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How Screen Readers Impact the Academic Work of College and Graduate Students with Visual Impairments

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Abstract

This study explored the effectiveness of screen readers on the academic life of higher education students with visual impairments, including reading, writing, access to the internet, exams, and general information for their courses. This study was designed as a qualitative study and applied a phenomenological approach in order to discuss the experiences of higher education students who use screen readers as assistive technology. One college student and six graduate students with visual impairments were interviewed in the United States. The findings revealed that higher education students with visual impairments benefitted from screen readers; however, they also noted some limitations: difficulties in accessing printed classroom materials, inaccessible digital content, and time lost due to technical issues. Students with visual impairments should be offered accessible documents such as electronic versions of classroom materials, accessible PDFs and websites, and software compatible with JAWS. Universities should provide accessibility training for lecturers who want to better serve students with visual impairments. University information technology services need to train their technical services staff about screen readers to provide 24/7 professional services for students with visual impairments.

Keywords

Visual impairments, screen readers, graduate students, academic work, daily life.

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INTRODUCTION

Rapid technological innovations in the "digital age" need to be considered when discussing the use of technology for educational purposes (Silman et al., 2017). Notably, computer-based practices are becoming increasingly popular since they shorten learning periods for students, increase student motivation, and support students' learning processes (Goker et al., 2016). Hasselbring and Glaser (2000) indicated that new computer-based technology allows rapid access to information, communication, and culture for students with disabilities. Both the Marrakesh Treaty and the United Nations Convention on the Rights of Persons with Disabilities (UNCRPD) underline the importance of using screen readers for individuals with visual impairments (VI). The international Marrakesh Treaty, adopted in 2013 in Marrakesh, Morocco, aimed to improve access to published works for individuals with VI and print disabilities. The Marrakesh Treaty allows authorized entities such as libraries, educational institutions, and organizations serving individuals with VI to produce and distribute accessible format materials without seeking permission from copyright holders (Helfer et al., 2020). It encourages countries to share their accessible format materials across borders, thus expanding the availability of these materials globally. This aspect of the treaty is particularly important for individuals with VI in developing countries such as Turkey, where access to accessible materials may be limited. In addition, the UNCRPD, adopted in 2006, recognizes the right of individuals with disabilities to access information and communication technologies and promotes measures to ensure equitable access to digital content and printed materials. Therefore, the use of computer-based technology such as screen readers has significantly affected the lives of students with VI (D'Andrea, 2012). It is important to use screen readers effectively for further advancements and accessibility to ensure that all students with VI can fully benefit from these accessible materials.

Access to Classroom Materials

Students with VI are a small number within the larger postsecondary student population, but their numbers in college and graduate education appear to be growing (Galdi, 2007; Perez, 2013). These students are provided with accommodations by university disability services, such as textbooks in an alternate format (Braille, large print, and audio) and computer-based software programs (screen readers). Perez (2013) indicated that one of the problems faced by graduate students with VI was gaining access to the reading materials they needed for their courses. Especially for college and graduate students with VI, the materials are more accessible to them when they are available online (Joshi, 2006; Perez, 2013).

Types of Screen Readers

For individuals with VI, computer software programs that read written text on a computer screen aloud through a speech synthesizer are the most popular assistive technology (AT) tool for accessing information from computers (Lazar et al., 2007). The four commonly used screen readers are JAWS, NonVisual Desktop Access (NVDA), Window-Eyes, and VoiceOver (Calvo et al., 2014; Kayte et al., 2015). According to the Web Accessibility in Mind (WebAIM) survey (2019), among these, JAWS has been the most broadly used screen reader around the world, and many programs globally have adopted it. NVDA is an open-source and free screen reader for Windows. Similarly, Window-Eyes was developed by GW Micro for the Microsoft Windows operating system. VoiceOver is a screen reader built into the Apple operating systems.

Screen Reader Accessibility

Screen readers can give individuals with VI much more independence by allowing them greater access to all print materials and the ability to read documents. Therefore, screen readers enable students with VI to become active learners in the classroom by providing them with the same access to information as their sighted peers. Also, screen readers may improve reading and writing skills for students with VI by allowing them to re-read and edit previously written texts (Alves et al., 2009; Hasselbring & Glaser, 2000), which is especially helpful for college and graduate students.

