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11. Changing times: emerging technologies for students with disabilities in higher education[1]

Catherine S. Fichten, Natalina Martiniello, Jennison Asuncion, Tim Coughlan, and Alice Havel

Imagine a world without digital barriers for post-secondary students with disabilities! Imagine a world where language does not place barriers on communication or collaboration! Imagine a future where the very idea of what defines disability in post-secondary education is dramatically different from what it is today! This world is closer than we may think, and it is being made possible by a variety of developments in technology and by creative uses of existing technologies.

IMAGINE A WORLD WITHOUT DIGITAL BARRIERS FOR POST-SECONDARY STUDENTS WITH DISABILITIES!

In Chapter 24 (Fichten et al., this *Handbook*) we highlight a number of tools and practices that helped eradicate many digital barriers. There we add to the discussion by highlighting some influential trends related to emerging technologies and digital accessibility and how these could help or hinder progress toward greater inclusion, particularly for students with disabilities pursuing post-secondary education.

ACCESSIBILITY OF GENERAL USE TECHNOLOGIES

As McNicholl et al. (2019) pointed out, the most important development of the past decade has been, "harnessing the potential of mainstream devices as AT (assistive technology) for all students" (p. 1). Many technologies popular in higher education have great built-in accessibility features. The inclusion of AT and accessibility features into operating systems is an important development that we expect will continue, making it increasingly less necessary for students to acquire high-priced, specialized AT products. For example, major technology companies and their products, such as Google (Google, n.d.; Nield, 2021), Facebook (Meta – American Foundation for the Blind, 2015), YouTube (Accessible Media Inc., n.d.; Rivenburgh, 2019), Microsoft (Microsoft, n.d.-a; Microsoft, n.d.-b; Microsoft, 2019), Adobe (2020), Android (Google Help Center, n.d.), and Apple (Apple, n.d.) have excellent built-in accessibility features, often thanks to artificial intelligence (AI).

To illustrate, 20 years ago one of the co-authors of this chapter taught a college student who was legally blind. The student needed a variety of technologies to help her complete schoolwork, including ZoomText (expensive top-of-the line magnification and text-to-speech software) and a large – and heavy – CRT (cathode ray tube) monitor placed on a raised, adjustable stand affixed to her desk, allowing her to position the monitor as needed. Today, that student is a work colleague. When asked about ZoomText and monitor stands she replied, "There is no need. I just use Windows" (Arcuri, Sept. 2020, personal communication).

Built-in technological accessibility aligns closely with a social definition of disability (i.e., disabling practices of society are a key cause of disability – Mole, n.d.) centered on empowerment. Like universal design in the built environment, it accounts for the fact that anyone can experience disability, depending on the context (e.g., due to poor lighting or contrast), and provides an option for all users to activate accessibility features. By extension, a student with a disability, even an invisible disability, can access these supports without being required to disclose their impairment to their post-secondary institution. In a study exploring the extent to which general use smartphones and tablets are replacing traditional assistive devices for users with visual impairments, stigma emerged as a significant consideration (Martiniello et al., 2019). This is noteworthy given that many students and staff with invisible disabilities choose *not* to disclose through traditional accommodation services. Students who are registered in colleges and universities to receive accommodations represent only one segment of post-secondary students, and they comprise less than half of the enrolled students with disabilities (Fichten et al., 2018; 2019). We need to seek out the non-registered students for their feedback to get the entire picture.

Built-in accessibility is a trend that we hope and expect to continue. This has occurred largely through integrating and improving existing AT designs in general use technologies – such as text-to-speech in operating systems, or the ability to control the computer using voice commands through Siri or Cortana. As operating systems and other platforms evolve with greater attention having been paid to accessibility in their design, this should result in the proliferation of new and more seamless features that make life easier for students with and without disabilities.

