

THESIS

PREDICTING ASSISTIVE TECHNOLOGY SERVICE UTILIZATION AND GRADE POINT  
AVERAGE FOR POSTSECONDARY STUDENTS WITH DISABILITIES

Submitted by

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## ABSTRACT

### PREDICTING ASSISTIVE TECHNOLOGY SERVICE UTILIZATION AND GRADE POINT AVERAGE FOR POSTSECONDARY STUDENTS WITH DISABILITIES

Postsecondary students with disabilities (SWD) face many barriers in their educational endeavors. Assistive technology (AT) is a necessary accommodation for postsecondary SWD intended to increase equitable access to physical and virtual educational environments. Despite the availability of AT for postsecondary SWD, barriers to equal educational opportunities persist. There is limited evidence demonstrating who is using AT or its impact on objective measures of academic performance, such as GPA. This study seeks to fill these evidence gaps. In addition to AT use, there are multiple potential predictors of GPA. The Human Activity Assistive Technology (HAAT) model specifies a transactional relationship between the person, their activity, context, and AT. Each of these pieces interact to influence the outcome. This model was used to consider multiple factors which may influence the outcome of GPA.

The purposes of this study were to 1) explore predictors of AT service utilization, 2) determine if AT service utilization or other personal or contextual factors predict GPA, and 3) identify a relationship between objective academic performance (GPA) and subjective academic performance (modified Canadian Occupational Performance Measure (mCOPM)). Binomial logistic regression was used to explore whether AT service utilization is related to first-generation status, disability diagnostic category, gender, race/ethnicity, socioeconomic status, and/or major. Multiple linear regression was used to determine if final cumulative GPA could be predicted by AT service utilization, first-generation status, disability diagnostic category, gender,

race/ethnicity, socioeconomic status, and/or major. Finally, Pearson correlation was used to identify a relationship between GPA and mCOPM.

While the full model used to explore predictors of AT service utilization was not statistically significant ( $\chi^2 = 15.62$ ,  $df = 10$ ,  $p = 0.11$ , *Nagelkerke*  $R^2 = 0.026$ ), we found first-generation students were significantly more likely to seek AT services, while students with psychological and cognitive disabilities were significantly less likely. The full model used to determine predictors of GPA significantly explained approximately 4% of variation in GPA ( $R^2 = 0.043$ ,  $F = 2.81$ ,  $df = 694$ ,  $p = 0.001$ ). AT service utilization, first-generation status, and multiple disabilities were significant predictors of students' cumulative GPA. In particular, SWD who utilized AT services earned a 0.14 higher GPA than their peers who did not use AT. Additionally, we found a small but statistically significant correlation between GPA and self-perceived academic performance ( $r = 0.21$ ,  $p < 0.01$ ) and satisfaction ( $r = 0.21$ ,  $p < 0.01$ ) as measured by the mCOPM.

Our research indicates personal characteristics, such as being a first-generation college student and type of disability can predict AT service utilization, and AT service utilization is among factors associated with earning a higher GPA. These findings have implications for universities, AT service providers, and SWD. Universities and service providers should be intentional and strategic about promoting AT services to students who are less likely to pursue them, while understanding and emphasizing the relationship between using AT services and increased GPA.

## ACKNOWLEDGEMENTS

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## Introduction

Postsecondary students with disabilities (SWD) experience many barriers to learning and increased risk for academic performance issues that impact academic outcomes, such as grade point average (GPA), persistence, and graduation (Koch, Lo, Mamiseishvilli, Lee & Hill, 2018). In fact, postsecondary SWD are around 24% less likely to graduate than their peers without disabilities (U.S. Department of Education, 2012; Newman et al., 2011). Not earning a postsecondary degree can have lifelong implications for achieving job security and living wages: adults who do not earn a postsecondary degree earn less money on average, are more likely to be unemployed, live in poverty, or be unsatisfied with their career (Pew Research Center, 2014). The dire impact of this discrepancy is highlighted by the sheer and increasing number of SWD in postsecondary institutions. During the 2015-16 school year, there were more than 3,755,000 SWD enrolled in postsecondary educational programs (Snyder, de Brey, & Dillow, 2019). The proportion of SWD in the postsecondary population has notably increased from approximately 11% in 2007-08 (Snyder, de Brey, & Dillow, 2016) to more than 19% in 2015-16 (Snyder et al., 2019). Barriers faced by SWD include physical and virtual inaccessibility, stigma, and discrimination. One student with disabilities described their overall college experience with such barriers as, “It’s just kind of like one wall after another and it’s never ending” (Francis, Duke, Fujita, & Sutton, 2019, p. 252).

The provision of assistive technology (AT) supports and services is intended to lessen and remove the barriers faced by postsecondary SWD. Assistive technology is “any item, piece of equipment, or product system, whether acquired commercially, modified, or customized, that is used to increase, maintain, or improve functional capabilities of individuals with disabilities” (Assistive Technology Act [ATA], 2004, p. 1710). In the postsecondary educational

environment, AT enables students to independently access learning materials in a way that works for them. For example, a student with dyslexia may use text to speech software to listen to their readings. The National Center for Education Statistics found 70% of postsecondary institutions deem AT to be a fundamental support for SWD (Snyder & Dillow, 2013). Assistive technologies most commonly used in postsecondary education include dictation software, magnification software, recording devices, and screen readers (Ofiesh, Rice, Long, Merchant, & Gajar, 2002).