It is imperative to ensure accessibility in higher education institutions, schools, and social and public services in order to encourage inclusivity and provide equal opportunities for all individuals, including those with disabilities. Staff members, faculty members, and service providers should receive comprehensive training on accessibility regulation and inclusive practices. Accessible websites, online platforms, and materials should be available to individuals with VI, as well as training and support for those who use screen readers. Therefore, continually evaluating and improving accessibility is essential, keeping in mind that accessibility is a journey that requires ongoing collaboration and commitment. Most of the screen reader-related literature has examined the accessibility of screen readers and discussed either access challenges or recommendations for improvements in accessibility (Cervone, 2013; Hill, 2013; Kayte et al., 2015; Southwell & Slater, 2013; Walker & Keenan, 2015). However, research on the use of screen readers by college and graduate students is needed to understand and address the challenges faced by students with VI in participating in academic activities and accessing educational materials (Delgado & Salmerón, 2021; Vandenhoek, 2013). The researcher found only a few studies that specifically discussed the use of screen readers for college and graduate students with VI (Argyropoulos et al, 2008; Corn & Wall, 2002; Galdi, 2007; Kelly, 2009), and found no qualitative studies that examine the use of screen readers for both academic and daily life. The goal of this qualitative study is to expand upon previous research by examining how screen readers impact college and graduate students in both academic and daily life.

The two research questions guiding this study are: 1) How do screen readers impact the academic life of college and graduate students with VI? 2) To what extent do screen readers impact the reading and writing of college and graduate students with VI?

METHOD

This study was designed as a qualitative study and applied a phenomenological approach in order to investigate the impact of AT on the academic lives of college and graduate students with VI. Phenomenology as a theoretical framework was developed to study individuals' experiences of phenomena (Creswell & Creswell, 2017; Moustakas, 1994). "The purposes of a phenomenological study are to understand and describe a given phenomenon in-depth and arrive at the essence of humans' lived experiences of that phenomenon" (Cilesiz, 2011, p. 495). As a method of research, phenomenology is becoming more popular, particularly in disciplines focused on human experience within a particular context (Cilesiz, 2011; Crotty, 1996; Crotty, 1998; Hayllar & Griffin, 2005; Palmer, et al., 2010).). In this study, the aim was to identify the experiences of higher education students regarding the use of screen readers. Therefore, the phenomenological approach is uniquely suited to research students' lived experiences with screen readers.

Participants

All seven participants were students with VI in a public university in the United States. Three students were studying for a master's degree, three students were studying for a Ph.D., and one student was studying for a bachelor's degree (Table 1). The participants were reached via email by the university disability resource center and snowball sampling. The author obtained information about students with VI who studied social sciences at the university from the university disability resource center. After their email addresses were obtained, the author sent an email with the information about the research and interview process. All social sciences students with VI who agreed to participate in the study were included. Also, all participants were asked to invite their friends with VI to the study and reach out to those students via email. Since social science students are expected to read and write a lot on the computer, the researcher interviewed students in social sciences to obtain more information about using screen readers in reading and writing. All participants needed to use braille as their primary literacy medium, be full-time students at the university, and use screen readers.

Table 1

Participant Demographic Information

Participants	Gender	Age	Grade	Primary Literacy Medium	Eye Condition	Nationality
Student Z	Female	33	Ph.D.	Braille	LCA*	Turkish
Student P	Male	32	Ph.D.	Braille	RP***	White American
Student T	Female	28	Ph.D.	Braille	RP***	Palestinian/ American
Student N	Female	30	Master	Braille	ROP**	African American
Student D	Female	48	Master	Braille	RP***	African American
Student A	Female	25	Master	Braille	ROP**	White American
Student I	Male	21	Bachelor	Braille	CG****	Asian/American

* Leber Congenital Amaurosis *** Retinitis Pigmentosa

** Retinopathy of Prematurity **** Congenital Glaucoma

Data Collection

The researcher employed a semi-structured interview to obtain in-depth information about how screen readers affect the lives of college and graduate students with VI (Creswell & Creswell, 2017). The interview form was sent out to two different experts who hold Ph.D. degrees in special education

in order to obtain their opinions. The experts analyzed the wording, structure, and overall appropriateness of the questions. They also recommended deleting one repetitive question and changing the order of two questions to ensure a more logical flow of topics. Once the experts had completed the review, the interview questions were revised and updated by eliminating the redundant question.

