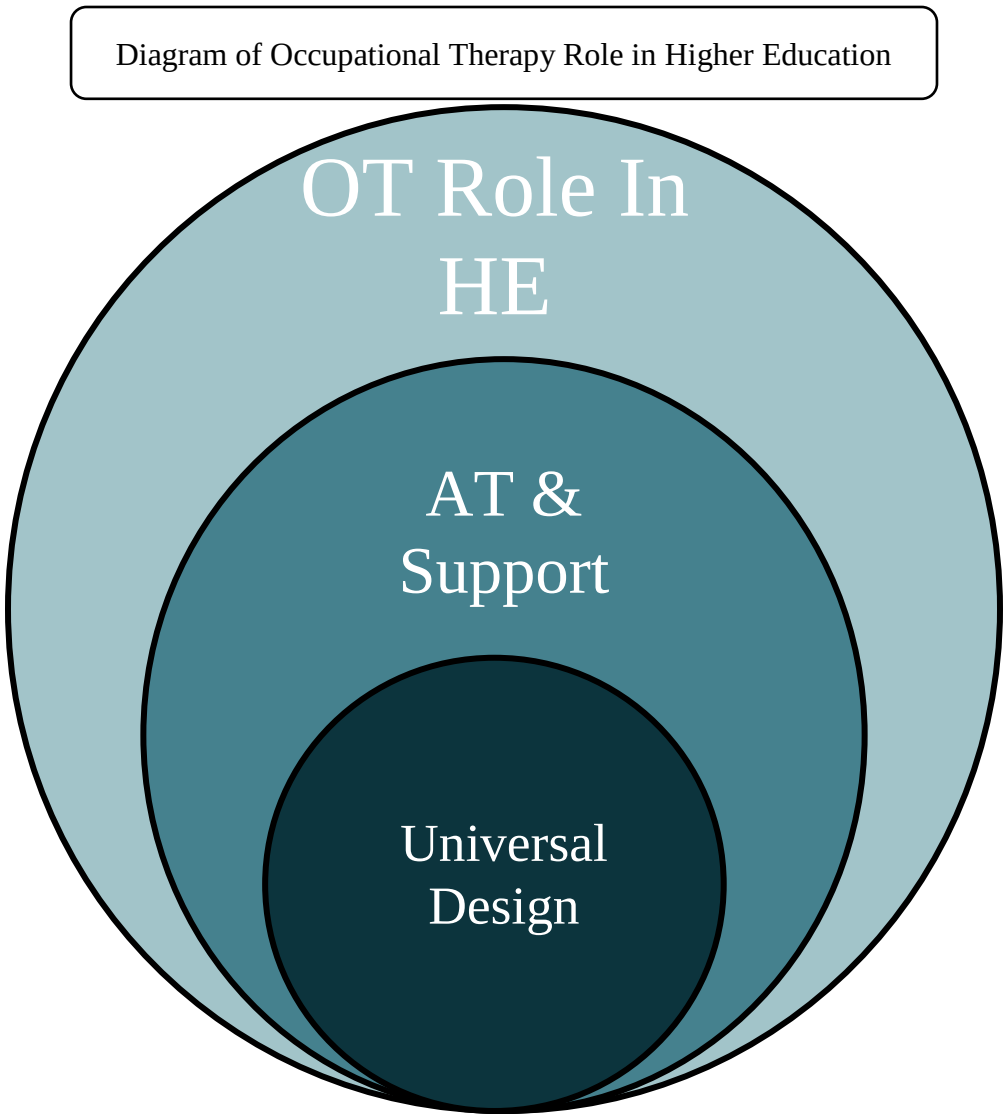

Figure 13 Diagram of Occupational Therapy Role in Higher Education

Limitations and Future Research

This study examined AT combined with individualized support for undergraduate students with and without disabilities utilizing an occupation-centered lens. While the study made strides in yielding preliminary findings promoting the use of AT combined with individualized support in HE, this study is not without limitations.

