AI-Based and Mobile Apps: Eight Studies Based on Post-Secondary Students' Experiences

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Abstract

We present eight studies dealing with artificial intelligence and mobile apps that assist post-secondary students with attention deficit hyperactivity disorder (ADHD) and other disabilities with their academic work. Study 1, based on an advisory board and on a Google search, provided glowing testimonials about AI tools. However, Study 2, a scoping review of the scientific literature, showed that research is scant. In Study 3 we explored how students with and without disabilities used AI-based intelligent virtual assistants to do schoolwork. Our findings show that students are not realizing the potential of these tools. In Study 4, we explored AI-based technologies used by 163 students with and 74 students without disabilities and in Study 5 we investigated AI-based technologies professors required students to use. These studies helped identify sustainable practices. In studies 6, 7 and 8 we explored apps for students with ADHD. Overall, the results show that students with and without disabilities use similar technologies. There will always be a place for traditional assistive technologies such as Jaws and ZoomText. However, general use technologies play an important role because the most common disabilities reported by students on post-secondary campuses include nonvisible disabilities, such as ADHD, mental and chronic health challenges, and specific learning disorders.

Keywords

AI, artificial intelligence, post-secondary students with disabilities, college, university, ADHD, Attention Deficit and Hyperactivity Disorder, mobile apps.

Introduction

Our goals in conducting the eight studies described below were to: (a) explore how useful artificial intelligence (AI) based technologies and apps are for students with disabilities, (b) discover what AI-based apps and technologies students with disabilities use to do schoolwork, (c) compare how students with and without disabilities use technologies and other apps to do schoolwork, (d) explore which technologies and apps used by college professors during COVID-19 emergency remote teaching should be retained for future face-to-face and hybrid classes, (e) explore whether students with attention deficit hyperactivity disorder (ADHD) use apps recommended for them by experts, and (f) to present evidence-based AI-based and mobile apps we can recommend for students with disabilities, access service providers and post-secondary faculty.

Artificial Intelligence (AI)

The popular press suggests that students with various disabilities, their instructors, and the professionals who provide them with assistive technology services can all benefit from the use of hundreds of AI-based apps (Martinez; Lillywhite and Wolbring). AI, used today in many technologies, has the potential to be especially helpful for students with various disabilities, not only as tools to do schoolwork, but also as assistive aids (see Martiniello et al.).

We have been unable to find a consistently used definition of AI. Here we use that of Microsoft (page 7): "AI represents a broad range of technologies that can perceive, learn, reason, assist in decision-making, and act to help solve problems. AI technology continually learns from user interactions and organizational data to provide better insights. These technologies can interpret the meaning of data from text, voice, and images, identify trends, and form conclusions."

AI can help students access information through various modalities. For example, Zoom ("Managing") and Microsoft Teams ("Use") can provide live captions as well as transcripts. Similarly, PowerPoint ("Present") offers live captions. These are beneficial for students with

hearing impairments and second language learners. Seeing AI can convert visual information into speech (Granquist, et al. page 115), which helps students with visual impairments. Students can use dictation in Word (Whitney) and Google Docs ("How"). This is especially useful for students with hand, arm or shoulder impairments and those with specific learning disorders. Students can also use AI to assist with organization (e.g., IFTTT) to automate routine tasks (Tivers). Articles and web sites are devoted to image and facial recognition, text-to-speech, and text summarization (Martinez).

We wanted to know more about AI-based apps and technologies that could benefit post-secondary students with disabilities. So, we carried out a series of studies to explore this topic.

Study 1: Advisory board recommendations. In 2020 we convened two advisory board meetings with 38 participants, composed of post-secondary students and consumers with disabilities, faculty, post-secondary disability/accessibility service providers, and technology experts from five countries. Advisory board members were enthusiastic about the potential of AI for students with disabilities. Based on their suggestions, we prepared an annotated listing of AI-based tools and related resources (see "Canadian") and synthesized our findings in a recent paper (Martiniello et al.). Our results, and those of a Google search, provided glowing testimonials. However, does this correspond with the scientific literature?

