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Current State of the Research on Artificial Intelligence Based Apps for Post-Secondary Students with Disabilities

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Abstract

We conducted a search of popular press articles on Google.com and a scoping review of various types of artificial intelligence (AI) based technology—mobile, web-based, software, hardware—used by college and university students to do school work. The main findings indicate (a) no generally agreed-upon definition of AI, and (b) a huge discrepancy between the popular press articles that are behind the promotion of AI in the popular press and the scientific literature. The popular press provides an overview of the AI tools available to students with disabilities and discusses how students can use these tools. The scientific literature is primarily devoted to tool development. We conclude that the potential of AI for post-secondary students with disabilities is enormous but that informed scientific research

about these tools is scant and demonstrates a profound lack of scalability. Research needs to address "real world" uses of AI-based tools by post-secondary students with disabilities.

Between 18% and 34% of Canadian college and university students have a disability (Canadian University Survey Consortium, 2020, 2021; Fichten et al., 2018). Artificial intelligence (AI) based software holds a key to assisting many of these students to succeed in their studies, in finding employment, and, ultimately, in their lives.

Artificial Intelligence Based Software

No Consensus on a Definition

It is particularly, interesting that the publicity around AI is happening in the absence of a common definition. Examples are

- Artificial intelligence (AI) is a wide-ranging branch of computer science concerned with building smart machines capable of performing tasks that typically require human intelligence.… It is the endeavor to replicate or simulate human intelligence in machines. (Built In, n.d., para. 1)
- Artificial Intelligence (AI) is an area of computer science that emphasizes the creation of intelligent machines that work and react like humans. (MicroKnowledge, n.d., para. 1)
- 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 from imperfect datasets to assist in decision-making. (Microsoft, 2019, p. 7)

Many people are still unaware of AI features. For example, Google adapts results based on a person's location, Amazon makes recommendations based on previous purchases, and Siri adapts to users' needs and commands. Examples of AI include Siri, Alexa and other intelligent virtual assistants, self-driving cars, robo-advisers, conversational chat bots, email spam filters, and Netflix's recommendations (Built In, n.d.). Indeed, AI has the potential to change just about everything we take for granted, including education (TeachThought Staff, n.d.).

Popular Press Views of AI for Post-Secondary Students with Disabilities

Popular press literature is material written for the general public, as opposed to scholarly material written for an academic or a research audience, or trade material written for an industry audience (Pierson, 2020). Most popular press materials are newspaper and magazine articles and web postings.

The popular press literature suggests that students with different disabilities, the instructors who teach them, and the professionals who provide assistive-technology services to them can all benefit from the use of hundreds of AI-based apps. For example, two apps intended primarily for individuals with visual impairments are Seeing AI and

Office Lens. Seeing AI helps to identify people and objects and to read text after taking a photo of a page and performing optical character recognition (Wong et al., 2019). Office Lens "lets users scan, capture, and annotate documents, whiteboards, business cards, and photos" (Educational App Store, n.d.). Such tools provide features such as optical character recognition of photos of text and tables, allow users to read these aloud in different languages, and produce face and scene recognition with text-based description (Kelley, n.d.). Such features are reflected in the literature when we do searches on Google.com using terms such as: "artificial intelligence college disability." There are also articles and web sites devoted to speech-to-text and transcriptions (Schwartz, 2019); these can help students with dexterity problems, specific learning disorders, and hearing impairments as well as second-language learners. Others deal with lip-reading recognition for people with hearing impairments, text summarization for people with cognitive impairments, and real-time captioning and translations for people with hearing impairments and for second-language learners (Martinez, 2021).

The list can go on. For example, AI-based apps can facilitate individualized learning (Analytics Insight, 2021), and wearable technologies such as smartwatches, fitness trackers and Google Glass can serve numerous purposes (Kelly, 2019; StrapsCo, n.d.). There are also many health-related AI tools for students with disabilities (e.g., Brain in Hand, Empower Me, SeizAlarm, and Woebot), along with a host of webinars (Adaptech Research Network, 2020). Also, tech giants have web sites and resources devoted to AI and accessibility, including Google (n.d.-b), Microsoft (n.d., 2019), Android (Google, n.d.-a), and Apple (n.d.). Furthermore, there are numerous position papers as well as college- and university-based web sites featuring accessible AI tools. For example, Fichten et al. (2021, in press) and Vo (2021) studied the use of virtual assistants and AI-based apps that college and university students with and without disabilities can and do use for school work.