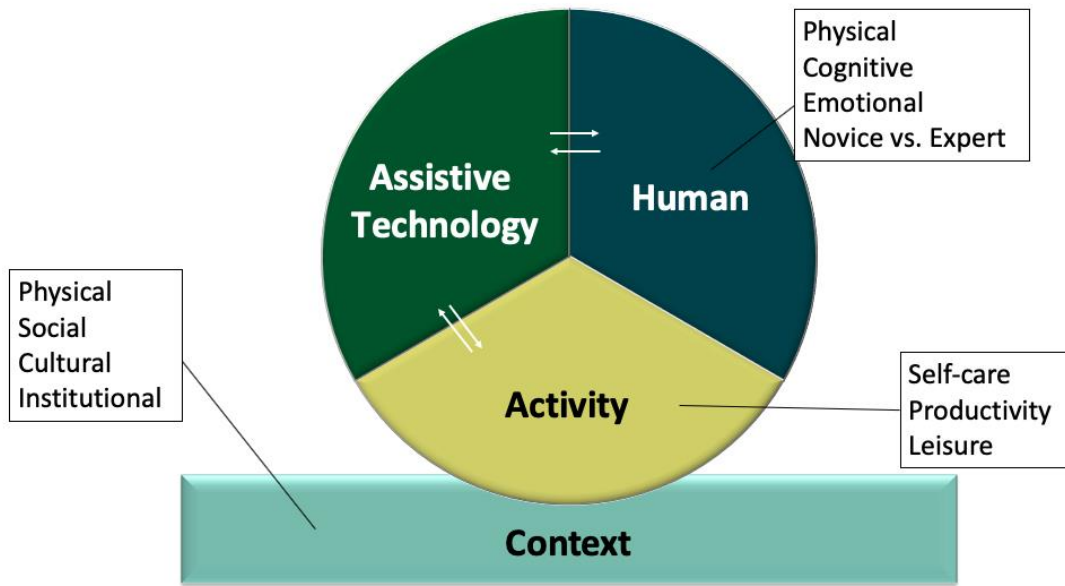
However, barriers persist for SWD despite postsecondary institutions recognizing the importance of AT and legislation such as the *Americans with Disabilities Act of 1990 (ADA)* and Section 504 of the *Rehabilitation act of 1973 (Section 504)*, which mandate AT service provision and other accommodations (U.S. Department of Education, 2018). One explanation for the continued barriers faced by SWD may be that AT services are not being utilized by all students who may need them. Disclosure of a disability is a voluntary process and many students choose not to pursue accommodations. They may fear stigma and discrimination from peers and professors (Hartman-Hall & Haaga, 2002; Martin, 2010), they may not be aware of available services due to insufficient transition planning (Newman & Madaus, 2015) or they may not believe they need or will benefit from accommodations (Collins & Mowbray, 2005). Thus, there is a critical need to understand factors that predict a student's decision to use AT services so that universities and AT service providers can more effectively promote their services and strategically recruit SWD who may need AT services.

Research shows when postsecondary SWD do utilize AT services, they report substantial increases in their academic performance and satisfaction (Malcolm & Roll, 2017b). SWD also report using AT helped them earn better grades and persist in their classes (Malcolm & Roll, 2017b). While these findings demonstrate the benefits of AT supports and services on college

SWDs' perceptions of their academic performance, little is known about how AT services relate to objective academic outcomes such as GPA. Using GPA as an outcome that objectively measures performance for AT users is a meaningful and relevant way to demonstrate to students, administrators, and service providers the vital role of AT in minimizing barriers for SWD to achieve their academic goals. GPA is an important academic performance outcome for postsecondary SWD because it is directly related to both retention and graduation (Pascarella & Terenzini, 2005). For example, Nakajima, Pembo, and Mossler (2012) found those who earned a higher cumulative GPA were twice as likely to persist in their schooling. We posit that AT service utilization is related to GPA, but we also recognize the importance of many other factors.

### **HAAT Model**

As AT service providers, we recognize there is a transactional relationship between a client, their chosen meaningful activity, and the context in which they perform that activity. Both AT services and AT outcomes evaluation must be considered from a multifactorial, ecologically-valid perspective. The Human Activity Assistive Technology (HAAT) model guides this thinking and was used as a framework for this study (see Figure 1). The HAAT model draws from other prominent ecological models in occupational therapy, such as the Person-Environment-Occupation (PEO) model, but the HAAT model uniquely integrates AT into this transactional relationship. According to this model, if the human, activity, assistive technology, and context are a good match, then the client's performance of the chosen activity will improve. In the case of postsecondary education, the client is the student, the activity may be any number of learning or academic-related tasks, and the context is the physical, digital, social, and cultural postsecondary environment (Cook & Polgar, 2015).



*Figure 1.* The HAAT model adapted from Cook and Polgar (2015) illustrates the transactional relationship between a person, the activity in which they engage, the context in which they are embedded, and the AT they are using.

The HAAT model is not only relevant to guiding AT service provision, but it can also be applied to research (Cook & Polgar, 2015; Giesbrecht, 2013). Researchers must consider the myriad of factors, related to the person, activity, environment, and AT that may influence the research outcome. Doing so helps build an evidence base relevant to AT service providers to consider when making and justifying their clinical decisions. For the present study, the outcome of interest is academic performance, as measured by cumulative GPA. GPA is a robust measure which is influenced by many factors. The HAAT model was applied to acknowledge this fact and provide a framework to organize and conceptualize aspects of GPA that may be inherent to the academic activity and context or related to the student.

**Important Variables to Consider**

Many personal, contextual, activity, and AT-related factors may relate to a student’s GPA. Previous research has found demographic variables such as gender, race, and diagnosis to be significantly related to GPA. Kim and Lee (2016) found white students earned a higher GPA

than their non-white peers, females earned a higher GPA than males, and students with multiple disabilities earned a lower GPA than students with a single disability. Further, Malcolm and Roll (2017a) reported self-perceived academic performance and satisfaction after utilizing AT services increased more substantially for students with mood disorders than any other disability category.

First-generation college students have demonstrated different academic needs and outcomes compared to continuing-generation college students. Lombardi, Murray, and Gerdes (2012) classified first-generation SWD as facing a “dual challenge or cumulative risk” (p. 811), suggesting the intersectionality of first-generation status with disability is cause for differential academic outcomes when compared with continuing-generation SWD. They further suggest the importance of researching disability services utilization among this specific population.

Additionally, financial stress and low socioeconomic status have been shown to be related to decreased academic performance (Joo, Durband, & Grable, 2009), and this finding was supported by Lombardi et al. (2012) among first-generation college SWD as well. Finally, Moon, Todd, Morton, and Ivey (2012) suggest science, technology, engineering and math (STEM) courses have very different pedagogies than non-STEM courses resulting in SWD in STEM majors having more complicated accommodation needs and STEM instructors being less prepared to accommodate the needs of SWD due to more diverse activity demands and content delivery methods for STEM courses. While these trends previously reported in the literature indicate the impact of various factors on GPA, there is limited information about the role AT service utilization may have among these other factors in predicting academic performance.