Study 2: Scoping review. We reviewed the scientific and gray literatures regarding AI and technologies that post-secondary students with disabilities use for schoolwork (Fichten et al., State). We searched 10 databases (e.g., ERIC, ACM Digital Library, Medline) for articles published in English between 2010 and 2020. Typical search terms used included: *("artificial intelligence" OR "machine learning" OR "intelligent tutor" OR "smart tutor" OR "virtual assistant") AND (disabilit* OR disabled OR impair* OR "special need*" OR blind* OR deaf* OR handicap*) AND ("higher education" OR "post-secondary" OR "post-compulsory" OR college OR university OR*

undergraduate) AND (teach* OR learn* OR educat* OR instruct* OR classroom OR school*).

Our main findings indicate that (1) there is no generally agreed upon definition of AI, (2) there is a huge discrepancy between the scientific literature and the hype about AI in the popular press and, (3) scientific articles were devoted primarily to tool development. Studies reviewed also showed that the most commonly mentioned tools are intelligent virtual assistant applications, Alexa, Siri, and Google Assistant, with the focus on facilitating the ability of students with disabilities to provide oral instructions and by communicating with these apps through voice input.

We concluded that while the potential of AI-based tools for post-secondary students with disabilities seems enormous, informed research is scant and urgently needed.

Study 3: Intelligent virtual assistants. Since virtual assistants (e.g., Siri, Google Assistant, Alexa, Bixby) were most frequently mentioned in the scientific literature, we wanted to know which of these students actually used to do schoolwork, how they input information, and the tasks for which they used these tools. A quick overview of the popular press literature showed a variety of schoolwork related tasks for which students can use virtual assistants (Vo).

In 2020, using an accessible LimeSurvey questionnaire, we surveyed 172 university and college students (121 with and 51 without disabilities) who indicated using at least one intelligent virtual assistant (Fichten et al., Academic). Most students with disabilities self-reported one or more of the following: mental health related disabilities, ADHD, a learning disability, chronic medical / health problems, and neurological disorders. Least frequently reported were visual, hearing, and mobility impairments. Of the 121 students, 50% had multiple disabilities.

Overall, our findings show that students did not frequently use intelligent virtual assistants for their studies. Table 1 shows that between two percent (Bixby and Alexa) and 15% (Google Assistant) of students used virtual assistants to complete schoolwork.

Table 1. Percentage of Students with Anand without Disabilities Who Use Google Assistant, Siri, Alexa and Bixby.

Intelligent Virtual Assistants	Students with Disabilities (n=121)	Students without Disabilities (n=51)
Google Assistant	15%	8%
Siri	12%	12%
Alexa	2%	4%
Bixby	2%	2%

Table 2 shows that students with and without disabilities used more Apple than Android devices and more smartphones than tablets.

Table 2. Number of Students With and Without a Disability Who Used Apple and Android Smartphones and Tablets.

Group	Any smartphone use	iPhone use	Android Phone use	Any tablet use	iPad use	Android tablet use	Any device use
Students with a disability	111	65	46	44	31	10	121 of 163 students
Students with no disability	45	34	11	20	18	1	51 of 74 students

We also asked students to write about the tasks for which they used the virtual assistants. Coded results show that students primarily used these for calendar alerts, Internet research, and the definition of words. Input differed across intelligent virtual assistants. For Google Assistant and Amazon Echo, most students used voice input. For Siri students relied on both voice and typing.

Overall, we concluded that students are not currently realizing the potential of intelligent virtual assistants for completing schoolwork. This led to Study 4.

Study 4: "Real-world" uses of AI-based tools by post-secondary students to do schoolwork. We surveyed 237 postsecondary students (74 without disabilities and 163 with

disabilities). Students had diverse disabilities, with the most common being mental health difficulties, ADHD, chronic medical / health problems, and neurological disorders). Students mentioned 278 apps in total (Fichten and Vo). By referring to the web description of the apps we determined that approximately 20% of these used AI (e.g., Adobe Creative Cloud, DeepL, Dragon, Dropbox, Evernote). With the exception of a few specialized apps (e.g., Seeing AI, Microsoft Lens), students with and without disabilities listed similar technologies. However, it is important to note that many of the AI-based apps are Google and Microsoft products.