Artificial intelligence can be beneficial for students with disabilities. For example, students with learning disabilities and motor impairments can use dictation apps (speech-to-text) to work on assignments; they can also use voice commands to research topics (Christopherson, 2015). Students with print impairments who, while listening to their textbook encounter a word or subject they are not familiar with, can verbally ask a virtual assistant for help. Similarly, students with visual impairments can use AI-based smartphone apps such as Seeing AI to identify people and objects (Wong et al., 2019). In addition, students with hearing impairments can use AI-based live-transcription apps such as AVA to communicate in groups (Matney, 2016), and there have been initiatives to teach Alexa to respond to sign language (Singh, 2018). For students with an accent and those with speech impairments (e.g., cerebral palsy, hearing impairments), who often have problems with dictation and with speech-to-text apps, Google has developed Project Euphonia (Wodecki, 2021) and is in the process of perfecting Project Relate (Coldewey, 2021). Moreover, traditional assistive technologies, such as Read&Write and Jaws, are starting to include AI in their products (Desmond, 2020).

Outside the Norms

However, there are also important cautions noted in the literature. For example, there are issues related to whether AI works effectively for individuals who are "at the edges of the bell curve" (e.g., Treviranus, 2019; Whittaker et al., 2019) and who are frequently

excluded from mainstream AI tool development. This can result in truly negative outcomes when the pattern-matching protocols of AI penalize people who differ from the norm, such as when driverless vehicles run over wheelchair users (e.g., Clegg, 2020). Baker (2019)'s interview with Treviranus yielded examples that showed how AI face recognition can be seriously biased by the choice of training models. "One large facial recognition program relied on data sets that were more than 75% male and more than 80% white—meaning it had very poor ability to identify people who, according to the data inputs, were 'outliers'" (para. 6). In the interview, Treviranus also stated, "Because the data used to create AI is made up of 'average' populations, it often performs poorly when presented with someone who is not average" (para. 7).

Students Without Disabilities

There are also numerous popular press articles related to AI and college and university students in general. These include AI-based chatbots (Chi, 2021) and IBM's Jill Watson, whom students failed to recognize as a robot (Goel & Polepeddi, 2018), and her recent offspring (Design & Intelligence Lab, n.d.). Furthermore, AI informs suggested responses in Gmail, automatic captions on Facebook, and image-library searches. Much of Microsoft 365 (e.g., PowerPoint, Word, Excel), which both students and faculty often use, is AI-enabled (Ungoti, n.d.), featuring dictation, an immersive reader, and PowerPoint live captions. One of the most popular AI applications is the Google search engine (Lateef, 2021).

Privacy

AI can be a double-edged sword. Along with the great benefits comes the downside. For AI to "learn," it needs data, and to obtain data it relies upon users' input. This has resulted in important concerns regarding privacy. For example, Berendt et al. (2020) discussed privacy concerns around intentional or incidental repurposing of data and around risks associated with fine-grained profiling of people. Zhang et al. (2021) specified that there are privacy and ethics issues related to techniques such as machine learning, data analysis, robots and intelligent systems, and cloud technologies.

In order for AI to function, it typically collects data from users so that the parent company may improve the product. Although some companies allow users to opt out of data collection, it is often up to the user to decipher how to do that. Also, if the user opts out of the data collection, AI performance may become limited or inadequate to their needs. Should the company collect the data, the user's privacy is in the company's hands, and it may use these data in any way it wishes. To address privacy concerns, most companies require the user to agree to their privacy policies before using their product.

There are always concerns about what information is given to these companies through the use of AI: Is the AI constantly collecting data? What exactly is collected, and how much data does the company have on its users? There are risks if a security breach occurs, and users' data are stolen or published online, since any identifying data about the user could expose them to potential danger. Therefore, even if the use of AI can assist with day-to-day tasks, there are concerns regarding how the data are managed and used by companies.

The Present Study

Our goal was to explore whether there is a scientific basis for the benefits of AI that have been identified in the popular press for post-secondary students with disabilities. To do this we conducted a scoping review of the academic and grey (e.g., reports, proceedings, dissertations [Johns Hopkins University and Medicine, n.d.]) literatures by examining 10 academic databases. It is by examining the scientific basis for the benefits of AI identified in the popular press that we can make confident conclusions about the actual impact and utility of AI for students with disabilities.