## **Case Example Incorporating the HAAT Model**

The following case example demonstrates how the HAAT model and many of the variables of interest described above can be applied to a practice scenario (see Figure 2). An AT service provider evaluates a client named Alex who is a sophomore in college and has dyslexia. He is a highly motivated and hard-working student. He reports he is an auditory/visual learner but that he is not highly tech-savvy. He is a first-generation college student and a Pell Grant recipient (considerations of the human). He is seeking AT supports to increase his performance in tasks of reading and test-taking. His major is mechanical engineering and he has difficulty completing the assigned readings for his engineering classes. He reports that when he reads, the words jump around on the page and he has to re-read each paragraph more than four times before he can comprehend its meaning. He is rarely able to complete all of his assigned course readings because each reading takes many hours. These barriers with reading have also caused Alex to perform poorly on tests because he quickly becomes anxious and frustrated having to re-read the questions, and he often does not finish (considerations of the activity). He has his own laptop (considerations of the physical context). His family is encouraging and supportive but because neither of his parents went to college, they cannot offer much advice related to the problems he is having in school. He has never received accommodations for his disability before and is nervous his classmates and professors will think he is incapable of completing the rigorous engineering coursework if he uses accommodations. However, his roommate, who uses accommodations and AT encouraged him to self-identify with the disability services office to get the supports he needs. Alex took his roommates advice and went to the disability services office. His disability specialist gave him extra time for exams and a referral to the AT services office (considerations of the social and institutional context). The AT service provider works with the student to

determine a text to speech program that will be able to read his texts including the equations and symbols inherent in engineering readings. He has his textbooks converted to accessible PDF format so he can read them using this text to speech software. The AT service provider trains the student to use the software until he is comfortable and competent enough to use it for readings and taking tests. The outcome is that this student uses AT to enable increased performance of reading and test-taking. He ultimately is able to complete more of his assigned readings, comprehend the material, and perform better on tests because he is able to actually finish them.

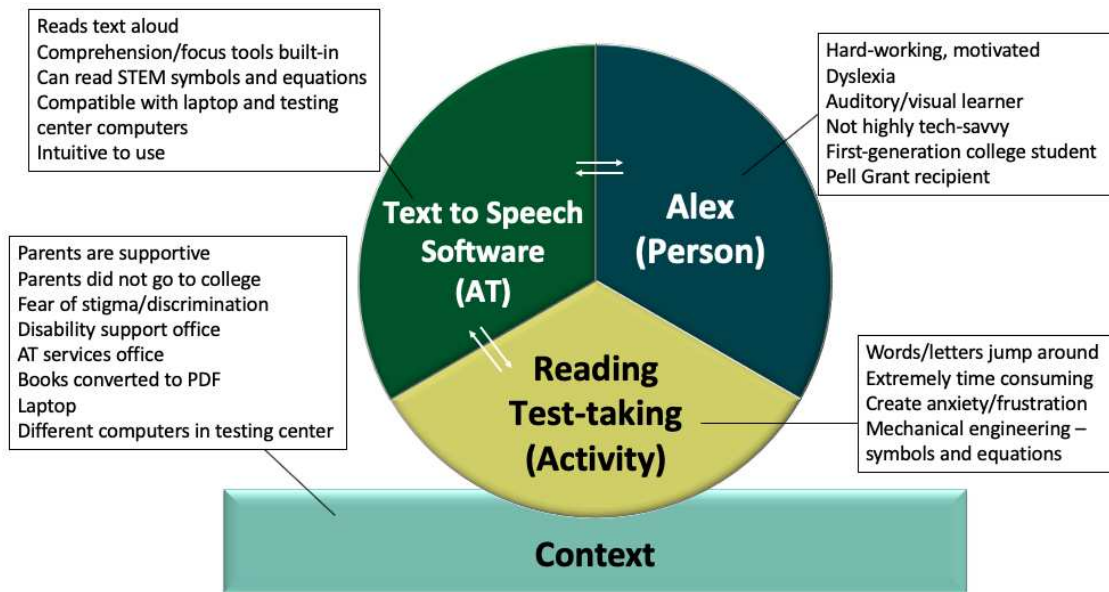


Figure 2. The HAAT Model adapted from Cook and Polgar (2015) applying information from the Alex case example.

### Research Aims

The purpose of this study was to increase our understandings of AT use and GPA for SWD by considering multiple factors involved in the transaction of the student, academic tasks, institutional context, and AT (or lack thereof). There were three research aims that guided this study. 1) Explore whether AT service utilization is related to first-generation status, disability diagnostic category, gender, race/ethnicity, socioeconomic status, and/or major, 2) Determine the

extent to which AT service utilization, first-generation status, disability diagnostic category, gender, race/ethnicity, socioeconomic status, and/or major predict GPA, 3) Examine the association between objective academic performance (GPA) and subjective performance and satisfaction (modified Canadian Occupational Performance Measure (mCOPM)).

## **Methods**

### **Study Design**

This study was a retrospective analysis of secondary data collected during regular service provision in the AT service center at a western public doctoral granting land grant university. Because this was a retrospective study of secondary data, the Institutional Review Board (IRB) did not consider this research data, and therefore obtaining informed consent from participants was not necessary. However, the AT center provided a letter to all students from the research director detailing the potential use of their de-identified data for research purposes and students were given the opportunity to opt out of research by contacting the research director. Data of students who opted out of research were excluded. Data pulled from the AT center's custom database included participant's disability diagnosis and level of AT service utilization. Regardless of whether students followed up on their referral for AT services, their referral was entered into the AT center's database along with pertinent information such as their disability diagnosis. De-identified data were retrieved from the AT center's database for students, including graduate and undergraduate students, who were referred to or sought AT services between fall 2015 and summer 2019. The AT center's data were then matched with demographic and academic performance records from the university's Institutional Research (IR) office. All data were checked to ensure there were no multiple data entries. Participants were excluded from the final analysis if data were missing for any of the predictor variables.