This study provided insight into the AI-based tools used by post-secondary students in 2020. However, we could not identify which tools students chose versus those that professors required.

Study 5: AI-based technologies professors required students to use. In 2021 we carried out an email-based study with 24 participants (20 students with and 4 without disabilities) (Fichten et al., Digital). Of the 13 technologies listed by at least two students, as determined by the web descriptions less than ½ of these used AI. These include Zoom, Microsoft Teams, Microsoft 365, VMware Horizon, and WebEx. Coded responses indicated a series of problems related to AI and non-AI based technologies. These include software and platform issues, how professors managed their courses, problems with connectivity, classmates' computer behaviors, and equipment issues.

In this study, we identified helpful practices and solutions to problems that provide the foundation for sustainable best practices for future online, hybrid, and blended courses.

What Mobile Apps do Students with Attention Deficit Hyperactivity Disorder (ADHD) Use?

In a series of three studies, we investigated specific technologies used by one of the most prevalent groups of students with disabilities on campus, those with attention deficit hyperactivity disorder (ADHD) (Gagné and Bussières, page 11; Green and Rabiner, page 560).

Study 6: Is there an app for that? In 2020, we compiled a list of mobile apps recommended for post-secondary students with ADHD to do schoolwork (Fichten et al., Is there).

We based this list on 23 articles or items in Google and Google Scholar between the years 2017 and 2020. Key words informing our search included *("attention deficit hyperactivity disorder" OR "ADHD") AND "apps" AND "college.*" We also checked the past three years of ADDitude Magazine as well as websites and Facebook groups. This comprehensive search resulted in identification of 208 different apps (Jorgensen et al.). Often, it was only one individual, from among people with ADHD and experts, who recommended the app. We calculated how often our various sources mentioned each app and checked if these apps were available in the Apple App Store and the Google Play Store in 2020. In Table 3 we present an annotated listing of the 20 schoolwork related apps mentioned by at least two sources. Based on their web descriptions, only five of the 20 technologies mentioned by experts used AI: Asana, Evernote, Google Calendar, IFTTT, and Todoist.

Table 3. Brief Descriptions of the 20 Apps Recommended by Experts for Students with ADHD.

App	Brief Description
Asana	Helps set goals and track progress using a Gantt chart
Dragon Anywhere	Dictation app for writing documents
Dropbox	Online file hosting that stores all files in the same place, across all devices
Due	'Auto Snooze' automatically reschedules overdue reminders as repeat reminders
Evernote	Task management and note taking that keeps all notes in one place
Focus@Will	Focusing music subscription service; customizes music for different activities
Forest	Growing a virtual tree: helps to set one's smartphone for specific time periods
Freedom	Focusing, distraction management app; blocks websites, apps, etc. for specific time periods
Google Calendar	Web based calendar and reminder that integrates with Gmail
IFTTT (If This Then That)	Connects apps, services, and devices to automate tasks
Microsoft To Do / Wunderlist	Task management app with a daily planner: breaks tasks down into simple steps
Mindnode 5	Mind-mapping brainstorming tool; users can add visual tags to track progress

App	Brief Description
Pomodoro Timer	Focusing app; sets study and break times
Quizlet	Study app that uses flashcards and games to facilitate learning
Read&Write	Provides text-to-speech, word prediction, and other literacy tools
Remember the Milk	Reminders by email, text, and Twitter; works across all devices
RescueTime	Time management app that tracks time spent on apps, websites, and specific documents
Time Timer	Visual countdown timer; helps notice time remaining for a task
Todoist	Prioritizes tasks, sets daily and weekly goals, rewards for completion
Voice Dream Reader	Provides text-to-speech reading aloud with synchronized highlighting

Although we now had an idea about what apps were recommended for them, we did not know whether students with ADHD were aware of these apps and if they used them.