The benefits of built-in accessibility stem from the recognition that what might be necessary for *some* is almost always beneficial for *all*. As an example, video captioning allows d/Deaf and hard of hearing users to follow dialogue, but a review of over 100 empirical studies also documents the benefits for second-language learners, early literacy development, and understanding dialogue in loud environments, such as a sports bar, or where the volume is set low, or when watching television late at night (Gernsbacher, 2017). Similarly, Siri, introduced as a general voice assistant for all Apple users, has proven especially helpful for interacting with a device when one's hands are otherwise occupied, such as when driving or exercising. However, it has also been harnessed as a vital accessibility feature for many students with disabilities. Even the proliferation of audiobooks and built-in text-to-speech software which provides audio access to students with print disabilities have been adopted as popular features by the general public. In fact, the growth of the audiobook industry, spurred by users who enjoy the convenience of listening to a book while driving, exercising, or commuting, has considerably increased the number of accessible audio-based titles available to students with print disabilities. Traditionally, students with print disabilities had to rely exclusively on specialized producers such as libraries for blind users. Audiobooks can now often be purchased on the day of release through mainstream providers, including Kindle, iBooks, and Audible.

TECHNOLOGICAL BARRIERS

Notwithstanding the benefits of more accessible educational technologies, there are a number of remaining barriers and challenges. Among these, educators and designers must bear in mind that digital technology – whether mainstream or not – does not, in and of itself, guarantee accessibility to all learners. A student may be able to access a computer, but this does not mean that a PowerPoint presentation or a particular document provided in class or on a website is accessible or usable. It is important that we recognize that for true inclusion to take place, future publishers, web designers, and educators must be trained in the fundamentals of accessible document and web design. Guidelines exist for the creation of accessible Word, PDFs, PowerPoint presentations (Adobe, 2022; Microsoft, n.d.-e) and websites, but these are still not routinely adopted. The inaccessibility of data analysis software and peer-reviewed journal databases remain significant barriers that prevent many students with disabilities from advancing in STEM (science, technology, engineering, and math; Wu et al., 2021). In addition, academic evaluations are often not designed with accessibility in mind, creating barriers that do not relate to the learning outcomes the assessment should actually test (e.g., requiring an oral presentation or to provide answers to questions in a short time frame). Likewise, images posted on social media sites such as Meta and Twitter are inherently inaccessible to blind users unless “alternative text” or “alt text” has been specifically provided by the poster (McEwan & Weerts, 2007). Although AI has increased access to such images by providing automated, machine-generated text descriptions of images, these are not consistently reliable. Easy-to-follow guidelines for manually adding “alt text” descriptions to images posted on social media and distributed in e-mail can be accessed online and should be adopted by all academic institutions (Site improve, 2020).

Artificial Intelligence (AI)

According to the Global Market Insight *AI in Education Market According to Research* (Prescient & Strategic Intelligence, 2020), the global AI in education market is expected to reach $25.7 billion by 2030, up from just $1.1 billion in 2019. Examples of AI being used today include answering college registration and application questions via chatbot, converting spoken lectures to lecture notes, and AI-powered discussion and tutoring platforms (Schroeder, 2022; Schwartz, 2019; Ullman, 2020). While these innovations appear intriguing, we could not find any evidence of considerations regarding AI-based discussion or tutoring platforms for people with disabilities. It is unclear whether the platforms themselves even meet minimal Canadian (e.g., Secrétariat du Conseil du trésor, n.d.) or international standards for digital accessibility (Web Accessibility Initiative, 2022) to make it possible for learners with a variety of disabilities to interact with these systems. If such systems are to become widely adopted, it is necessary to engage people with disabilities and digital accessibility experts *now* to avoid introducing barriers during what is expected to be continued experimentation and rapid adoption.

Specialized Assistive Technology

While a push toward mainstream accessibility represents a positive step forward, there remains a need to continue supporting the development of highly specialized accessibility tools. For example, although sighted users of technology do not read and write in braille, the braille code will remain a crucial form of literacy for individuals who are blind (Martiniello, Haririsanati, & Wittich, 2020). Like print, braille provides vital access to spelling, grammar, and other nuances that may not be easily grasped through audio alone by students who are blind. There is a strong correlation between braille literacy and higher levels of education, income, and employment (Martiniello & Wittich, 2019). This need for highly specialized accessibility tools might be another important caution not to focus solely on mainstream technology.

While braille has traditionally been accessed through hard copy paper format, the growing proliferation of electronic braille displays has significantly increased access to digital content in braille for those who use these tools by translating smartphone, tablet, and computer screen content into instant braille using a series of pins that rise and fall to form braille symbols (Martiniello & Wittich, 2021). Unfortunately, these refreshable braille display devices remain costly (ranging from $2,000 to $10,000 or more). While lower cost braille displays are being introduced, it is important that research, resources, and funding are devoted to increase access to more affordable braille displays.