Sample Size and Demographics

The population sample presents several limitations which jeopardizes the generalizability of the results of this study. Firstly, the sample size (N=11) was small and therefore not generalizable to a larger population. Further, our participants were a convenience sample of undergraduate female students recruited from DUC. DUC is a private four year university which does not represent the spectrum of college experiences nationwide. This yielded a homogenous sample, which is representative of Dominican University's predominantly female population. Future research should consider a larger, more diverse sample size.

Control Group

Another limitation to the study was the lack of a true control group due to the implementation of UD. Participants in our control group were given support in the form of in person initial training on how to use the apps, video training modules on how to use the apps, weekly check-ins and baseline and exit interviews prompting discussion about learning and AT tools. These supports for the control group were markedly less than the intervention group, yet it is critical to note that the amount of the support given via this research design may have contributed to the clinically meaningful mean change scores. As a result, future research should consider implementation of true control groups (1) without training or follow up with the apps

and (2) a control group that is “standard of care” meaning they are not given any additional AT, but are just asked about their current tech tools in use.

Assistive Technology Used

Another limitation to this study was the inability to customize the apps implemented to each individual participant due to the nature of the research study. Rather, both BEST Suite© and Notability© were distributed among the entire sample to establish consistency and have a reliable research protocol. This of course, would not mirror practice as the apps chosen would be based on individualized needs.

As BEST Suite© was originally designed for individuals with traumatic brain injuries, the app consisted of many step-by-step supports intended to support individuals with cognitive limitations. For undergraduate students, the detail-oriented nature of BEST Suite© added too many layers of support and was not conducive with their busy daily schedule. Therefore, another limitation found in this study was generalizing BEST Suite’s© use to the undergraduate student population. While benefits were found among its implementation among HE, abandonment of the app was highly prevalent (six of 11 participants), further emphasizing the need to individualize the AT used among this population. This is a consideration for further research efforts to explore the benefits and barriers of customized AT support in HE.

Conclusion

Considering the growing number of students with disabilities enrolling in college, HE is outgrowing its existing supports for undergraduate students. This research suggests utilizing an UDL approach to learning may benefit undergraduate students in incorporating AT in HE. In addition, the use of individualized support was found to positively impact participant use of AT for self-identified academic challenge areas. The implementation of individualized support from an OT who can facilitate the use and effectiveness of AT may provide a valuable asset to existing disability services and academic services in HE.

However, for AT to be successfully used in academic engagement, this research found several factors that influenced perceived success. First, initial trainings on specific AT was shown to increase students' efficacy with applying technology to support learning. Additionally, the consideration of pairing appropriate AT to the individual may increase effectiveness of use. This parallels the concept that occupational performance is best achieved when a person, their environment, and their preferred occupation are harmonious (Law et al., 1996). Therefore, it is important to seek AT that meets a student's academic needs within the context of their education and their individual needs / abilities. Next, individualized support while using AT is vital to maximize student usage and diminish the likelihood of abandonment. Students in this sample reported the benefits of a client-centered approach to their AT usage; thus, positively impacting their self-reported satisfaction and performance in self reported top challenging academic areas. Even without one-on-one guidance, the provision of minimal support (i.e., initial training and weekly email check-ins) provided accountability to the students. This minimal support also resulted in a positive impact on self-reported satisfaction and performance in academic areas. These results were found, through inclusion of a participants' lived experience with the

implementation of AT, which researchers deemed as valuable and is a vital measure when understanding AT impacts for students with and without disabilities. Through these considerations, OTs can facilitate modernized solutions to meet the needs which are evident in current academic entities, such as accessibility and disability services, to support students and their AT usage in the future.

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Appendix A – Recruitment Flyer

UNDERGRADUATE VOLUNTEERS NEEDED

Do you have trouble...

- Organizing your day?
- Accomplishing goals?
- Managing class notes and materials?

Try the apps, Notability & BEST Suite, for FREE!

We are studying the benefits of apps in the lives of college students.