### **AT Service Process**

At the university in which the present research study was conducted, AT services fall under the jurisdiction of a distinct and specialized AT services office, housed within an academic occupational therapy program. This contrasts from a common AT service provision model at

many postsecondary institutions, in which AT services are provided by the general disability services office along with other academic accommodations. Many students who self-identify with the student disability center to receive academic accommodations for their disability are referred to the AT center. The AT center is staffed by occupational therapists, occupational therapy graduate students, information technology (IT) professionals, and one assistive technology professional (ATP). The AT service process is highly individualized and dependent on the unique student's needs. Therefore, the length and intensity of intervention and training varies greatly. Students who initiate services with the AT center go through an initial evaluation meeting, in which the AT service provider thoroughly assesses the student's academic strengths and barriers using a semi-structured interview and a modified version of the Canadian Occupational Performance Measure (mCOPM). Main areas of focus include reading, writing, note-taking, studying, and time management/organization. Time permitting, the service provider tries to provide "quick solutions" or make initial recommendations for AT or referrals to relevant resources during the first appointment, but in most cases, the student is asked to return for one or more follow-up meetings. During follow-up meetings, students work together with AT service providers to find and trial AT solutions and strategies that fit their academic needs. Many of the technologies offered by the AT center include software or applications that can be installed on the student's personal computer, phone, or tablet, or are implemented in a campus computer lab or study room of the student's choosing. Other technologies include hardware, which the student can trial or check out as a loan from the AT center. AT service providers then train the student to use and apply any new technologies or strategies to their academic tasks. The student and AT service provider may meet several times until both parties feel confident that the student is comfortable and competent with using any technology and able to apply the tools to meet their

academic needs. After regular service meetings, the service provider will check in with the student by email or phone periodically to answer any further questions or training needs that may arise.

### **Aim 1 Variables**

The goal of aim 1 was to explore whether AT service utilization was related to first-generation status, disability diagnostic category, gender, race/ethnicity, socioeconomic status, and/or major. The dependent variable for aim 1 was AT service utilization, which was handled as a binary variable. The two groups were the services group and the referral-only group. The services group included students who received AT services. The referral-only group included the students who were referred by the disability services office but never sought AT services.

With the exception of disability diagnostic category, each variable was handled as a binary variable. Several of these variables were inherently binary and several were transformed into binary variables. First-generation college students were those who do not have at least one parent who earned a postsecondary degree. During the admissions process, students indicated if they are a first-generation or continuing-generation college student. This data was collected by IR. Data about disability diagnosis were extracted from the AT center database. Disability diagnoses were grouped into five categories. The cognitive disabilities category included students who identified as having attention deficit disorder/attention deficit hyperactivity disorder, autism spectrum disorder, cognitive or intellectual disability, learning disability or traumatic brain injury (TBI). The psychological disabilities category included students who identified as having mental illness or psychological conditions. Physical disabilities included students who identified with a mobility limitation or orthopedic impairment. Sensory disabilities included students with visual or hearing impairments, and multiple disabilities included students

with multiple disabilities reported. Students with a diagnosis listed as “other” in the database and were excluded from this study. Dummy coding was used to turn these disability categories into independent binary variables to assess the predictive validity of each disability category. Although gender is not binary, it was treated as a binary variable (male or female) for the purposes of this study and students with nonbinary, unknown, or missing gender data were excluded from analysis. Race/ethnicity, also collected by IR during the admissions process, was transformed into minority race/ethnicity vs. non-minority race/ethnicity. Major was transformed into STEM vs. non-STEM major based on the list of STEM majors provided by IR, which follows the STEM-Designated Degree Program List (U.S. Immigration and Customs Enforcement [ICE], 2012). Pell Grant recipient was a binary variable indicating whether or not a student has received a Federal Pell Grant, which is partially contingent upon financial need and therefore an indicator of socioeconomic status (U.S. Department of Education, 2015).

## **Aim 2 Variables**

The goal of aim 2 was to determine if final cumulative GPA can be predicted by AT service utilization, first-generation status, disability diagnostic category, gender, race/ethnicity, socioeconomic status, and/or major. The dependent variable for aim 2 was final cumulative GPA, a continuous variable. Final cumulative GPA was recorded for each student at the end of their final term at the university. For students who graduated or left the university prior to summer 2019, this represented their cumulative GPA for their entire postsecondary career at this university. For students in the dataset who were still attending the university, their cumulative GPA in the summer of 2019 was recorded as their final cumulative GPA.

Independent variables were the same predictor variables used in aim 1, with the addition of AT service utilization. For this aim, AT service utilization was not treated as a binary variable

(as in Aim 1), but rather as a three-level categorical variable: referral-only, intake-only, intake+ follow-up(s). Students in the referral-only group were referred by the student disability center to the AT center but never received AT services. Students in the intake-only group were referred and came to the AT center for an initial meeting but never returned for a follow-up. This was a distinct service level because students in this group may have received the supports they were seeking within the first meeting or they may have decided not to return for other reasons. Students in the intake + follow-up(s) group were referred, came for an initial appointment, and then returned for one or more follow-up appointments.

### **Aim 3 Variables**

The goal of aim 3 was to identify a relationship between objective academic performance (GPA) and subjective performance and satisfaction (mCOPM). Each of these variables were continuous. The mCOPM is a modified version of the Canadian Occupational Performance Measure (COPM), which is an assessment widely used by occupational therapists across various populations and practice settings as a client-centered evaluation and outcome measure. Through semi-structured interview, the therapist asks the client to identify problems with performance in tasks of self-care, leisure, and productivity. The client is asked to rank the importance of each task on a scale of 1-10, then for the tasks they deemed most important, ranks their self-perceived performance and satisfaction on a scale of 1-10. The COPM has moderate test-retest reliability (Eyssen, Beelen, Dedding, Cardol, & Dekker, 2005) and good convergent and divergent validity (Dedding, Cardol, Eyssen, Dekker, & Beelen, 2005). The AT center has modified the COPM to be more specific and relevant to academic tasks, rather than the broad categories of self-care, leisure, and productivity. During the intake appointment, the AT service provider administered the mCOPM, which includes the following tasks: reading, writing, notetaking, time management,

studying, and other (an optional space for students to add an academic task of their choice such as math or research). The student was asked to rank, on a scale of 1-10, how important each task is, how well they perform each task, and how satisfied they are with their performance in each task. All mCOPM scores were an average of the student's scores across each academic category, with the 'other' category excluded if not scored.