Moreover, advancements in digital accessibility must also consider the importance of ensuring equitable access to content in the format that is best suited for a given learner and task. A poignant example of this is in the fields of STEM, where students who are blind remain significantly under-represented (Swenor, 2021). It can be difficult for students to access certain types of content through audio alone, particularly in those subjects where spatial information and layout is crucial. Having access to a math problem or scientific figures or graphs on a full page of paper braille can greatly increase inclusion for students who would otherwise be unable to participate. In recent years, we have seen a positive and exciting surge of new prototypes in development that provide a full page of electronic braille and tactile graphics. For example, the American Printing House (2016) developed a tactile graphics display to address this need.

Similarly, the Canute 360 braille display (Bristol Braille Technology, 2022), while currently unable to translate graphics into tactile format, provides multiple lines of braille. Ensuring these future innovations remain easily usable and affordable will help remove barriers in the sciences. Alongside an increased use of 3-D printing technology to enhance access to visual concepts (e.g., geometry), these developments hold the empowering potential to increase access to the sciences for students with visual impairments and others who benefit from a more hands-on approach.

Identifying Barriers to Online Learning Using Analytics

As more learning occurs online (e.g., fully online degree programs, massive open online courses (MOOCs), blended learning), and as online learning becomes more accessible, improved learning analytics data from students with disabilities may be available (i.e., collection and analysis of data about learners to better understand and improve learning). For example, data drawn from interactions with virtual learning environments, assessment scores, and other systems can be used to identify where materials or activities present barriers to learning (Cooper et al., 2016; Coughlan et al., 2019).

IMAGINE A WORLD WITHOUT LANGUAGE BARRIERS TO COMMUNICATION AND COLLABORATION!

There are approximately 7000 languages spoken around the world (Anderson, n.d.). In Canada, a land of immigrants, over 200 languages are spoken (EduCanada, 2019). Thus, our post-secondary institutions have large numbers of immigrants and second language learners. For many of them, automatic translation could facilitate their learning. Recently, Google, Microsoft, and Zoom have touted their capability to provide or to translate video conferencing collaborations in real time. We tested the automatic language translation of automatic captions in Microsoft Teams, a feature prominently advertised by Microsoft (Microsoft, n.d.-c; Microsoft, n.d.-d), but after two hours of frustration and consultation with two IT specialists, this feature was still not working. Yet, in Canada, a bilingual country (French-English), many meetings and courses take place in both languages (i.e., some participants speak in English, some in French). Although AI-based captioning is now a built-in feature on the Zoom video conferencing platform (Yale University, 2021), it remains limited in that it cannot convert languages other than English into written text, placing non-English speakers who require this feature at a significant disadvantage (Zoom Video Communications, 2021). Similarly, although Google advertised: “Google Meet can now translate speech and turn it into captions on the fly”; the small print said: “Only in beta, though” (Schroeder, 2021). By the time you read this chapter, these language features will likely be functional. When coupled with captioned course videos (e.g., Macmillan Learning, 2021) and automatic captioned MOOCs, free online courses available to anyone (edX, n.d.; Loftus, 2021; Schaffhauser, 2019), education has the potential to become far more accessible to post-secondary learners with and without disabilities worldwide.

A further challenge being recognized and addressed is that some people have accents, speech impairments, or conditions that affect their speech patterns. For example, in Project Euphonia, Google is supporting work to collect data from people with speech difficulties and to optimize recognition algorithms so that they can understand these speakers (Google, 2019). Wider work on responsible AI, that recognizes biases and barriers that arise in systems due to disabilities along with other individual differences, such as cultural backgrounds, is growing (Brewer, 2022).

INTERESTING RECENT ADVANCES

As noted by our international AI advisory Board in 2020 (Adaptech Research Network, 2020; Martiniello et al., 2020), some of the innovations mentioned above are now available, some are still in development, and others have yet to be imagined. By the time of publication, we hope that many of the innovations mentioned below – as well as innovations yet to be imagined – will be a reality.

There have been numerous recent developments such as AI-assisted hearing aids (Hear Soundly, 2021). This is also true of AI-based psychological support "apps" including, for example, *Headspace* (Biswas, 2021) and Optania (n.d.), a mental health AI chatbot that uses French and was developed in Canada.