Eligible participants must:

- Be undergraduate students
- Be full time students
- Be 18+ years old
- Own Apple products (iPhone & iPad/Mac)
- Have no prior experience with Notability or BEST Suite

Participants can expect to:

- Complete an eligibility screening
- Participate in individualized support for app use
- Use both apps during Spring semester (2019)
- Be in frequent contact with the research team
- Complete an exit interview

If interested, contact Hess Lab:
assistivetechcapstone@gmail.com

THANK YOU!

Appendix B - Consent Form and Bill of Rights

DOMINICAN UNIVERSITY OF CALIFORNIA CONSENT FORM TO BE A RESEARCH PARTICIPANT

Purpose and Background

Erin Camarena, Cayla Chapman, Sara Delucchi, Grace Erhardt, Christine Jacob, Michelle Morello, and Bethany Young, graduate students from the Department of Occupational Therapy at Dominican University of California are conducting a research study designed to assess if the use of the mHealth app BEST Suite© and Notability© can impact the learning strategies among various students at DUOC. This research is a capstone research project for Mrs. Erin Camarena, Ms. Cayla Chapman, Ms. Sara Delucchi, Ms. Grace Erhardt, Ms. Christine Jacob, Ms. Michelle Morello, and Ms. Bethany Young at Dominican University of California, California. This research project is being supervised by Dr. Laura Greiss Hess, PhD, OTR/L, Assistant Professor, Occupational Therapy, Dominican University of California.

Procedures

If I agree to be a participant in this research study, the following will occur:

General:

1. I understand that participating in this research will involve taking part in an approximate 8-week study during my Spring 2019 semester.
2. I understand that all of the study's procedures will take place at Dominican University of California, located at 50 Acacia Avenue, San Rafael, California.
3. I understand Notability© and the BEST Suite© are apps that may assist me in managing my learning skills.
4. I understand that I need daily access to an iPhone AND either a MacBook or iPad to participate in the study.

ecruitment/Training:

5. I understand that I will be asked to disclose my demographic information to research assistants on an intake form via Google forms. I understand that I have the right to not disclose information for questions regarding diagnosis, disability, and gender.
6. I understand I will be asked to attend an initial training session at the beginning of Spring semester, 2019 and a final meeting session after Spring break 2019 on the Dominican campus.
7. I understand I will spend time learning how to use the BEST Suite© app and Notability© over Winter break 2018/19.

Pre-Test/Post-Test:

8. I understand that during the initial meeting in January 2019 I will be asked to complete a questionnaire about my learning style and discuss it with a graduate student researcher.
9. I understand that I will participate in a multiple question pre-test and post-test based on my learning and assistive technology.
10. I understand that I will be asked to have an audio recorded exit interview with an OT graduate student researcher at the conclusion of the 8-week research study. I understand that I have the ability to decline to be audio recorded.

Active Study Phase (Eight weeks, approximately semester week 2 - week 10 in Spring 2019):

11. Subjects will be randomized to a control group or intervention group. Based on which group I am assigned to, I understand that participation in this study may involve three individualized guidance sessions with an OT graduate student approximately two weeks, four weeks, and six weeks into the study for approximately 30 minutes. This can take the following forms: in-person, over FaceTime or phone.These meetings will not be held in a

public place.

12. I understand that I will be asked to share data from the BEST Suite© app two times (approximately midway through the study and again at the end of the study).
13. I understand that I will participate in a brief weekly check-in survey via a Google forms that ask about how and when I use the app during the 8 weeks of the study.
14. I understand that I will use the BEST Suite© application for at least one identified task of my choosing.
15. I understand that I will use Notability© for one course of my choosing.
16. I understand that I will be asked to self-reflect on my own perceived learning abilities and share them with an OT graduate student researcher as part of this study via an audio-recorded interview in a non public place and that I can decline to be audio recorded.

Risks and/or Discomforts

1. I understand that I will be discussing topics of a personal nature and that I may refuse to answer any question that causes me distress or seems an invasion of my privacy at any time without any adverse consequences.
2. I understand that my participation in this study involves no physical risks using the BEST Suite© or Notability© application itself. If I experience any problems or distress due to my participation, I can contact the OT graduate student researchers, review frequently asked questions handout and write down any questions or concerns to take with me to the follow-up meeting with the OT student researchers.
3. I understand that I may refuse to participate and withdraw from the study at any time before, during, or after the study begins without any adverse consequences.