### **Statistical Analysis**

IBM SPSS Statistics 26.0 was used to conduct all statistical analyses for this study (IBM, 2019) and alpha set at  $\alpha = 0.05$  for all analyses. For aim 1, binary logistic regression was used to assess the relationship between the binary dependent variable, AT service utilization, and the predictor variables, gender, first-generation status, minority race/ethnicity, Pell Grant recipient, STEM major, and diagnostic category. The forced entry method was used to enter covariates into the regression. *Nagelkerke R<sup>2</sup>* was used to assess the proportion of variance in AT service utilization associated with the predictor variables.

For aim 2, multiple linear regression was used to assess the relationship between the dependent variable of final cumulative GPA and the predictor variables of AT service utilization, gender, first-generation status, minority race/ethnicity, Pell Grant recipient, STEM major, and diagnostic category. The forced entry method was used to enter independent variables into the regression. The coefficient of determination, *R<sup>2</sup>*, was used to explain the proportion of variance in final cumulative GPA predicted by this model. The coefficient of determination, *R<sup>2</sup>*, is a value between  $0.00 \leq R^2 \leq 1.00$ , with 0.00 indicating no relationship and 1.00 indicating 100% of variance in GPA can be explained by this combination of independent variables.

For aim 3, Pearson correlation was used to assess the relationship between subjective self-reported measures of academic performance and satisfaction, as measured by mCOPM, and

objective measures of academic performance, as measured by final cumulative GPA. We examined GPA and mCOPM data for normality. Although data were slightly negatively skewed, data were fairly normally distributed and therefore, Pearson correlation was appropriate, instead of a nonparametric correlation measure such as Spearman rho. To determine the strength of a significant correlation, the following criteria were used: a value of  $r > 0.75$  would be considered a strong positive relationship,  $0.50 < r < 0.75$  would be considered a moderate positive relationship,  $0.25 < r < 0.50$  would be considered a fair positive relationship, and  $0.00 < r < 0.25$ , would be considered a small relationship (Portney & Watkins, 2009).

## Results

### Descriptive Data

There were 956 students in the dataset, though not all students had complete data for all variables of interest. Total sample size for each variable and characteristics are represented in Table 1. Gender was fairly evenly split among this sample, with 47.4% of the sample identifying as male and 52.6% female. First-generation students comprised 22.0% of the sample, while 20.0% identified as minority race and/or ethnicity, 24.7% received a Pell Grant, and 46.5% were STEM majors. The largest diagnostic category was cognitive disability, which included 54.9% of students, and the smallest category, sensory, included 4.2% of students. All students in the sample were referred for AT services, however, 34.3% never followed up on the referral (referral-only group), 17.5% completed the intake process and appointment with the AT office (intake-only group), and 48.2% sought services and continued services after their intake appointment (intake + follow-up). The average final cumulative GPA was 2.78 (SD=0.78).

Table 1. Characteristics of the sample

<b>Variable</b>	<b>Frequency (n)</b>	<b>Percent (%)</b>
<b>Gender</b>		
Male	453	47.4
Female	503	52.6
Total	956	
<b>Generation status</b>		
Continuing generation	746	78.0
First-generation	210	22.0
Total	956	
<b>Race/ethnicity</b>		
Non-minority	728	80.0
Minority	182	20.0
Total	910	
<b>Pell Grant Recipient</b>		
No	720	75.3
Yes	236	24.7
Total	956	
<b>Major</b>		
Non-STEM	460	53.5
STEM	400	46.5
Total	860	
<b>Diagnostic category</b>		
Cognitive	463	54.9
Psychological	86	10.2
Physical	54	6.4
Sensory	35	4.2
Multiple	205	24.3
Total	843	
<b>AT Service Utilization</b>		
Referral-Only	323	34.3
Intake-Only	165	17.5
Intake + Follow-up(s)	453	48.2
Total	941	
<b>Variable</b>	<b>Frequency (n)</b>	<b>Avg (SD)</b>
Final Cumulative GPA	812	2.78 (0.78)
mCOPM Performance Reassessment Score	359	7.46 (1.22)
mCOPM Satisfaction Reassessment Score	359	7.35 (1.57)

### AT Service Utilization

The full model for predicting AT service utilization was not statistically significant ( $\chi^2 = 15.62$ ,  $df = 10$ ,  $p = 0.11$ , *Nagelkerke*  $R^2 = 0.026$ ), indicating the independent variables did not

collectively predict if a student will utilize AT services. Examination of independent predictor variables revealed first-generation students were 52% more likely to seek AT services than continuing generation students ( $p = 0.040$ , CI = [1.020, 2.263]). Additionally, when compared with students in other disability categories, students with cognitive and psychological disabilities were 35% ( $p = 0.032$ , CI = [0.442, 0.964]) and 51% ( $p = 0.014$ , CI = [0.395, 1.574]) less likely, respectively, to seek AT services. The remaining independent variables, gender, minority race/ethnicity, Pell Grant recipient, STEM major, physical, sensory, and multiple disabilities, were not significantly related to AT service utilization.

### **GPA**

The full model for predicting GPA was statistically significant ( $F = 2.81$ ,  $df = 694$ ,  $p = 0.001$ ) and explained 4.3% of variation in final cumulative GPA ( $R^2 = 0.043$ ). Being a first-generation student was associated with 0.16 lower GPA compared with continuing-generation students ( $p = 0.035$ , CI = [-0.311, -0.011]). Each increase in AT service utilization level (e.g., intake-only to intake+ follow-up(s)) was related to a 0.14 grade point increase in GPA ( $p < 0.001$ , CI = [0.070, 0.200]). For example, if a student who was referred for AT services but never scheduled an appointment with the AT services office (i.e., referral-only) earned a 3.00 GPA, the student who initiated AT services but only attended one appointment (i.e., intake-only) would earn a 3.14 GPA, and the student who attended multiple AT services appointments (i.e., intake + follow-up(s)) would earn a 3.28 GPA. Being in a specific disability category was generally unrelated to GPA, but having multiple diagnoses was associated with 0.25 higher GPA ( $p = 0.046$ , CI = [0.005, 0.496]). Gender, minority race/ethnicity, Pell Grant recipient, and STEM major were not statistically significant predictors of final cumulative GPA.

Table 2. Regression results for binary logistic regression predictors of AT service utilization and multiple linear regression predictors of final cumulative GPA.