Also, in a recent development, some textbooks and journal articles have appeared not only in PDF but also in the typically more accessible EPUB format. As a "born accessible" format (Beaumon, 2015), EPUB has long been available for eBook readers, where its digital properties make it especially user-friendly (EBSCO Connect, 2020). The appearance of textbooks and academic journal articles in EPUB format is an indication that post-secondary institutions are increasingly aware of the need to provide accessible academic content and are engaging with publishers to make this a consistent option.

Some specialized ATs have also recently made an appearance. This includes Microsoft's Immersive Reader for Word and Teams (Mohapatra, 2020; Veroniiiica, 2018), which can declutter text, change the color of the background, divide words into syllables, and use narration to hear the text aloud (with the words highlighted to follow along). Another important recent advance is voice search for search engines (Chrome Web Store, n.d.). This allows students with dexterity issues, specific learning disorders, and related disabilities to search the web vocally, without having to type.

Microsoft, in a recent blog (Smith, 2021), noted the introduction of built-in accessibility remediation tools across their platforms:

> A new background accessibility checker will provide a prompt to fix accessibility issues in content across the core Office apps and AI in Microsoft Word will detect and convert to heading styles crucial for blind and low-vision readers. A new Excel navigation pane designed for screen readers will help people easily discover and navigate objects in a spreadsheet. We're expanding Immersive Reader, used by 35 million people every month, to help with the comprehension of PowerPoint slides and notes. In Teams, high-contrast

> mode can be used to access shared content using PowerPoint Live which will reduce eye strain and accommodate light sensitivity with Dark Mode in Word. New LinkedIn features that include auto-captioning for LinkedIn Live broadcasts, captions for enterprise content and dark mode (para. 6).

Virtual Reality and the Metaverse

We are not sure what it is, but it is definitely coming, as noted on the cover of a recent Time Magazine issue (Ball, 2022). In *Immersive Learning Environments: Designing XR into Higher Education* Dodds (2021) offers this explanation of terminology:

> The terms metaverse, virtual reality (VR), mixed reality (MR) and cross reality (XR) are used interchangeably in common parlance despite nuanced differences that are debated among experts. All terms imply instances of the user having an immersive experience facilitated by technology. Virtual reality has traditionally been more popular terminology than XR (para. 4).

Virtual and augmented reality are increasingly being applied to post-secondary educational environments. For example, both are viable alternatives to traditional methods of education in the physical and health sciences and medical and nursing courses (Moro et al., 2021; Staff Writers, 2021; TU Delft, 2021). Fortunately, with the growth taking place there is a community called XR Access (n.d.) which exists with a mission, "To modernize, innovate, and expand XR technologies, products, content and assistive technologies by promoting inclusive design in a diverse community that connects stakeholders, catalyzes shared and sustained action, and provides valuable, informative resources" (para. 3). While this technology is still under development, it will be crucial that any number of accessibility concerns, from managing motion that impacts students with vestibular disorders, to having fully functional screen reading software that can work in these environments, among other issues (Alexiou, 2022; Evans, 2022; Phillips, 2020; Spillers, 2018), be considered and resolved. Augmented reality has already been used to help individuals with visual impairments – for example, to help with shopping by adding accessible annotations onto physical objects in the environment (AR Kid, 2018; Coughlan & Miele, 2018). Virtual reality has also been used in psychology for the treatment of anxiety disorders (McCann et al., 2014), in the development of chemistry labs (Demirel et al., 2021), in telecollaboration (i.e., remote access to real-world field trips for those with mobility impairments; Collins et al., 2016), and is already being used in gaming and linking with friends on Meta (Facebook, n.d.; Robertson, 2021).

Smart Glasses

Smart glasses include eyeglasses that embody cameras, headphones, heads-up displays, and text displays. A well-known pioneer in this area is Google Glass, which can replace traditional information and communication technologies by providing the information to Google Glass in a view similar to a heads-up display (Al-Maroof et al., 2021). The latest model embodies artificial reality (CNET, 2022). Since its introduction, a variety of other wearable glasses have been introduced (Medcalf, 2019; Sell, 2020). Several of these are intended for individuals who are blind and those who have low vision; they can be combined with virtual reality as well as with other AI features that can assist with doing schoolwork. While smart glasses have not yet had an impact in post-secondary education, it is only a matter of time before these are used in chemistry, physics, and other STEM courses.