Scoping Review

According to popular press articles, the potential for AI-based technologies to help students with academic work and to improve their motivation and performance seemed limitless. However, it was unclear to what extent this enthusiasm carried over to the scientific literature. We decided that before a meta-analysis or systematic review could be considered, we first had to "survey the lay of the land" by conducting a scoping review of the literature (Arksey & O'Malley, 2005; Sucharew & Macaluso, 2019) on the use of AI tools and apps for doing school work by college and university students with disabilities. The scoping-review methodology, pioneered by Mays et al. (2001), is intended to explore a research area and main sources of evidence and is described as "a useful way of mapping fields of study where it is difficult to visualize the range of material that might be available" (p. 21). Our goal was to reflect the current state of empirical research, both quantitative and qualitative, and to inform educational practitioners and interested scholars of expectations for and the actual use of learning technologies that may be encompassed under the AI umbrella. We followed the five steps outlined by Arksey and O'Malley (2005):

1. Identifying the research question
2. Identifying relevant studies (through searches of databases, search engines, etc.)
3. Study selection (screening of abstracts for relevance)
4. Charting the data (study features such as type of technology, disability, etc.)
5. Collating, summarizing, and reporting the results

An Artificial Intelligence Advisory Board (Adaptech Research Network, 2020) consisting of an international team of consumers, scholars, and researchers indicated that the literature on the issue, though of apparent interest and timeliness, is rather sparse and predominantly descriptive (e.g., Martiniello et al., 2020) and that there is little consensus among stakeholders about how to define AI and AI-enabled functionality to facilitate learning. Consequently, our systematic search strategy was built around the explicit use of the key term "artificial intelligence," supplemented by indications of relevant educational purposes, settings, environments, and categories of learners.

Identifying the Research Questions

As stated earlier, the main objective of this scoping review was to explore the state of the research literature on the use of AI tools and applications to facilitate learning for

post-secondary students with disabilities. Review of the full-text documents identified for potential inclusion proceeded, closely guided by the following research questions.

1. What research methodologies are featured in the literature on AI-based learning assistance for students with disabilities?
2. What particular tools and applications are explicitly named in the research literature as falling under the category of AI learning tools?
3. What categories of students with disabilities are reported in the literature as using AI-based tools for their learning?
4. How does the research literature present the outcomes (both expected and observed) of AI use by students with disabilities (i.e., what outcome categories could be consistently identified and documented)?

Identifying Relevant Studies: Search Strategy

The targeted search strategy to collect empirical scholarly literature focused on the intersection of AI and digital tools intended to assist the learning of post-secondary students with disabilities. The primary method consisted of searches of bibliographic databases spanning multiple disciplines. In total, we searched 10 databases including for education (ERIC and Education Source), computer science (Computers & Applied Sciences Complete), engineering (Inspec and ACM Digital Library), and medicine (Medline and PsycINFO), as well as several multi-disciplinary databases (ProQuest Central, Academic Search Complete and Web of Science). The search parameters for studies included a publication date of 2010 or later, having been written in English, and dealing with various types of AI-based technology—such as mobile, web-based, and software or hardware based—that were used by college and university students to do school work.

The search terms used were customized to take advantage of database-specific options and filters. The following is a typical representation of the strategy employed: ("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*).

We tested our search terms on two databases. Based on the results of the initial test run, we updated our search terms (e.g., removed "intellectual") and completed the searches during the final week of December 2020. All articles that met the search parameters were imported into the bibliographic management software Endnote for processing. Duplicates were removed. To complement the formal literature searches we employed a parallel strategy to locate grey-literature items. Finally, we scanned the bibliographies of the literature reviews identified in the results for additional relevant articles. Table 1 provides an overview of the articles that met the search parameters.

Table 1
Sources

Data Source	Initial Results	Results After Duplicates Removed
ERIC	20	20
ERIC update	6	1
Education Source	12	10
Education Source update	0	0
ProQuest Central	67	66
ProQuest Central update	4	1
Web of Science	10	6
Web of Science update	12	3
Google Scholar	22	18
Google Scholar update	5	1
PsycINFO	15	12
PubMed	43	31
Academic Search Complete	30	19
ACM Digital Library	27	27
Computers & Applied Sciences Complete	6	1
Inspec	27	26
Grey literature	54	54
Branching (reference list searches)	9	9
Total	369	305

Study Selection: Inclusion Criteria and Screening Results

In a scoping review, it is difficult to identify and apply clear-cut inclusion/exclusion criteria such as those used for a meta-analysis. Instead, the review was guided by more loosely formulated criteria such as (a) a document under review contained some reference to a broad class of technologies, which it explicitly described as having AI qualities; (b) the technologies were for use by post-secondary students with a variety of disabilities other than intellectual disabilities; and (c) the technologies provided students with disabilities with various means of learning assistance such as note-taking, text-to-speech, and help with organization and productivity. We were open to either qualitative or quantitative empirical studies, as well as to descriptive studies (for example, an article describing the development of a specific tool without any experimental testing).