This study was reviewed and approved by the human subject committee of a university in the United States. After approval was obtained from the Institutional Review Board (IRB), an email outlining the research was sent to the university disability resource center listserv. Upon acceptance, participants were contacted by email with the interview information. All the interviews were conducted in a quiet library room on the university campus. After each participant signed the consent form, the researcher interviewed the students with open-ended questions, allowing them the freedom to talk about their experiences in depth, avoiding misunderstandings, encouraging cooperation and rapport, and eliciting unexpected answers (Robson, 2011). The students were provided with a set of 20 guiding questions about using screen readers and their responses were audio recorded. First, the interview gathered general information about the students and their current experiences, such as eye condition, age, and primary literacy medium. Next, the interview was conducted to inquire about the students' preferences, practices, and essential experiences with screen readers. Since the students were free to ask for clarification before answering open-ended questions, the validity of the reports increased substantially. For example, if the students did not understand a question, they could ask the researcher to repeat or rephrase the question before they answered it. Each interview lasted about 90 minutes and was recorded. All interviews were completed in one month.

Data Analysis

All audio-recorded interviews were transcribed verbatim during the interviews by using Dragon software. Dragon speech-to-text apps, also known as Dragon dictation apps, are software applications that utilize speech recognition technology to convert spoken words into written text. Dragon speech-to-text apps are available for various platforms, including desktop computers, smartphones, and tablets. During the interview, the researcher employed a dual approach to ensure accurate transcription and backup in case of any technical issues. She used her laptop with Dragon software for real-time transcription from speech to text. Additionally, she used her phone for voice recording. After all interviews were completed, the first step was revisiting and reading the data to identify patterns and recurring ideas. Later, the transcriptions were analyzed word by word and phrase by phrase to detect similar statements, sentences, and quotes by using color coding.

An inductive thematic analysis was used to identify themes. After initial coding, the researcher sought to identify and describe themes from the perspective of the students (Creswell, 2013) using open coding transcriptions to categorize similar statements into themes (Marshall & Rossman, 2016). The researcher used these significant statements and the associated themes that emerged to represent what the participants experienced regarding the screen readers. Accordingly, the data analysis involved synthesizing the important quotes, statements, and sentences relevant to each identified theme. This approach is consistent with the process of thematic analysis, where themes are identified based on the data obtained.

Themes were identified based on what occurred most frequently across interview transcripts. Lastly, the results of the open-coded transcriptions were categorized into six themes: access to classroom materials, using screen readers for writing and reading, using screen readers for daily life, advantages

of screen readers, disadvantages of screen readers, and inadequate knowledge about screen readers. These emerging themes were used to write a description of what the participants experienced regarding the phenomenon (Creswell, 2013). Important quotes, statements, and sentences were presented under each related theme in the results section. Figure 1 is a visual depiction of how the findings were coded.

Researcher bias and reactivity are the two main threats to validity (Maxwell, 2013). To eliminate any threats to the validity of the data analysis and conclusions, the researcher used two accepted strategies. One common strategy is member checking (Maxwell, 2013), considered to be the most critical technique for establishing credibility (Creswell, 2013). All participants were contacted via email to verify the findings after the analysis of the themes was completed. Participants were asked to read the transcripts and comment on whether they felt the synthesized results were the same as their experiences (Birt et al., 2016). They were also asked if they would like to change or add to the transcripts to improve the analyses. The researcher allowed two weeks to return the transcripts. All participants indicated that they agreed with the results and had no additional comments to add. This procedure provided an opportunity for the participants to comment on the findings regarding their accuracy.