Sign Language

Although some wearable technologies are now readily available, others are still in development as noted by our AI Advisory Board in 2020 (Adaptech Research Network, 2020; Martiniello et al., 2020). For example, a variety of wearable technologies are already in use, most commonly in fitness and health related areas (Accessibility in 2030; Anderson & Anderson, 2019). Smart Gloves, created by the University of San Diego, can translate sign language signs into digital text that appears on a computer screen or smartphone (Disability Experts of Florida, 2020). Another advancement is an AI development by Google (Staff Writers, 2019). This product can convert hand gestures into speech. Research has been advanced on sign language avatars and interpretation for quite a few years, however, the degree of progress that has been made toward actual use by people is unclear. SignGlasses, another device, may eventually allow students to receive live sign language overlaid on top of the classroom environment using smart glasses (Medcalf, 2019). With these glasses a student can watch a lecture without shifting focus between the instructor, the interpreter, and their notes, as the interpreter or captions appear on the surface of the glasses.

Indoor Navigation

A thorny problem relates to mapping interior spaces to aid navigation for individuals with visual impairments. A variety of techniques are in development (Antonowicz & Saik, 2020; Goodmaps, 2020; Holton, 2019). Thus far, none are in mainstream use.

Braille Smartphone and AI Guided “Be My Eyes”

On the “imagined” spectrum is the possibility of a braille tablet or smartphone that wirelessly translates anything written on a connected digital screen. While “apps” such as Be My Eyes (Lynch, 2018) allow a student to request the assistance of a sighted volunteer to read text or navigate in their environment, AI-powered mobile apps such as Microsoft’s “Seeing AI” can also help to recognize locations, items, and text captured by a smartphone camera.

Robots

How robots with a variety of functionalities can assist individuals with a variety of medical conditions is reflected in the professional literature (Zhang & Hansen, 2022). Similarly, the topic of robots assisting and teaching young children is also being addressed (Tugend, 2022) as is the use of robots to perform complex medical procedures safely and to simulate scenarios for scientific calculations or even for emergency response training (Purdue Online, n.d.). With the exception of highly specialized applications, there is relatively little information available on the use of robots in post-secondary education other than for telepresence uses (Reis et al., 2019). Yet, we believe robots are likely to be of meaningful use in STEM areas such as chemistry and physics labs, where students with dexterity problems may experience difficulties. Moreover, research on combining robots with AI-based language comprehension (Ahn et al., 2022) and Google's LaMDA (Thoppilan et al., 2022; Walsh, 2022) holds much promise.

TOWARDS INCLUSIVE ASSISTIVE TECHNOLOGY RESEARCH

This chapter has provided numerous examples of the exciting technology innovations that are already underway as well as those we can expect in the years to come. Through a combination of inclusive learning pedagogies (e.g., Universal Design for Learning: CAST, 2018), mainstream accessibility through smartphones, tablets, and apps, and specialized ATs (e.g., braille displays), students will have the flexibility and options necessary to succeed. While research around AT development is vital and exciting, people with lived experience of disability have also raised issues of inclusion in this domain (Mankoff et al., 2010). Among the criticisms highlighted is that technologies are often developed without consultation with people who have disabilities and who can share vital first-hand insights (Martiniello et al., 2019). The result is devices may be developed based on misconceptions about what students with disabilities need and want and may, therefore, not respond to actual community needs. The abandonment of assistive devices among people with disabilities remains alarmingly high, despite their many benefits (Fuhrer, 2001; Martiniello et al., 2019; Shinohara & Wobbrock, 2011). Factors leading to device abandonment include the design of products that are costly (to purchase or to maintain) and poor design that either increases stigma or leads to impractical usage. For example, vests and shoes that vibrate to notify the wearer of upcoming barriers are impractical in a crowded pedestrian environment, and the stigmatizing effect of wearing such specialized devices may limit interest in their utilization.

It is impossible to discuss emerging trends in AT without raising these important inclusion issues. For future devices to be responsive, accessible, and adopted, researchers must meaningfully include people with disabilities from design to inception. While this involves including people with lived experience at the stage of determining user needs and what products can respond to those needs, it also should involve supporting future researchers with disabilities to occupy positions of authority and to lead projects in this domain (Wu et al., 2021). We need to go beyond the importance of lived experience in research (i.e., nothing about us without us) and ensure that students with disabilities have the support and opportunity to train as researchers by attending graduate school.