Study 7: Do students with ADHD know about and use the apps recommended by the experts? In 2020 we used an online LimeSurvey to ask 35 students with ADHD and 74 students without disabilities whether they used any of the 20 recommended apps and which ones they found helpful (Fichten et al., Let's). We excluded students with specific learning disorders because we did not want to confound the findings with technologies intended for students with learning disabilities. The most common comorbidity for the 35 students with ADHD was a mental health related disability ($n = 21$). We listed the 20 schoolwork related apps presented in Table 3 and asked students to check: "Which of the following apps have you tried? (Select all that apply)." Using JavaScript, we presented students with a list of apps that they indicated having tried and asked them "Of the apps that you tried, which ones did you like? (Select all that apply)."

Both groups of students were familiar with: Asana, Dragon, Dropbox, Due, Evernote, Forest, Google Calendar, IFTT, Pomodoro Timer, Quizlet, Read&Write, and Microsoft To Do / Wunderlist. Both groups liked most of these, although students with ADHD did not indicate liking

Asana, Due, Microsoft To Do / Wunderlist or Forest.

This study showed that students with ADHD and students without disabilities used the same apps and found many of the same apps helpful. Students with ADHD were familiar with approximately half of the 20 "recommended" apps and liked even fewer. To gain a more comprehensive understanding, it is crucial to find out how they use these apps and technologies.

Study 8. How do apps help students with ADHD do academic work in class and out of class? In 2021 we interviewed nine of the 35 participants with ADHD from Study 7, either via Zoom or telephone (Fichten et al., Let's). Coded responses indicate that when students were in class (face-to-face or by Zoom), they were most likely to use their smartphones' camera app to take pictures of notes and information on the board or the screen, especially when instructors did not post these online. They also used recording apps to help with momentary lapses of attention or missed classes. As with camera apps, students reported that recording was most useful when professors did not post their lectures online. Kahoot was also frequently mentioned; students used it to ask questions in class, for quizzes, and as an interactive language learning app. Students found Zoom helpful to connect with classmates.

For doing schoolwork outside the class, the most frequently mentioned app was Discord. Students utilized it to communicate with their classmates using chat and text, sharing screen shots of course slides, and asking questions that peers could answer. In addition, students found a variety of reading and writing tools helpful for getting feedback though collaboration and for screen reading. It is important to note that students frequently specified Microsoft and Google tools. Most of the apps and technologies mentioned work across several platforms. Students found the reminder feature of Google Calendar especially valuable because it facilitates time-management and scheduling daily tasks. They also liked Pomodoro Timer to schedule both study and break times. Students also appeared concerned about their mental health: they mentioned meditation and

relaxation apps, including Insight Timer and Respirelax, as helpful.

Discussion

Artificial Intelligence Apps for Doing Academic Work

So, after five studies, what can we conclude about AI-based technologies used by students with disabilities to do schoolwork? Overall, our findings show that AI-based technologies and mobile tools have tremendous potential. However, our results also show that students are often not aware of the benefits. As increasing numbers of technologies are integrating AI into their technologies, it becomes important to identify AI features on products' web sites, including how privacy is addressed. Informed research about the efficacy of these tools is also urgently needed.

For example, Zoom, the most popular post-secondary remote teaching videoconferencing technology (Aratani) recently incorporated AI-based live captions. This is true as well of its major competitor, Microsoft Teams. Both also provide transcripts. Many colleges and universities provide free Microsoft subscriptions to their students and faculty. Free Zoom versions are available. Both work on virtually all platforms, a feature that students consider important.

The same applies to Microsoft 365 ("Get"), which recently incorporated numerous AI features. Again, many colleges and universities provide free licenses for students and faculty. Microsoft tools are interesting because of their collaboration features, which were essential during the COVID-19 pandemic, and their accessibility features for students, such as speech-to-text and text-to-speech. For faculty, there are live captions in PowerPoint ("Present") and most Microsoft 365 products have accessibility checkers ("Improve"). Other large tech companies, such as Adobe and Google are also incorporating accessibility related AI into their suites (Potoroaca; Bayern).

Although students with and without disabilities generally use the same apps, there are specialty AI-based mobile apps for students with certain disabilities, such as those visual impairments (i.e., Seeing AI, Microsoft Lens). However, it seems that operating systems, especially

those of iPhones and iPads, have excellent accessibility features, some with AI capability. It was not surprising to find that Apple smartphones and tablets were preferred over Android by students both with and without disabilities. Regrettably, intelligent virtual assistants, typically used on smartphones, tablets, and standalone devices, do not seem to be living up to their potential.