4.

Benefits

The anticipated benefits of this study include:

1. I will receive complimentary, free apps for both the BEST Suite© and Notability© upon enrollment in the study.
2. I may see improvements in learning strategies and time management.
3. I may learn new note-taking and time management strategies that may benefit my participation in coursework.
4. I may be randomized to receive individualized learning support as part of this study with one of the graduate OT student researchers.

Costs/Financial Considerations

Participating in this study will require a time commitment of one hour of initial training, and weekly individualized ATIG sessions if you are selected as a part of the ATIG. Additionally, an effort cost is required to learn how to use the applications and any additional academic skill sets (i.e. a new approach to note-taking, studying, etc.). I will also be asked to respond to email surveys throughout the 8 weeks, although designed to be brief, this is a time cost.

Payment/Reimbursement

You will not receive any payments or reimbursements for participation in this research study. However, participants will receive a complimentary, free download of the BEST Suite© and Notability© apps, in addition to the chance to receive one on one services with an occupational therapy student at zero cost to the participant.

Questions

I understand that if I have any further questions about the study, I may contact the student researchers at cayla.chapman@students.dominican.edu or their faculty supervisor, Dr. Laura Greiss Hess at Department of Occupational Therapy, Dominican University of California at laura.hess@dominican.edu.

If I have further questions or comments about participation in this study, I may contact the Dominican University of California Institutional Review Board for the Protection of Human Participants (IRBPHP), which is concerned with the protection of volunteers in research projects. I may reach the IRBPHP Office by calling (415) 482-3547 and leaving a voicemail message, by FAX at (415) 257-0165 or by writing to the IRBPHP, Office of the Associate Vice President for Academic Affairs, Dominican University of California, 50 Acacia Avenue, San Rafael, CA 94901.

Consent:

I have been given a copy of this consent form, signed and dated, to keep for my future reference. I understand participation in this research study is voluntary. I understand I can withdraw my participation at any time without fear of adverse consequences. All procedures related to this research project have been satisfactorily explained to me prior to my voluntary election to participate.

I have read and understand all of the above explanation regarding this study. I voluntarily give my consent to participate.

I HAVE READ AND UNDERSTAND ALL OF THE ABOVE EXPLANATION REGARDING THIS STUDY. I VOLUNTARILY GIVE MY CONSENT TO PARTICIPATE. A COPY OF THIS FORM HAS BEEN GIVEN TO ME FOR MY

FUTURE REFERENCE.

_____

PARTICIPANT'S NAME (PRINTED) Date

_____

PARTICIPANT'S SIGNATURE Date

_____

STUDENT RESEARCH'S SIGNATURE Date

IRBPHS RESEARCH PARTICIPANT'S BILL OF RIGHTS

Every person who is asked to be in a research study has the following rights:

1. To be told what the study is trying to find out;

2. To be told what will happen in the study and whether any of the procedures, drugs or devices are different from what would be used in standard practice;

3. To be told about important risks, side effects or discomforts of the things that will happen to her/him;

4. To be told if s/he can expect any benefit from participating and, if so, what the benefits might be;

5. To be told what other choices s/he has and how they may be better or worse than being in the study;

6. To be allowed to ask any questions concerning the study both before agreeing to be involved and during the course of the study;

7. To be told what sort of medical treatment is available if any complications arise;

8. To refuse to participate at all before or after the study is stated without any adverse effects. If such a decision is made, it will not affect him/her rights to receive the care or privileges expected

if s/he were not in the study.