Table 2

Template for coding themes

Themes (Emerging from participants' experiences)	Categories
Access to Classroom Materials (I use my personal computer with JAWS)	
Using Screen Readers for Writing and Reading (I am able to navigate the digital text)	• *Writing* (I am able to produce my academic work) • *Reading* (I can adjust my speed according to how fast it reads)
Using Screen Readers for Daily Life (I use maps on my phone to navigate independently)	
Advantages of Screen Readers (Screen reader makes my life more accessible)	
Disadvantages of Screen Readers (Multiple barriers make it difficult to use JAWS)	• *Inaccessible images* (If there is no alt text, JAWS is unable to interpret visual information)

	• *Incompatible PDF files, websites, and apps* (Designers do not really think about screen reader users) • *The voice of JAWS* (It is kind of robotic and annoying) • *Technical issues.* (It takes a long time for us to fix the problem)
Inadequate Knowledge of Screen Readers (TVIs did not have advanced experience in using JAWS)	

External audits were used as a second method of validation (Creswell, 2013). The external auditors assessed whether the data supported the findings, interpretations, and conclusions. The external auditors provided important feedback that can lead to stronger and better-articulated findings (Creswell, 2013). For the external audit of the data analysis, the researcher collaborated with two research assistants: One research assistant in the special education department, who is working on her Ph.D. at the same university, and another research assistant in a different university, who is working on his Ph.D. in the program for teaching students with VI. Since all audio-recorded interviews were transcribed with Dragon software, the auditors only looked at the transcripts and identified themes; they were otherwise unconnected with the study. The external auditors independently coded the same set of data and then discussed and resolved any discrepancies through online meetings. The coders compared their codes and ultimately reached a consensus on the appropriate codes for each finding. All three coders were able to achieve 100% agreement by the end of the meetings.

Ethical Principles

Ethics committee permission for this study was obtained from University of Arizona Committee of Research, Discovery and Innovation with the decision dated 15.04.2019 and numbered 1903481207.

FINDINGS

This qualitative study aimed to explore the lived experiences of college and graduate students with VI who use screen readers. All students reported that they used JAWS and VoiceOver in their academic and daily life. Only two students indicated that they sometimes used NVDA for their math tasks. According to the results, all students used VoiceOver and JAWS for different tasks. For example, JAWS was used by students for academic tasks such as reading and writing, using Microsoft Office (Word, Excel, and PowerPoint), taking exams, and using the internet. The students used VoiceOver in their social life (e.g., texting, communication, shopping, listening to music and books, navigation, maps, and games).

Access to Classroom Materials

Since JAWS allows students to access electronic versions of documents immediately, they always used personal computers with JAWS for accessing classroom materials. When asked about access to classroom materials, all students indicated that they mostly preferred to use digital text (e.g., PDF, Microsoft Word, PowerPoint, and Excel). Digital text is delivered on a computer, as an electronic version of a written text, and enables users with VI to access the information in audio format. Students specified that they felt more comfortable using digital text because JAWS allowed them to have the same access to information as their classmates. Student A said, "I use JAWS to access classroom materials because I'm able to do what I need to do." However, students indicated that faculty members were usually unaware of their needs and were unwilling to share electronic documents earlier than the course time. Students suggested that faculty should share the electronic versions of the documents at least one week before class in order to ensure that the material is accessible to students. All students stated that they were able to use JAWS with headphones in the classroom and participate in classroom activities independently. For example, student N highlighted that she was able to rapidly access information on the internet with JAWS when her class activities required it.

Using Screen Readers for Writing and Reading

All students indicated that they mainly used JAWS for their reading and writing. The students agreed that JAWS allowed them to engage in both writing and reading by providing access to content and auditory feedback. By using JAWS, students were able to navigate the digital text for either reading or editing existing electronic files (PDF, Word, PowerPoint, etc.,) without a mouse.