<b>Predictors of AT service utilization</b>							
<b>Dependent variable</b>	AT service utilization						
<b>Regression result</b>	$\chi^2 = 15.62, df = 10, p = 0.11, Nagelkerke R^2 = 0.026$						
<b>Coefficients</b>							
Predictor variable	B	S.E. B	Wald $\chi^2$	p	Exp (B)	95% C.I. for Exp(B)	
						Lower	Upper
<b>First-generation</b>	0.418	0.203	4.224	0.040	1.519	1.020	2.263
<b>Gender</b>	-0.146	0.156	0.877	0.349	0.864	0.637	1.173
<b>Race/ethnicity</b>	0.077	0.190	0.165	0.684	1.080	0.745	1.566
<b>Pell recipient</b>	-0.166	0.187	0.785	0.375	0.847	0.587	1.222
<b>STEM major</b>	-0.005	0.154	0.001	0.974	0.995	0.736	1.345
<b>Cognitive disability</b>	-0.426	0.199	4.604	0.032	0.653	0.442	0.964
<b>Psychological disability</b>	-0.718	0.292	6.057	0.014	0.488	0.275	0.864
<b>Physical disability</b>	-0.237	0.353	0.453	0.501	0.789	0.395	1.574
<b>Sensory disability</b>	0.368	0.492	0.557	0.455	1.444	0.550	3.790
<b>Multiple disabilities</b>	-0.103	0.298	0.118	0.731	0.903	0.503	1.619
<b>Predictors of final cumulative GPA</b>							
<b>Dependent variable</b>	GPA (continuous)						
<b>Regression result</b>	$R^2 = 0.043, F = 2.81, df = 694, p = 0.001$						
<b>Coefficients</b>							
Predictor variable	B	S.E. B	$\beta$	t	p	95% C.I. for B	
						Lower	Upper
<b>AT Service utilization</b>	0.135	0.033	0.154	4.080	<0.001	0.070	0.200
<b>First-generation</b>	-0.161	0.076	-0.086	-2.110	0.035	-0.311	-0.011
<b>Gender</b>	0.109	0.062	0.069	1.769	0.077	-0.012	0.230
<b>Race/ethnicity</b>	0.047	0.075	0.024	0.632	0.528	-0.100	0.195
<b>Pell recipient</b>	0.067	0.072	0.038	0.940	0.348	-0.073	0.208
<b>STEM major</b>	-0.062	0.061	-0.039	-1.014	0.311	-0.182	0.058
<b>Cognitive disability</b>	0.046	0.076	0.029	0.606	0.545	-0.103	0.196
<b>Psychological disability</b>	0.032	0.116	0.012	0.277	0.782	-0.196	0.260
<b>Physical disability</b>	0.216	0.155	0.056	1.391	0.165	-0.089	0.521
<b>Sensory disability</b>	0.130	0.165	0.032	0.792	0.428	-0.193	0.454
<b>Multiple disabilities</b>	0.250	0.125	0.084	2.001	0.046	0.005	0.496

### mCOPM

mCOPM scores were only available for students in the intake + follow-up(s) group because mCOPM reassessment is administered during a follow-up appointment. There were 359 students with complete data for mCOPM performance and satisfaction at reassessment. The average mCOPM performance score upon reassessment was 7.46 (SD = 1.22) and the average

mCOPM satisfaction score upon reassessment was 7.35 (SD = 1.57). The average final cumulative GPA was 2.78. See Table 1 for additional details. Using Pearson Correlation, a small but statistically significant correlation was found between final cumulative GPA and both mCOPM performance ( $r = 0.214, p < 0.001$ ) and satisfaction scores ( $r = 0.216, p < 0.001$ ). These findings indicate students who earned a higher GPA tended to perceive themselves to have better performance and be more satisfied with their academic performance.

## Discussion

### AT Service Utilization

Our findings align with previous research indicating not all students are equally likely to seek AT services after being referred (Malcolm & Roll, 2019). Understanding the likelihood that a student will seek AT services based on their personal characteristics is necessary for increasing outreach and promotion of AT services. Malcolm and Roll (2019) found that as class-level increased, students were more likely to seek AT services. Our research adds to this finding, showing generation status and diagnostic category were also related to likelihood of seeking AT services. First-generation SWD were more likely to seek AT services than their continuing-generation peers. Lombardi et al. (2012) similarly found first-generation SWD were more likely to seek general disability accommodations than continuing-generation SWD. However, these findings do not mean that efforts to promote services specifically to first-generation SWD should be decreased or diverted towards other students. These findings may, in fact, reflect a need for first-generation students to depend on institutional supports more than familial supports (Lombardi et al., 2012). First-generation students tend to experience more challenges in their transition from high school to postsecondary school and they may have different financial, emotional, and social supports from their families than do continuing-generation students (Pascarella, Pierson, Wolniak, & Terenzini, 2004; Bryan & Simmons, 2009). Therefore, it remains critically important to target outreach specifically to first-generation students to ensure they continue to seek all available support services offered by their institution. Additionally, students with cognitive or psychological disabilities were less likely to seek AT services. A similar trend was found among students with learning disabilities who were less likely to seek general disability support services (Newman & Madus, 2015). This is a problem that warrants

attention because each of these diagnostic categories comprise large numbers of SWD. Among our sample, the cognitive diagnosis category was the largest, while psychological diagnoses are highly prevalent and increasing nationwide, especially among college-age adults (National Institute of Mental Health, 2019). Each of these diagnostic groups have reported substantial academic benefits of utilizing AT services (Malcolm & Roll, 2017a). In fact, students with mood disorders, a diagnostic category similar to our psychological disability category, perceived the greatest increase in their performance of academic tasks following AT service utilization, compared to other diagnostic groups (Malcolm & Roll, 2017a). Notably, cognitive and psychological disabilities tend to be non-apparent disabilities. Hamblet (2009) discusses how students with non-apparent disabilities may be less likely to receive accommodations in grade school or even less likely to be screened and identified as having a disability. College may be the first-time many students in these cognitive and psychological disability groups are seeking services, and very likely the first time they have had the opportunity to use AT as an accommodation for their disability. Alternatively, many students with learning disabilities or mental health diagnoses do not seek accommodations because they worry they will be stigmatized or discriminated against (Hartman-Hall & Haaga, 2002; Martin, 2010). Considering students with cognitive and psychological disabilities benefit greatly from using AT services, yet are less likely to seek them out independently, reveals a need for institutions and AT service providers to be more active and intentional about recruiting these students.