9. To receive a copy of the signed and dated consent form;

10. To be free of pressure when considering whether s/he wishes to be in the study.

If you have questions about the research you may contact us at cayla.chapman@students.dominican.edu. If you have further questions you may contact my research supervisor, Dr. Laura Greiss Hess, laura.hess@dominican.edu or the Dominican University of California Institutional Review Board for the Protection of Human Subjects (IRBPHS), which is concerned with the protection of volunteers in research projects. You may reach the IRBPHS Office by calling (415) 482-3547 and leaving a voicemail message, or FAX at (415) 257-0165, or by writing to IRBPHS, Office of Associate Vice President for Academic Affairs, Dominican University of California, 50 Acacia Avenue, San Rafael, CA 94901

Appendix C - Screening Form

Pre-Screening Form

PHONE CALL

* Required

Name

Your answer

Are you over 18 years of age? *

- Yes
- No

Are you a FULL TIME UNDERGRADUATE student at Dominican University of California? *

- Yes
- No

Do you identify as having a disability? *

- Yes
- No

Have you ever used BEST Suite or Notability before? *

- ○ Yes
- ○ No

Which of the following devices do you currently have daily access to? *

- ☐ iPhone
- ☐ iPad
- ☐ MacBook

How do you access and activate your aforementioned devices? *

- ☐ Manual typing on typical keyboard
- ☐ Manual typing on touch screen (iPad, iPhone)
- ☐ Screen reader
- ☐ Text to speech
- ☐ I-Tracker
- ☐ Voice to text
- ☐ None
- ☐ Other: _____

Appendix D - Intake Form

Participant Intake Form

This form will allow researchers to collect and analyze data regarding participant demographics.

* Required

Participant ID *

Your answer

Date of Birth *

Date

mm/dd/yyyy

Gender *

- ○ Female
- ○ Male
- ○ Prefer not to say
- ○ Other:

Undergraduate Year *

- [ ] Year 1
- [ ] Year 2
- [ ] Year 3
- [ ] Year 4
- [ ] Year 5
- [ ] Year 5+

What is your expected date of graduation?

Date

mm/dd/yyyy

Major *

Your answer

Please indicate any/all of the following technology and software you use for college purposes: *

- [ ] MacBook (laptop)
- [ ] iPhone (cell phone)

- [ ] iPad (tablet)
- [ ] Microsoft Office (PowerPoint, Excel, Word)
- [ ] Google Office (Docs, Sheets, Slides)
- [ ] Apple Office (Keynote, Pages, Numbers)
- [ ] Other: _____

What tasks do you perform using the technology you indicated above as useful? *

- [ ] Note taking
- [ ] Writing assignments (essays, papers, etc.)
- [ ] Calendar
- [ ] Researching information
- [ ] Reminders
- [ ] Study
- [ ] Presentations
- [ ] Group projects
- [ ] Other: _____

Please indicate how helpful technology is to you for college purposes: *

- ◯ Extremely/Can not live without it
- ◯ Above average
- ◯ Somewhat
- ◯ Very little to minimal
- ◯ Not at all

Do you have difficulties in any of the following areas? *

- ☐ Time Management
- ☐ Self Regulation
- ☐ Organization
- ☐ Note Taking
- ☐ Studying
- ☐ Test Taking
- ☐ Reading
- ☐ Writing (Handwriting or Typing)
- ☐ Assignment Completion

- [ ] Group Work/Projects
- [ ] Other: _____

Based on your previous answer, please explain

Your answer

Do you currently utilize any specific assistive technology or apps to assist in the following: *

- [ ] Time management
- [ ] Self-regulation
- [ ] Academic skills
- [ ] No, I do not use any assistive technology to assist with the items listed
- [ ] Other: _____

If indicated above that you utilize specific assistive technology or apps please state the name and purpose. (Please write "N/A" if not applicable). *

Your answer

Please indicate if you currently use or have previously used any of the following services at Dominican University: *

- [ ] Academic Advising
- [ ] Integrative Coaches
- [ ] Tutoring Services
- [ ] Peer Mentor Program
- [ ] Accessibility and Disability Services
- [ ] No, I have never used any of these services

Do you self identify as having a diagnosis/disability? If you are comfortable sharing this information please note that this form does not have your name on it and is only identified by your ID, therefore your identity is protected. *

- ○ Yes
- ○ No
- ○ I prefer not to state.