Subsequently, the 305 information sources found were screened for relevance by title and abstract (using the above inclusion/exclusion criteria), with the sources classified in the following categories:

- Irrelevant (262)
- Potentially relevant, empirical (25)
- Potentially relevant, non-empirical (21)

There were many reasons for irrelevance. Some studies focused on the incorrect population group (not post-secondary students and/or not those with disabilities), and many were studies that used AI in the diagnosis of various special needs or disabilities. We retrieved and screened the full text of the 46 potentially relevant studies. After this screening, we retained 4 empirical studies and 9 non-empirical publications for final review and analysis. These are marked in the reference list with an asterisk (*) to the left of the article entry.

Charting the Data and Collating, Summarizing, and Reporting the Results

Research Question 1. What Research Methodologies Are Featured in the Literature on AI-Based Learning Assistance for Students With Disabilities?

None of the identified studies used a rigorous experimental design. Two studies (Athanaselis et al., 2014; Rodolitz et al., 2019) reported using a post-test only design. There was one detailed case study (Roach, 2018) and one qualitative study that reported the results of interviews and journal entries (Forbes, 2019).

Research Question 2. What Particular Tools and Applications Are Explicitly Named in the Research Literature as Falling Under the Category of AI Learning Tools?

The technologies used in the reviewed studies were categorized by common themes, with virtual assistants being the most common (but even then, in only 4 of the 13 reports; see Table 2).

Table 2
Themes Mentioned

Category of Technology	Number in Final Set
Adaptive reading assistance	1
Augmentative and alternate communication (AAC)	1
Automatic speech recognition	1
Sensory augmentation	2
Smart glasses	1
Smartphone apps	1
Speech-to-text	1
Text summarization	1
Text-to-speech	2
Virtual assistants	4
Virtual/adaptive learning environments	2

Various specific applications and technologies were mentioned in the literature selected for review, but again there was very little emphasis on any one tool. The most prevalent were intelligent virtual-assistant applications, with the focus being on facilitating

the ability of populations with disabilities to speak to them and to give instructions. The specific technologies are noted in Table 3.

Table 3
Specific Technologies Mentioned

Specific Branded Technology	Number in Final Set
Agent-DYSL	1
Alexa	3
ALSHI (Adaptative Learning System for Hearing Impaired)	1
Amazon Echo	1
Apple Watch	1
Be Focused (app)	1
Breathe2Relax (app)	1
Circle of 6 (app)	1
CoLLeGE (Computer-based Laboratory for Language Games in Education)	1
EquatIO	1
gMath	1
Google Assistant	1
Google Glass	1
Habitica (app)	1
Left for Spending (app)	1
MoodPanda (app)	1
myHomework (app)	1
Oculus Rift	1
Pearson Accessible Equation Editor	1
Penultimate (app)	1
Raspberry Pi	1
Shopping List Ease (app)	1
Siri	2
Sit With Us (app)	1
Tacotron 2 (Google)	1
Tesseract (open source Optical Character Recognition Tool)	1
Verbal Victor	1
WaveNet (Google)	1

Research Question 3. What Categories of Students With Disabilities Are Reported in the Literature as Using AI-Based Tools for Their Learning?

Various disabilities were addressed by AI-based technologies in the literature, but sensory disabilities (sight and hearing) predominated. Table 4 lists these.

Table 4
Disability Groups

Disability	Number in Final Set
Autism spectrum disorder	1
Autoimmune diseases/Chronic illness	2
Communication disability	1
Dyslexia	2
Hearing impairment	4
Visual impairment	6

Research Question 4. How Does the Research Literature Present the Outcomes (Both Expected and Observed) of AI Use by Students With Disabilities (i.e., What Outcome Categories Could Be Consistently Identified and Documented?)

There was an emphasis on tool development, with some effectiveness trials, but impact on student learning was not addressed frequently. For example, Rodolitz et al. (2019) reported findings from an experiment with three conditions that were based on how inputs were given to a virtual assistant (text-to-speech, American Sign Language, or gesture) and how effective each was in getting Amazon Echo to understand the instruction. In a dissertation with a qualitative research design (Forbes, 2019), users were asked in semi-guided interviews about their use of virtual assistants. The interviews focused on features used, user experiences, and how use minimized disability-related stress. In Athanaselis et al. (2014), some student outcomes, such as reading pace, accuracy, motivation, self-esteem, and relevance, were tested after use of a tool to help students with a learning disability (dyslexia), with modest positive gains found.