Other variables were not significantly predictive of AT service utilization including gender, minority race/ethnicity, Pell Grant recipient, STEM-major, and diagnosis of physical, sensory, or multiple disabilities. Similarly, Newman and Madus (2015) reported gender, and race/ethnicity were not related to general disability service utilization. Taken together, our study

and Newman and Madus (2015), show there were not disparities in disability or AT service utilization related to gender or minority race/ethnicity characteristics. However, contrary to our finding that Pell Grant recipient had no effect on service utilization, they found household income to have a significant effect. While household income and Pell Grant were both intended as measures of family socioeconomic status, they may not capture the same students because there are additional criteria, beyond income, the student must meet to receive a Pell Grant (U.S. Department of Education, 2015).

Despite all that we learned about student characteristics that relate to AT service utilization, our full model was not statistically significant, indicating there are other variables that also relate to AT service utilization. Characteristics such as first-generation status, disability type, and socioeconomic status should continue to be explored as predictors of AT service utilization. Targeted outreach to students who are less likely to seek services may increase their service utilization. Understanding the relationship between AT service utilization and GPA could be helpful for promoting AT services to students who do not intend to seek AT services.

## **GPA**

Objective outcomes for AT service utilization among postsecondary SWD are underreported in the literature. Research that captures the subjective experience of AT users found 84% of students believed using AT related to improvements in their grades (Malcolm & Roll, 2017b). However, until now, we did not have sufficient evidence to substantiate these outcomes objectively. A few studies have examined AT among other disability accommodations but did not find AT to be a significant or positive predictor of GPA (Chiu et al., 2019; Kim & Lee, 2016). Studying AT services and use separately from general disability services is warranted because AT tools uniquely help students gain equal access to digital educational

materials, which is increasingly important in postsecondary education with the growing use of digital learning platforms and electronic course materials (Schmid et al., 2014). While AT service utilization is underreported, other student characteristics have repeatedly been shown to relate to GPA, and therefore, were also accounted for in our study. We found AT service utilization, generation status, and having multiple disabilities to be significantly related to GPA.

Each level of service utilization (referral-only, intake-only, intake + follow-up(s)) predicted an increase in final cumulative GPA. This finding differs with previous research that found no relationship (Chiu et al., 2019) or a negative relationship (Kim & Lee, 2016) between AT and GPA. This difference may be due to our university's relatively unique and comprehensive approach to AT service provision and/or our study's method of measuring AT utilization. Chiu et al. (2019) and Kim and Lee (2016) examined the provision of multiple academic accommodations, including AT, provided by their university's general disability services office. At our university, students who seek accommodations from the general disability services office are referred for AT services, provided through a distinct and specialized office. We believe our focus and specialized knowledge of AT and our occupational therapy approach results in more thorough evaluation, training, and follow up, which could certainly result in different academic performance outcomes. Additionally, Chiu et al. (2019) used approval to receive AT as their indicator of AT utilization. They suggested their lack of significance could be because students may not actually use recommended accommodations. Whereas, our study identified three distinct levels of service utilization beyond approval of AT use. While we also did not have a metric for whether the AT was actually used by the student for academic tasks, we believe that training and follow up increases a student's likelihood of successfully implementing AT in their lives. Therefore, we are confident that students in our intake + follow-up(s) group

were the most likely to utilize the AT they sought, and we are encouraged by our finding that AT service utilization was related to an increase in GPA in our AT service center.

Additionally, we found first-generation SWD tended to earn a lower GPA than their continuing-generation peers. This finding was consistent with Lombardi et al. (2012). They suggest this trend to be a result of the intersecting first-generation and disability identities causing the student to be at “cumulative risk” (p. 811) of lower academic performance outcomes. SWD may find it harder to adapt to the new expectations and requirements of the postsecondary educational environment (Finn, 1998), and may encounter inaccessible physical and virtual environments, ignorance, stigma, and discrimination (Francis et al., 2019). Similarly, for first-generation students, the risk of being from a low-income family and/or low socioeconomic background is increased and financial burden has been linked to increased non-persistence (Chen, 2005; Wagner, Newman, & Cameto, 2004). Additionally, first-generation students tend to work more during school, which decreases time available for studying and assignments, and they are less likely to go on to graduate programs after college (Pascarella et al., 2004). Lombardi et al. (2012) posit that being a first-generation student consistently stands out as a significant variable to impact academic outcomes among many demographic and personal factors in research of this nature. This warrants consideration of the specific needs and attributes of this population when promoting and implementing services for SWD (Lombardi et al., 2012) and our study’s finding validates this assertion.

Finally, we found that students who reported multiple disability diagnoses earned a higher GPA than their peers who identify with a single disability diagnosis. This is an important finding that differs from previous work. For example, Kim and Lee (2016) predicted a significant decrease in GPA for students with multiple disabilities. There are several possibilities for why

this difference may exist. One explanation is that students in our sample with multiple disabilities were more prone to seek services and supports. In contrast to students with a single cognitive or psychological diagnosis who are less likely to have received accommodations in secondary school (Hamblet, 2009), students with multiple disabilities may be more likely to have received academic accommodations or used assistive technology in secondary school. This may explain why, within our sample, approximately 71% of students with multiple disabilities sought assistive technology services, compared with approximately 62% of students from all other singular disability categories combined. Another potential explanation for this finding is statistical error caused by unequal numbers of cases amongst groups. The multiple disabilities group was the second largest disability category in our sample (n = 205), behind cognitive disability (n = 463). The smallest disability category was sensory disability (n = 35).

Other variables were not significantly predictive of GPA including gender, minority race/ethnicity, Pell Grant recipient, STEM-major, or the singular disability categories cognitive, psychological, physical, or sensory disability. Previous research has suggested gender is usually not a factor involved in academic performance, especially when the use of technology for academic tasks is incorporated (Dockrell, Bennett, & Culleton-Quinn, 2015). However, we were surprised to find there was no significant relationship between GPA and STEM major because Moon et al. (2012) suggest content of STEM courses tends to require more involved accommodations for SWD and Malcolm and Roll (2019) reported there are less AT options compatible with unique language, symbols and activities required of STEM courses. We classified each student's final major at our university as either STEM or non-STEM according to the list provided by ICE (2012). However, students often change majors throughout the course of their college career and all students take courses outside of their major, which also contribute to

their GPA. These reasons may explain the lack of predictive validity we had expected related to STEM majors.