If you identify with a diagnosis/disability and are comfortable sharing that information with us, please check all that apply. Please note that this form does not have your name on it and is only identified by your ID, therefore your identity is protected: *

- [ ] I do not identify with a diagnosis/disability.
- [ ] I prefer not to state
- [ ] Learning disability (reading, math, writing, dyslexia)
- [ ] ADHD
- [ ] ADD
- [ ] Psychological/Psychiatric (anxiety, depression, PTSD, etc.)
- [ ] Acquired Brain Injury
- [ ] Autism
- [ ] Other: _____

If YES, how does this diagnosis/disability impact studying/learning?

Your answer

If you identify with a diagnosis/disability are you connected with Dominican Disability Services? *

- ○ I do not identify with a diagnosis/disability
- ○ Yes
- ○ No

SUBMIT

Never submit passwords through Google Forms.

Appendix E - Higher Education Learning Performance and Satisfaction Scale (HELPSS)

Higher Education Learning Performance and Satisfaction Scale (HELPSS)

Adapted from the COPM (Law et al., 2014) and Malcolm & Roll, AT Research (Malcolm & Roll, 2017)

* Required

Participant ID *

Your answer

Please check at least three areas of learning that are challenging to you: *

- [ ] Time Management
- [ ] Self Regulation
- [ ] Organization
- [ ] Note Taking

- [ ] Studying
- [ ] Test Taking
- [ ] Reading
- [ ] Writing (Handwriting or Typing)
- [ ] Assignment Completion
- [ ] Group Work/Projects
- [ ] Other: _____

NEXT

Never submit passwords through Google Forms.

Higher Education Learning Performance and Satisfaction Scale (HELPSS)

* Required

Problem Areas

From the above check list, please list your FIRST most difficult area. *

Your answer

How well do you feel you are performing in your FIRST listed area? *

	1	2	3	4	5	6	7	8	9	10	
Not able to do it at all	○	○	○	○	○	○	○	○	○	○	Able to do it extremely well

How satisfied do you feel in your FIRST identified area? * 1 point

	1	2	3	4	5	6	7	8	9	10	
Not satisfied at all	○	○	○	○	○	○	○	○	○	○	Extremely satisfied

From above check list, please write SECOND most difficult learning area. *

Your answer

How well do you feel you are performing in your SECOND listed area? *

	1	2	3	4	5	6	7	8	9	10	
Not able to do it at all	○	○	○	○	○	○	○	○	○	○	Able to do it extremely well

How satisfied do you feel in your SECOND identified area? *

	1	2	3	4	5	6	7	8	9	10	
Not satisfied at all	○	○	○	○	○	○	○	○	○	○	Extremely satisfied

From above checklist, please write THIRD most difficult learning area. *

Your answer

How well do you feel you are performing in your THIRD listed area? *

	1	2	3	4	5	6	7	8	9	10	
Not able to do it at all	○	○	○	○	○	○	○	○	○	○	Able to do it extremely well

How satisfied do you feel in your THIRD identified area? *

	1	2	3	4	5	6	7	8	9	10	
Not satisfied at all	○	○	○	○	○	○	○	○	○	○	Extremely satisfied

BACK SUBMIT

Never submit passwords through Google Forms.

Appendix F - Weekly Check-In Form

BEST Suite: Weekly Check-In Form

* Required

Participant ID *

Your answer

BEST Suite: For which task did you use the app? *

Your answer

BEST Suite: What features are you using on the app? *

- [ ] Pace My Day
- [ ] Reach My Goals
- [ ] Strategize My Life
- [ ] Wakeup Questionnaire
- [ ] Bedtime Questionnaire
- [ ] Reminders
- [ ] Breaks
- [ ] Other:

BEST Suite: How satisfied do you feel with the app? *

	1	2	3	4	5	6	7	8	9	10	
Not satisfied at all	○	○	○	○	○	○	○	○	○	○	Extremely satisfied

BEST Suite: Please leave any additional comments here. If you have specific questions you would like us to answer, we want to support you, but also support your confidentiality! Please email assistivetechcapstone@gmail.com with a brief statement of the problem(s) you have and we will contact you directly in order to support your use of the app.