The grey literature frequently described the development of tools or applications. Some articles reported on testing tools developed by the researchers. For example, AlSaid et al. (2019) used Raspberry Pi (a no-frills, pocket-sized computer), a webcam, Google's text-to-speech, and other technologies to develop and test a set of smart glasses that could double as an educational aid for students with visual impairments. Others merely proposed ideas for applications with specific technical suggestions as to how these might be developed. For example, Amarawansha et al. (2019) proposed a tool to extract and parse methodologies from research articles to assist students with visual impairments. Others reviewed tools and applications available to users with various disabilities (Francis et al., 2018; Wood, 2019) or explored the ethical issues that arise in their development (Findlater et al., 2019).

Discussion

So, based on the scientific literature, what can be concluded about the use and effectiveness of AI-based apps and technologies for post-secondary students with disabilities? Frankly, very little of substance.

First, it needs to be noted that there is a lack of general agreement on the definition of AI. It is one of those "I know it when I see it, but I cannot define or describe it."

Second, there are huge discrepancies between the popular press literature and the published scientific literature. The popular view endorses the potential of AI-based tools and provides descriptions of the tools that are available and how they can assist students with disabilities. The scientific literature deals primarily with tool development and some effectiveness trials, but there is little mention of the impact on student learning or on doing school work.

Third, the scientific literature seems to focus on tool development and its evaluation using less than rigorous methodology (e.g., lack of controls, small sample sizes) and mentioning a narrow range of student disabilities. For example, Rodolitz et al. (2019) investigated the use of voice-activated intelligent agents by d/Deaf and hard-of-hearing populations but used a post-test only design and did not report the number of participants. Forbes (2019) investigated the use of virtual assistants by individuals with visual impairments and used interviews and writing tasks as their data sources; however, this investigation had a convenience sample of only 7 students. These and other articles point to the nascent quality of the research into the use of AI-based technologies to improve the educational outcomes of higher-education students with disabilities.

Although the popular press generally says that AI-based tools are helpful and have the potential to improve people's lives, including the academic lives of post-secondary students with disabilities, there are important privacy concerns. Furthermore, there is a cautionary note about the lack of engagement of people with disabilities in training AI engines. This lack of engagement can result in a variety of biases that are created when training AI. For example, it can lead to paternalistic designs that fail to meet actual needs and could disregard privacy concerns over "always on" technologies that inadvertently share private information (e.g., audio recording or object recognition by visual assistants).

Implications

What about research and practice? First, when AI-based tools are used, the benefit on the one hand, and the potential privacy costs on the other, need to be considered and evaluated. Second, it is important to include students with disabilities in AI-based tool development, and possibly to oversample them, to ensure that their needs and concerns are reflected in the data (Treviranus, 2019). For students with disabilities, this means that they should be included when training AI technologies because they are valuable stakeholders in AI development.

Empirical research needs to be done in the "in the real world" of post-secondary students with disabilities. Rather than focusing primarily on tool development, research also needs to focus on evaluating the impact of AI tools on the stress of academic life, on the technology's usability, and on its impact on academic outcomes, such as grades and time to complete tasks.

As for practice, because students, professors, and access professionals often do not know about AI-based tools, information should be made available on post-secondary web sites. This, of course, includes providing accessible training documents (e.g., YouTube videos, Google documents) that are available when the user needs them.

In summary, the potential of AI for post-secondary students with disabilities is enormous, but informed research about these tools is scant, with a profound lack of demonstrated scalability.

References

Adaptech Research Network. (2020, May). Canadian and international experts weigh in: An annotated list of AI-related resources for college and university students with and without disabilities. https://adaptech.org/publications/canadian-and-international-experts-weigh-in-an-annotated-list-of-ai-related-resources-for-college-and-university-students-with-and-without-disabilities/

*AlSaid, H., AlKhatib, L., AlOraidh, A., AlHaidar, S., & Bashar, A. (2019, October 9–11). *Deep learning assisted smart glasses as educational aid for visually challenged students* [Paper presentation]. 2nd International Conference on New Trends in Computing Sciences, Amman, Jordan. https://doi.org/10.1109/ICTCS.2019.8923044