Although our model to predict final cumulative GPA was statistically significant, it only accounted for ~4% of variation in final cumulative GPA, indicating there are additional variables to explore. According to the HAAT model, “the performance of the entire system, rather than evaluation of human performance, [is] considered paramount” (Giesbrecht, 2013, p. 231). Therefore, we must consider the myriad of other personal, activity, and contextual factors that influence GPA for postsecondary SWD who use AT. Other variables related to the human may include self-efficacy, self-advocacy, motivation, post-graduation goals, pre-college variables, and the use of other disability services. For example, number of credits attempted, self-advocacy skills, and academic self-efficacy, or confidence in one’s own academic capabilities, have been shown to positively predict GPA among student-veterans with disabilities (Kinney & Eakman, 2017; Eakman, Kinney, Schierl, & Henry, 2019). Tinto’s (1993) institutional departure model is a prominent and well-researched model in higher education retention research, which suggests pre-college variables and postsecondary goals contribute to academic performance. Variables related to the context may include campus-wide social attitudes towards diversity and disability, attitudes of professors towards students with accommodations, disability policies, financial aid resources, and campus-wide accessibility initiatives. Herbert et al. (2014) explored financial aid and living situation but did not find these factors to be predictive of graduation for college SWD. Variables related to the activity may include credit load, course requirements, mode of instruction, and format of learning assessment (i.e., tests, papers, projects, etc.). Variables related to the use of assistive technology include adoption vs. abandonment of AT (Cook & Polgar, 2015).

Several studies that report the subjective experience of SWD lend additional guidance as to factors that influence student's academic success, even though they do not look at impact on GPA or graduation, specifically. In a multi-university study that surveyed students with psychiatric disabilities, Collins and Mowbray (2005) found many students reported low self-esteem and conflicts with faculty to be barriers they have encountered. They also surveyed faculty and found that over 19% of instructors had questioned whether students with disabilities could handle their course load and 5% of instructors believed that students with disabilities should not receive differential treatment. Though impact of these beliefs on GPA were not evaluated in either of these studies, it is clear that there are barriers within the environment that SWD uniquely face which likely influence their academic success.

### **mCOPM**

Occupational therapists place great value in understanding the subjective experience of their clients. Understanding the relationship between subjective and objective academic outcomes for AT users offers a more comprehensive appreciation of the relationship between academic performance and the use of AT services. We hypothesized there would be a strong positive correlation between mCOPM and GPA. However, we found only a small positive correlation between GPA and mCOPM performance and satisfaction scores. In a study by Malcolm and Roll (2017b), students demonstrated an increase in perceived academic performance as measured by the mCOPM and also reported they believed using assistive technology positively influenced their GPA. However, their research did not measure GPA, and only looked at student's self-perception of their GPA. To our knowledge, there are currently no other studies that specifically examined a correlation between the COPM and GPA. Perhaps term GPA for the semester in which the student completed mCOPM reassessment would be a stronger

and more relevant variable. For some students, there are many semesters between completion of mCOPM reassessment and their final semester, from which their final cumulative GPA was used. In future studies, use of semester GPA during the semester of mCOPM reassessment may provide a more direct and meaningful correlation between objective and subjective academic performance.

### **Limitations and Future Research**

This research was conducted using secondary data from a single university, and therefore results may not be generalizable to all postsecondary institutions or AT settings. Furthermore, the university in which this study was conducted follows a relatively unique AT service model in which AT services are not provided out of the general disability support services office, but instead out of a distinct office, the AT center, staffed by occupational therapists, information technology specialists, and an assistive technology professional. Services provided by the AT center follow the occupational therapy process and the HAAT model to provide comprehensive and thorough evaluation, training, and follow up with all students who receive services. This model is believed to increase adoption of AT and foster improved performance of academic tasks using AT. While this is a strength of the AT center at our university, it is inherently a limitation to our research because it further limits generalizability to other institutions that follow different service models. A multi-university study comparing AT service models is needed to understand how students may benefit differently from receiving AT services under different service models.

Due to the use of an observational methodology and secondary data, we are not able to conclude causal relationships. For example, students who seek AT services may be intrinsically more motivated and/or better self-advocates than those who do not. They may be more apt to seek out other disability support services such as division of vocational rehabilitation (DVR), or

campus support services such as TRIO programs, tutoring and study groups, cultural heritage pride groups, etc. These factors may be related to the increase in GPA found for AT service users. There may be students who received AT supports outside of the AT center and conversely, students who received AT supports from the AT center but never actually utilized the AT, as students do occasionally stop using AT due to malfunctioning or complicated technologies, cost, discomfort with using, or location (Malcolm & Roll, 2017b). Using an additional measure to verify a student's regular use of AT beyond follow-up would allow researchers to evaluate the impact of AT use rather than AT service provision. In future research, data should be collected intentionally to capture meaningful variables of interest, such as AT use, self-advocacy, or academic motivation. Using a prospective or experimental research design rather than a retrospective observational design is warranted to further delineate whether it is the use of AT or characteristics of the AT user that contribute to increased academic performance.

## **Conclusion**

While disability accommodations and AT services exist in postsecondary settings to support SWD and minimize barriers to achieving academic success, a discrepancy in academic outcomes for SWD persists. There has been relatively little information published about why students do initiate disability services and even less about what factors may cause a student to seek services beyond general disability accommodations, like AT services. Additionally, until now, there has not been research specifically evaluating the relationship between AT service utilization and GPA. The present research study investigated these questions, adding new findings to the evidence base that are relevant to AT service providers, postsecondary institutions, and SWD. Factors related to diagnosis, and first-generation status predict AT service utilization and should be considered when promoting such services to SWD. Furthermore, AT service utilization, first-generation status, and having multiple diagnoses are related to final cumulative GPA. More research is needed to determine other factors associated with both outcomes as we continue to build evidence about services and outcomes for SWD who use AT so that institutions and service providers can best serve and promote equal opportunity for postsecondary SWD.

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