Your answer

NEXT

Never submit passwords through Google Forms.

NOTABILITY: Weekly Check-In Form

NOTABILITY: In which class did you use the app? *

Your answer

NOTABILITY: Which features did you use? *

- [ ] Typing
- [ ] Voice recording
- [ ] Drawing pictures
- [ ] Highlighter
- [ ] Other:

NOTABILITY: What tasks are you using the app for? *

- [ ] Studying
- [ ] Note taking
- [ ] Lists
- [ ] Other:

NOTABILITY: How satisfied do you feel with the app? *

	1	2	3	4	5	6	7	8	9	10	
Not satisfied at all	○	○	○	○	○	○	○	○	○	○	Extremely satisfied

NOTABILITY: Please leave any additional comments here. If you have specific questions you would like us to answer, we want to support you, but also support your confidentiality! Please email assistivetechcapstone@gmail.com with a brief statement of the problem(s) you have and we will contact you directly in order to support your use of the app.

Your answer

BACK SUBMIT

Never submit passwords through Google Forms.

Appendix G - Assistive Technology Intervention Note

ATIG- Check-in Questions

Will be distributed based on client preferences in person, Facetime, or phone call in a non public place; questions shall be tailored to the individual based on the goals identified during the pre-test HELPSS interview.

BEST Suite©

1. What are you currently using the BEST Suite© for?
2. How is that going? Helpful or not? Please describe.
3. Is there anything you would like us to customize for your use?
4. Are there features you would like assistance with?
5. Are there other tasks in your daily life that you would like to explore whether the BEST Suite© would be applicable?
6. Are there any other overall concerns about the BEST Suite© you would like to discuss at this time?

Notability©

1. What are you currently using Notability© for?
2. How is that going? Helpful or not? Please describe.
3. Is there anything you would like us to customize for your use?
4. Are there features you would like assistance with?
5. Are there other tasks in your daily life that you would like to explore whether Notability© would be applicable?
6. Are there any other overall concerns about Notability© you would like to discuss at this time?

Appendix H - In-Person Exit interview

We are so pleased you were able to participate in this research study. Your information will help us learn a lot about how assistive technology impacts college student learning. The purpose of this exit interview is to learn more from your perspective about how the apps and specific features may have had an impact.

First, let's talk about the BEST Suite©

1. How did you use it?
2. What features did you use most and for what purpose?
3. Did you find it useful?
4. What suggestions for changes if any would you suggest?
5. Anything else you would like us to know about your experience with the BEST Suite©?

Next, let's talk about Notability©

6. How did you use it?
7. What features did you use most and for what purpose?
8. Did you find it useful?
9. What suggestions for changes if any would you suggest?
10. Anything else you would like us to know about your experience with the BEST Suite©?

<u>For the ATIG participants:</u>

You were included in our AT intervention group and you were connected with an OT graduate student throughout the eight-week study.

1. What was this experience like for you?
2. Can you tell us what aspects if any were helpful?
3. What suggestions do you have for changes if any?

4. Did you find it helpful to receive additional support throughout the study? Why or why not?

For the AT only group:

You were provided with the apps, access to modules for training, and email check-ins periodically throughout the study. Do you think you would have liked additional, more personalized support throughout the study? Why or why not?

Appendix I - IRB Approval Letter

DOMINICAN UNIVERSITY of CALIFORNIA

November 7, 2018

Cayla Chapman
50 Acacia Avenue
San Rafael, CA 94901

Dear Cayla,

On behalf of the Dominican University of California Institutional Review Board for the Protection of Human Participants, I am pleased to inform you that your proposal entitled *Assistive Technology Applications in Higher Education for Students with and without Disabilities* (IRBPHP Application #10706) has been approved.

In your final report or paper please indicate that your project was approved by the IRBPHP and indicate the identification number.

I wish you well in your very interesting research effort.

Sincerely,

Randall Hall, Ph.D.
Chair, IRBPHP