*Amarawansha, K., Dasanayaka, D., Rajapaksa, C., Fernando, V., & Thelijjagoda, S. (2019, December 5–7). *Tool to extract and summarize methodologies of research articles for visually impaired researchers* [Paper presentation]. International Conference on Advancements in Computing, Malabe, Sri Lanka. https://doi.org/10.1109/ICAC49085.2019.9103342

Analytics Insight. (2021, April 5). *8 ways AI can support students' learning experience.* https://www.analyticsinsight.net/8-ways-ai-can-support-students-learning-experience/

Apple. (n.d.). *Accessibility.* https://www.apple.com/ca/accessibility/?afid=p238|stgJ3Zcs5-dc_mtid_209251kg40341_pcrid_484073470999_pgrid_117344075714_&cid=wwa-ca-kwgo-features-slid-----

Arksey, H., & O'Malley, L. (2005). Scoping studies: Towards a methodological framework. *International Journal of Social Research Methodology*, *8*(1), 19–32. https://doi.org/10.1080/1364557032000119616

*Athanaselis, T., Bakamidis, S., Dologlou, I., Argyriou, E. N., & Symvonis, A. (2014). Making assistive reading tools user friendly: A new platform for Greek dyslexic students empowered by automatic speech recognition. *Multimedia Tools and Applications*, *68*(3), 681–699. https://doi.org/10.1007/s11042-012-1073-5

Baker, J. (2019, November 25). Is bias baked into AI? *Learning2030*. https://www.d2l.com/blog/learning2030-is-bias-baked-into-ai/

Berendt, B., Littlejohn, A., & Blakemore, M. (2020). AI in education: Learner choice and fundamental rights. *Learning, Media and Technology*, *45*(3), 312–324. https://doi.org/10.1080/17439884.2020.1786399

Built In. (n.d.). *Artificial intelligence: What is artificial intelligence? How does it work*? Retrieved October 29, 2021, from https://builtin.com/artificial-intelligence.

Canadian University Survey Consortium. (2020). *2020 middle-years student survey: Master report: June 2020.* https://cusc-ccreu.ca/?download=823

Canadian University Survey Consortium. (2021). *Graduating student survey: Master report*: *June 2021*. https://cusc-ccreu.ca/?download=922

Chi, C. (2021, December 14). 14 of the best AI chatbots for 2022. *HubSpot.* https://blog.hubspot.com/marketing/best-ai-chatbot

Christopherson, R. (2015, August 25). *Freedom of speech: Is voice-recognition software a healthier way of working?* Personnel Today. https://www.personneltoday.com/hr/freedom-speech-voice-recognition-software-healthier-way-working/

Clegg, A. (2020, January 26). How to design AI that eliminates disability bias. *Financial Times*. https://www.ft.com/content/f5bd21da-33b8-11ea-a329-0bcf87a328f2

Coldewey, D. (2021, November 9). *Google tests Project Relate, a voice recognition and synthesis app for people with speech impairments*. TechCrunch. https://techcrunch.com/2021/11/09/google-project-relate-speech-ai-impairments/amp/

Design & Intelligence Lab. (n.d.). *Jill Watson: A suite of online learning tools*. Retrieved July 5, 2021, from http://dilab.gatech.edu/a-suite-of-online-learning-tools/

Desmond, N. (2020, September 16). *JAWS architect Glen Gordon is joining Sight Tech Global, a virtual event Dec. 2-3.* TechCrunch. https://techcrunch.com/2020/09/16/jaws-architect-glen-gordon-is-joining-sight-tech-global-a-virtual-event-dec-2-3/

Educational App Store. (n.d.). *Office Lens.* https://www.educationalappstore.com/app/office-lens

Fichten, C., Jorgensen, M., Arcuri, R., Vo, C., Budd, J., Legault, A., & Havel, A. (2021, June 3). *Are AI-based virtual assistants such as Siri, Alexa, and Google Assistant ready for college?* [Virtual poster presentation]. 10th annual SALTISE conference, Montreal, QC, Canada. https://adaptech.org/wp-content/uploads/SALTISEfichtenEtAl2021.pptx

Fichten, C., Jorgensen, M., Havel, A., & Vo, C. (n press). AI-based and mobile apps: Eight studies on post-secondary students. *Journal on Technology & Persons with Disabilities*.