IMPLICATIONS

The inclusion of AT and accessibility features into operating systems and apps makes it increasingly unnecessary for many students with disabilities to acquire high-priced, specialized AT products, although these latter will always be necessary. As a result, many students and staff with invisible disabilities choose not to disclose as they may no longer need to access institutionally owned AT or traditional accommodations. However, the trend toward mainstream AT has numerous implications that must not be forgotten when considering the development of technology in the future.

There will always be a need for specialized technology for certain individuals in specific circumstances. One example is that users of braille will continue to need refreshable braille devices in situations where it is more suitable than audio format. Maturing technologies and trends now have the potential to support students to overcome barriers independent of help from others and, therefore, extend individual autonomy and opportunities. However, there is a caveat if responsibility remains with the individual, rather than the onus being on organizations to make their services and products accessible. Even if technology is to be used, accessible documents and websites are required. Post-secondary institutions must continue to engage their stakeholders, such as publishers of academic material, procurement officers, campus IT specialists, teaching and learning specialists, instructional designers, and librarians to ensure that accessibility standards are met.

This can present a particular problem in Canada, where accessibility laws vary from province to province and legislation is sometimes inadequately enforced, thus not motivating institutions to conform to a clear set of standards (Doyle, 2021). Much of the progress that occurred in the past in Canada was driven by a strong moral conscience to make colleges and universities accessible but there is presently a shift toward the development of accessibility, diversity, and inclusion policies.

Developers of technology have a significant role to play. Not only do they need to maintain built-in accessibility, usability, and affordability in the forefront, they need to meaningfully include students with disabilities from inception to design to implementation and evaluation. One possibility is to recruit – and financially compensate – students with disabilities to serve on committees to assist with the development of products from their inception, as usability testers for products in development, and as researchers if they possess the requisite skills. Once a product is released, developers should assess its effectiveness and be attentive to user feedback. They should also be responsible for making the public aware of what technology presently exists, the ease with which it can be utilized, and what technology is cutting edge.

Canada's neighbor to the south, the United States, has always taken the lead on the development and marketing of both assistive and general use technologies. This has many benefits in terms of the size of population served, financial resources made available, and legislation driving the effort. However, user feedback given to major technology companies is primarily from American users. Canada, as a French-English bilingual country, often requires tools in both languages and American products cannot always meet this need. As well, automatic translation in video conferencing software appears lagging and does not meet Canada's need for English/French translation. In addition, many Canadians are not native speakers of English or French and, thus, software requiring accurate voice recognition can be problematic.

To keep up to date, Canadian stakeholders must participate in conferences such as the CSUN Assistive Technology Conference in California or the Accessing Higher Ground Conference in Colorado, which provide settings for researchers, practitioners, exhibitors, and end users to share the latest knowledge and best practices in the field. However, it may prove too costly for smaller Canadian post-secondary institutions to participate and remain informed and there are no Canadian equivalents.

Educators are also an important consideration in the future of technology. They must be trained in the fundamentals of producing accessible documents and in the incorporation of technology in their teaching to meet the needs of diverse learners (Siu & Presley, 2020). It is important to note that documents can be technically accessible but still pedagogically inaccessible (e.g., because of the design of the assessment or learning activities). It is vital that educators, adapted services counselors, and access technologists receive professional development to allow them to keep abreast of rapid technological changes and their implementation.

A final comment involves the role of AI in the future of technology. Although there seems to be little evidence it is being widely used or is effective in education, it stands to reason that as AI evolves it will have a major role to play in the advancement of technology. The biases in the training of AI, and the resultant barriers that exist, especially those that impact on diverse groups, including students with disabilities, need to be challenged. In addition to performance, AI developers will need to promote only explainable, ethical, and trustworthy tools and offer the means for disinformation detection and correction.

CONCLUSION

There is an old saying that goes, "Predicting the future is easy … getting it right is the hard part." For example, in 1903 the president of the Michigan Savings Bank advised Henry Ford's lawyer, Horace Rackham, not to invest in the Ford Motor Company by saying, "The horse is here to stay but the automobile is only a novelty – a fad" (Szczerba, 2015, para. 8). Access technology is likewise developing too rapidly to see accurately into the future. What may have appeared innovative at the time of writing may be a reality by the time this book is available. However, the implications we have proposed, including the importance of communication among developers, users, and other stakeholders, should hold true regardless of what unfolds a decade from now.

NOTE

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