Writing

Students declared that JAWS provided them with the ability to freely navigate documents, such as PDF files, Microsoft Word documents, PowerPoint files, Excel spreadsheets, and internet pages, giving them opportunities to use the advanced features of a computer by using keyboard commands. Students stated they were able to review their writing (e.g., proofreading, editing, checking punctuation, deleting, inserting icons, and rearranging text fonts) by using JAWS. Student Z stated:

> *When I write, for formatting, I can use different JAWS features …. There are shortcuts that I can see if it's bolded or italicized. You can adjust your JAWS to just say the word that you typed wrong, and you can correct it [word]. In addition, you can see the comments and track changes on the documents.*

In addition, they said that JAWS provided opportunities for them to work with their peers at the same time. For example, student N indicated:

> *I use Google Docs, so think about if I cannot use it, I will be excluded from my classmates. Thanks to JAWS, I am able to read and write and produce my academic work, I can access information on the internet just like my sighted peers.*

Reading

Students noted that they had the opportunity to obtain any critical information from the reading text when they used JAWS. For instance, JAWS provided a way to read an electronic file character by character, word by word, line by line, and paragraph by paragraph as well as moving back and forward between paragraphs. Furthermore, the students stated that JAWS allowed them to make all sorts of annotations, such as adding text, commenting, highlighting, adding bookmarks, and more.

Additionally, the students were able to adjust JAWS settings according to their own needs, such as choosing different voices, adjusting the speed of the voice, and changing the level of the voice. Student D described her experience with JAWS:

> *For reading, I can adjust my speed according to how fast it reads. I can go back and forward between paragraphs, I can read it character by character, word by word, line by line, I can adjust it when reading without stopping. You can make it [JAWS] stop whenever you want.*

The students indicated that without screen readers, they would have not only slower access to text content but also less independence and success in learning.

Using Screen Readers for Daily Life

When students were asked how they used screen readers in their daily lives, they responded that they usually used VoiceOver for reading emails, texting, shopping, scanning printed information, playing games, and navigating around. All students stated that they mostly used VoiceOver in their daily tasks for both portability and free screen reader access. Most students stated that they had their phones with them all the time; thus, they were more independent in their social life. Student P described how she used VoiceOver in her daily life:

> *I have my phone on me all the time; I use VoiceOver for texting and checking my emails, reading my emails and my messages, going on social media, listening to music, and playing games. I have been able to find numerous applications in order to be independent in my life. For example, there are apps to identify colors and scan barcodes and printed documents. When I go shopping, I do not need sighted persons; I use the apps to read the price of items and recognize the color of items. Also, I use maps on my phone to navigate independently.*

Since VoiceOver allows individuals with VI to use their iPhones as much as their sighted peers, there is no doubt that VoiceOver provides many opportunities for individuals with VI such as communication, traveling, shopping, entertainment, and accessing the internet.

Advantages of Screen Readers

All students declared that screen readers prevented long wait times for accessing the content of classroom materials. Student T said, “generally, professors post class materials in electronic formats. I can get access to them with JAWS. Also, I access my books if they are available in electronic formats like on Bookshare or any other websites. Thanks to JAWS, I do not have to wait to get them in braille.” Moreover, students expressed their opinion that screen readers were a way to open the door to university for them. Student Z stated:

> *I couldn't be here in my life and education and career or anything like that without having accessible software [screen readers]. JAWS gives us a life of progress and gives us a way to live. Life is a word that has a lot of meanings. One [meaning] is to have a better job, and for the student to do all that, and be included in society… If I didn't use JAWS and VoiceOver, I don't think I would be able to do the things that I am doing today and live independently. For example, I wouldn't be here today as an educated woman and independent woman who is traveling by herself.*

The students described screen readers as being user-friendly and a bridge to an independent life. When asked about how satisfied they were with screen readers, all students rated themselves as “very satisfied”. All students expressed that they were pleased to use JAWS because they did not need to

carry a device other than their computers. They added that using a mainstream device made them feel more comfortable. Student D said, “I didn't want to seem different”. Student P noted that “I personally prefer not to use so many different things [AT devices] for so many purposes if I can get it done on my iPhone; I don't need different things [AT devices] like a barcode reader”. Student T, who is an international student, said, “I do not know braille in English, screen readers help me to adapt easily. I did not have to learn braille in English thanks to the screen reader.”

Disadvantages of Screen Readers

All students noted that multiple barriers made it difficult to use JAWS, such as inaccessible images; incompatible PDF files, websites, and apps; the voice of JAWS; and technical issues.

Inaccessible Images

The students identified one of the disadvantages of using JAWS for reading images. All students agreed that if there is no alt text, JAWS is unable to interpret visual information such as pictures, drawings, and maps.