Fichten, C. S., Havel, A., King, L., Jorgensen, M., Budd, J., Asuncion, J., Nguyen, M. N., Amsel, R., & Marcil, E. (2018). Are you in or out? Canadian students who register for disability-related services in junior/community colleges versus those who do not. *Journal of Education and Human Development*, *7*(1), 166–175. http://dx.doi.org/10.15640/jehd.v7n1a19

*Findlater, L., Goodman, S., Zhao, Y., Azenkot, S., & Hanley, M. (2019). Fairness issues in AI systems that augment sensory abilities. *SIGACCESS Newsletter*, *125*, Article 8. https://doi.org/10.1145/3386296.3386304

*Forbes, M. R. (2019). *Experiences of using intelligent virtual assistants by visually impaired students in online higher education* [Doctoral dissertation, University of South Florida]. University of South Florida Scholar Commons. https://scholarcommons.usf.edu/cgi/viewcontent.cgi?article=9224&context=etd

*Francis, G. L., Duke, J. M., Kliethermes, A., Demetro, K., & Graff, H. (2018). Apps to support a successful transition to college for students with ASD. *Teaching Exceptional Children*, *51*(2), 111–124. https://doi.org/10.1177%2F0040059918802768

Goel, A. K., & Polepeddi, L. (2018). Jill Watson: A virtual teaching assistant for online education. In C. Dede, J. Richards, & B. Saxberg (Eds.), *Learning engineering for online education: Theoretical contexts and design-based examples* (1st ed.; Chapter 7). Routledge. https://doi.org/10.4324/9781351186193-7

Google. (n.d.-a). *Android accessibility overview.* https://support.google.com/accessibility /android /answer/6006564?hl=en

Google. (n.d.-b). *Products and features*. https://www.google.com/accessibility/products-features/

Johns Hopkins University and Medicine. (n.d.). *What is gray literature? How do I search for it?* Retrieved October 29, 2021, from https://welch.jhmi.edu/get-help/what-gray-literature-how-do-i-search-it

Kelley, S. (n.d.). *Seeing AI: Artificial intelligence for blind and visually impaired users.* VisionAware. Retrieved October 15, 2019, from https://visionaware.org/everyday-living/helpful-products /using-apps/seeing-ai-app/

Kelly, R. (2019, November 19). *End users will spend $52 billion on wearables in 2020.* Campus Technology. https://campustechnology.com/articles/2019/11/15/end-users-will-spend-52-billion-on-wearables-in-2020.aspx

*Lancheros Cuesta, D., Carrillo Ramos, A., & Pavlich-Mariscal, J. A. (2012). Adaptation and disability aspects in a virtual learning environment. *DYNA*, *79*(173), 6–14. http://www.scielo.org.co/scielo.php?script=sci_arttext&pid=S0012-73532012000300016

Lateef, Z. (2021, January 29). *Most frequently asked artificial intelligence interview questions in 2021*. edureka! https://www.edureka.co/blog/interview-questions/artificial-intelligence-interview-questions/

*Littrell, C. (2018). Apple Watch breaking barriers for students with disabilities. *Disability Compliance for Higher Education*, *23*(7), 7. http://dx.doi.org/10.1002/dhe.30390

Martinez, C. (2021, March 5). Artificial intelligence and accessibility: Examples of a technology that serves people with disabilities. *Inclusive City Maker*. https://www.inclusivecitymaker.com/artificial-intelligence-accessibility-examples-technology-serves-people-disabilities/

Martiniello, N., Asuncion, J., Fichten, C., Jorgensen, M., Havel, A., Harvison, M., Legault, A., Lussier, A., & Vo, C. (2020). Artificial intelligence for students in postsecondary education: A world of opportunity. *AI Matters*, *6*(3), 17–29. https://doi.org/10.1145/3446243.3446250

Matney, L. (2016, November 21). *Ava gives the deaf and hard-of-hearing a more present voice in group conversations.* TechCrunch. https://techcrunch.com/2016/11/21/ava-gives-the-hearing-impaired-a-more-present-voice-in-group-conversations/

Mays, N., Roberts, E., & Popay, J. (2001). Synthesising research evidence. In N. Fulop, P. Allen, A. Clarke, & N. Black (Eds.), *Studying the organisation and delivery of health services: Research methods* (Chapter 12). Routledge. https://doi.org/10.4324/9780203481981

MicroKnowledge. (n.d.). *All about AI: What you need to know*. Retrieved July 5, 2021, from http://www.microknowledge.com/all-about-ai-what-you-need-to-know/

Microsoft. (n.d.). *Accessibility*. Retrieved July 5, 2021, from https://www.microsoft.com/en-ca/accessibility?rtc=1

Microsoft. (2019). *Everyday AI in Microsoft 365*. https://query.prod.cms.rt.microsoft.com/cms/api/am/binary/RE2AA0b