It is evident that many companies are incorporating AI related to accessibility into general use technologies, often obviating the need for expensive assistive products. Nevertheless, there will always be a place for the traditional assistive technologies such as Jaws, ZoomText, Kurzweil, and Read&Write. Such products help power users and are of enormous use to students with certain disabilities such as visual impairments and specific learning disorders. A listing of assistive technology companies and products is available (CSUN Exhibitor Directory).

Mobile Apps for Students with Attention Deficit Hyperactivity Disorder (ADHD)

Three studies later, we concluded that students with ADHD and those with no disability found the same apps helpful to do schoolwork. Most students used tools that facilitated academic work, such as Pomodoro Timer and Quizlet. Although some students with ADHD expressed concerns about the functional limitations of their disability, few reported using the apps recommended by the experts, with two exceptions: Google Calendar because of its ease of use and level of integration with Gmail, and cloud drives such as Dropbox to help with organization. Furthermore, students with and without ADHD liked apps that worked across several platforms.

The literature shows that anxiety is increasing among students in post-secondary education (Hoyt et al. page 272), especially among students with disabilities (Union). It is a well-known fact that students with ADHD have comorbid anxiety disorders (Schatz and Rostain). Therefore, as our findings suggest, some students found apps for meditation and paced breathing helpful.

Conclusions and Recommendations

Developers of AI-based tools need to consider and evaluate their usefulness as well as

potential privacy concerns. These should be indicated on their web pages. As tech companies integrate AI into more and more technologies, students with disabilities should be involved in developing and training these (Treviranus).

There will always be a place for the traditional high-end assistive technologies. But it is important to note that the post-secondary population of students with disabilities is changing, as is evident from our research. Students with non-visible disabilities such as ADHD, mental health related disabilities, chronic health challenges, and learning disabilities are more likely to be found on our campuses than students who are blind, have low vision or a mobility impairment. Moreover, over half of the students who self-identity as having a disability do not register for campus disability services (Fichten, et al., Are; Fichten et al., Academic), making them ineligible for subsidies or for assistive technology support. Thus, general use technologies have an important role to play in supporting students, necessitating a reconsideration of what is defined as assistive technology.

Poor organization, a common trait of ADHD, makes keeping track of assignments, exams, and course materials over multiple platforms exceptionally challenging. Therefore, it was not surprising to find that students with ADHD, one of the largest group of students with disabilities on campus, like to keep their documents in one place. Tools such as Microsoft OneNote, and cloud drives, such as Dropbox, OneDrive, and Google Drive, facilitate this task (Brown and Mitroff). Also, it would be helpful if institutions developed guidelines limiting the number of learning management (LMS) platforms professors use because a key source of difficulty for all students involves confusion related to the number of different LMS platforms used in their courses.

Based on our findings, we recommend that students with ADHD use Google Calendar, as it easily interfaces with Gmail to send reminders and notifications. Our findings also suggest that Pomodoro Timer is useful for scheduling study and break times. Insight Timer can be useful for finding meditation apps that can reduce anxiety, a common ADHD comorbidity.

Our findings also suggest that students appreciate when faculty upload PowerPoints and lecture videos. This practice would benefit students with attention related challenges and could obviate the need for taking photos of the screen or recording the lecture on a mobile device.

Our findings suggest that it will be easy to integrate effective teaching techniques learned during the COVID-19 pandemic into blended and hybrid courses once the pandemic ends. Post-secondary faculty (Lombardi) and students (Top) are interested in keeping certain aspects of remote teaching when classes return to normal. Peter Salovey (President) recently noted in Time Magazine that remote teaching has taught faculty to use digital tools for learning activities. He also stated that, "Recorded lectures will allow many to make the best use of class time with students and provide more learning resources. Remote teaching formats featuring transcripts and captions also increase accessibility of course content for all students." We certainly agree and add that access to asynchronous lectures can help all students, including those whose first language is not the language of instruction and those whose work schedules do not permit attending the live class.

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