Incompatible PDF Files, Websites, and Apps

All students stated that sometimes websites, apps, and PDF files are not created in an accessible format. They discussed that having inaccessible sources was another disadvantage of using JAWS. For example, students indicated that faculty members were usually unaware of this accessibility; therefore, they did not provide accessible classroom materials such as websites and PDFs. For this reason, students were not able to access sources to complete their classroom tasks.

Also, students stated that inaccessibility impacted their privacy and independence because they could not access the content by using screen readers. Student Z stated:

> *It is really frustrating when things are not accessible, because the designers do not really think about us as screen reader users. For example, my bank website was updated, and I can no longer instantly use it by myself, and most private information like your bank account, you wouldn't want to show it to somebody, you would want to do it by yourself. Inaccessibility impacts your privacy and dignity as well.*

However, the students indicated that accessibility was not a problem because of JAWS; it was a problem because of the websites and apps themselves. Therefore, all students suggested that companies should be aware of making their software, websites, and documents compatible with screen readers.

The Voice of JAWS

Some students mentioned that having a monotone voice was another disadvantage of JAWS. Student I described the JAWS voice as "robotic" and added that there are other options to use as voice synthesizers:

> *I initially thought that JAWS is really annoying, but now what I have on my computer is not the traditional voice. I downloaded one of the other synthesizers because personally, I don't like using the regular voice of JAWS. I don't find its voice emotional; it is kind of robotic and annoying.*

Technical Issues

Screen reader users sometimes face difficulties with technical issues. All students remarked that when they experienced a technical issue with JAWS, it may take a very long time to fix it. For example, some students indicated that the laptop might shut down, freeze, or stop talking while they were working with it. In this case, all students expressed that they first restarted the laptop or rebooted the program with which they were working. If the technical issue was not solved, they searched online about the specific technical issue or accessed technical support such as Freedom Scientific, which provides technical services for JAWS, or the university's information technology service. Student P specified:

> *I call Freedom Scientific. I generally say that something has happened to my laptop. They walk me through it [solving the problem] or I just search for it on Google because they have tutorials, and they have some guidelines on the websites. If I cannot repair my laptop, I take it to the university computer technical service.*

Inadequate Knowledge of Screen Readers

None of the students indicated that they had obtained adequate training about screen readers. When the participants were asked how they learned to use screen readers, all students responded that the most helpful persons were teachers of students with VI (TVIs) and family. All students agreed that TVIs introduced JAWS and encouraged them to use it. However, none of the students agreed that TVIs or their families had adequate information about screen readers. The students stated that TVIs did not have advanced experience in using JAWS. Student T said:

> *In the beginning, it was her [TVI] but she had just started. I mean she had information to get me started and then I took it and built on it, and then my brother, if I needed anything my brother helped me. My family supported me in general, like encouraging me to use [JAWS]or helping me to use it, but they don't have the knowledge or understanding of JAWS.*

RESULTS, DISCUSSION AND RECOMMENDATIONS

In this study, the following research questions were answered: 1) How do screen readers impact the academic lives of college and graduate students with VI? 2) To what extent do screen readers impact the reading and writing of college and graduate students with VI? The findings revealed that screen readers have a great impact on being successful and independent for students with VI; however, inaccessibility negatively impacts their success, privacy, and independence (Napoli et al., 2021). Fichten et al. (2019) found that Canadian and Israeli higher education students with disabilities mainly prefer to use smartphones in the classroom to record lectures, view projected lecture PowerPoints, and use Google. In contrast to Israeli and Canadian higher education students, college and graduate students in the USA mainly use JAWS in the classroom in their academic lives for reading, writing, and classroom tasks, and VoiceOver (smartphone) in their daily lives for shopping, communication, traveling, entertainment, and reading novels. The findings show that college and graduate students with VI had only JAWS training because JAWS has been around longer. Also, JAWS works with the Windows operating system. Therefore, they prefer to use JAWS in their academic work. On the other hand, the biggest reason why students with VI use VoiceOver in everyday life may be its portability (Fichten et al., 2019).