*Nganji, J. T., & Brayshaw, M. (2017). Disability-aware adaptive and personalised learning for students with multiple disabilities. *International Journal of Information and Learning Technology*, *34*(4), 307–321. http://dx.doi.org/10.1108/IJILT-08-2016-0027

*Pauca, V. P., & Guy, R. T. (2012, February–March). Mobile apps for the greater good: A socially relevant approach to software engineering. *SIGCSE '12: Proceedings of the 43rd ACM technical symposium on computer science education* (535–540). Association for Computing Machinery. https://doi.org/10.1145/2157136.2157291

Pierson, T. (2020, December 15). *What are "popular press articles" and how can I find them?* Walden University. https://academicanswers.waldenu.edu/faq/72688

*Roach, J. (2018, April 5). AI technology helps students who are deaf learn. *The AI Blog*. https://blogs.microsoft.com/ai/ai-powered-captioning/?utm_source=pre-amp&utm_campaign=74863

*Rodolitz, J., Gambill, E., Willis, B., Vogler, C., & Kushalnagar, R. (2019). Accessibility of voice-activated agents for people who are deaf or hard of hearing. *The Journal on Technology and Persons with Disabilities, 7*, 144–156. https://scholarworks.calstate.edu/downloads/h415pf19f?locale=en

Schwartz, N. (2019, April 4). *Will artificial intelligence make the college classroom more accessible?* Education Dive. https://www.educationdive.com/news/will-artificial-intelligence-make-the-college-classroom-more-accessible/551988/

Singh, A. (2018, August 8). *Getting Alexa to respond to sign language using your webcam and TensorFlow.js*. Medium. https://medium.com/tensorflow/getting-alexa-to-respond-to-sign-language-using-your-webcam-and-tensorflow-js-735ccc1e6d3f

StrapsCo. (n.d.). *Wearable technology guide for people with disabilities*. https://strapsco.com/wearable-tech-for-people-with-disability/

Sucharew, H., & Macaluso, M. (2019). Methods for research evidence synthesis: The scoping review approach. *Journal of Hospital Medicine, 14*(7), 416–418. https://doi.org/10.12788/jhm.3248

TeachThought Staff. (n.d.). Ten roles for artificial intelligence in education. *The Future of Learning.* Retrieved August 2, 2019, from https://www.teachthought.com/the-future-of-learning/10-roles-for-artificial-intelligence-in-education/

Treviranus, J. (2019, April 21). *Inclusive design: The bell curve, the starburst and the virtuous tornado*. Medium. https://medium.com/@jutta.trevira/inclusive-design-the-bell-curve-the-starburst-and-the-virtuous-tornado-6094f797b1bf

Ungoti. (n.d.). What are Office 365 AI features? *Ungoti*: *Innovating Ideas*. Retrieved December 28, 2021, from https://ungoti.com/blog/microsoft-office-365-ai-features/

Vo, C. (2021, January 28). *Use of virtual assistants for schoolwork*. Adaptech Research Network. https://adaptech.org/publications/use-of-virtual-assistants-for-schoolwork/

Whittaker, M., Alper, M., Bennett, C. L., Hendren, S., Kaziunas, L., Mills, M., Morris, M. R., Rankin, J., Rogers, E., Salas, M., & West, S. M. (2019). *Disability, bias, and AI*. AI Now. https://ainowinstitute.org/disabilitybiasai-2019.pdf

Wodecki, B. (2021, May 18). *Giving voice to the voiceless: Voiceitt CEO explains how AI can help people with speech impairments.* AI Business. https://aibusiness.com/author.asp?section_id=789&doc_id=769592&

Wong, T. A., Sukhija, S., & Bradley, M. (2019, January 18). Innovative mobile technology targets low vision. *Optometry Times*, *11*(2). https://www.optometrytimes.com/view/innovative-mobile-technology-targets-low-vision

*Wood, A. (2019). Inclusive education for students with chronic illness—technological challenges and opportunities. In J. Knox, Y. Wang, & M. Gallagher (Eds.), *Artificial intelligence and inclusive education: Speculative futures and emerging* practices (pp. 135–148). Springer. https://doi.org/10.1007/978-981-13-8161-4_8

Zhang, Y., Wu, M., Tian, G. Y., Zhang, G., & Lu, J. (2021). Ethics and privacy of artificial intelligence: Understandings from bibliometrics. *Knowledge-Based Systems, 222*, Article 106994. https://doi.org/10.1016/j.knosys.2021.106994

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