The students emphasized that screen readers are a crucial tool for them to open the door to university because screen readers provide the same opportunities to these students as their sighted peers. For example, using a screen reader prevents a long wait time for printing braille materials by allowing students to access the internet and electronic versions of written information (Holt et al., 2019; Stone et al., 2019). Also, screen readers remove barriers between graduate students and the academic world by giving them access to almost all the opportunities provided by a computer. For example, all graduate students with VI can efficiently use advanced techniques for reading and writing with the keyboard. Students are able to read a word, a sentence, a paragraph, or a whole page, as well as move the cursor in the document freely. Likewise, they can review and add to their writing, such as proofreading, editing, copying, pasting, deleting, checking punctuation, and rearranging fonts by using JAWS. All students noted that changes and adjustments could easily be made to existing electronic files by using JAWS because there are many options available in JAWS to modify electronic files. Hence, when accessible documents are provided to students with VI, they are able not only to read and navigate documents but also to make all sorts of annotations, such as adding text, commenting, highlighting, creating shapes, attaching files, and more (Alves et al., 2009; Hasselbring & Glaser, 2000).

Outside of the classroom, the findings showed that screen readers promote greater independence for students with VI in their daily lives. The numerous smartphone apps are specifically designed to make students with VI more independent. Without screen readers like VoiceOver, students would not be able to use these apps because they would have to purchase different assistive technology devices for each task. The findings of this study confirm the early findings that smartphones are a cheap alternative to increase access to information, allow e-inclusion, and decrease the digital divide for individuals with VI (Leporini et al., 2012).

The findings revealed that college and graduate students with VI benefitted from screen readers; however, they also noted some limitations due to technical difficulties. According to the Americans with Disabilities Act (ADA), universities must ensure that their programs, services, websites, and physical facilities are accessible and make reasonable accommodations to support the needs of students with disabilities. Digital applications such as educational software, and online platforms, can play a significant role in supporting academic and social participation and early skills acquisition for students with VI by allowing the use of screen readers without the need for braille prints. However, students encounter some difficulties in accessing classroom materials, software, and websites. Difficulties in accessing classroom materials were also reported in a previous study (Galdi, 2007). The results of the current study revealed that even after more than a decade, difficulties in accessing classroom materials still exist as a barrier for these students. The lack of training on how to provide accessible documents to students in higher education is a valid concern. Therefore, providing accessibility workshops for faculty members may help them facilitate accessible classroom materials for their students with VI (Rachel et al., 2017).

Additionally, we know that computers may break down at any time; however, it is frustrating when the laptop's voice is shut down because screen reader users cannot figure out the technical issues without the voice. Therefore, technical issues requiring repair cause lost time for users with VI. In order to reduce this lost time for repairing computers with screen readers, the university information technology services need to train their technical services staff about screen readers to provide 24/7 professional services for students with VI.

The surprising finding is that college and graduate students use JAWS almost always as an assistive technology tool in their academic work. It was expected that students would use at least two different screen readers depending on their work. Using only one screen reader might be due to a lack of training about using screen readers provided for those students. The findings show that none of the students had obtained adequate training regarding screen readers. Although TVIs teach basic skills of JAWS and encourage students to use screen readers, all students agreed that TVIs did not have advanced skills with JAWS (Kirboyun, 2020). Previous research results show consistency with the current study. For instance, a study conducted in Turkey (Yılmaz, 2018) suggested that the teacher who is to teach using screen readers should have sufficient equipment, knowledge, skills, and attitudes. In addition, Yılmaz (2018) pointed out a common view expressed by both students and teachers about the need for an appropriate curriculum and materials while learning the use of screen readers. Also, Bayır, Keser, and Numanoğlu (2010) stated that an information technologies program for individuals with VI should be developed in order to use assistive technologies efficiently and make individuals with VI a member of the production team in this society as well as to contribute positively to both their personal development and social development (Şimşek et al., 2010). TVIs' lack of knowledge about screen readers may impact students' acquisition of screen reader skills. Therefore, providing pre- and in-service training for TVIs regarding screen readers may play an important role in improving students' screen reader-using skills.

The legal regulations, including the ADA, the Marrakech Treaty, and the UNCRPD collectively highlight the rights of individuals with visual impairments to use screen readers in educational contexts. Universities and colleges are therefore required to provide the necessary support and accommodations, including the provision of screen readers, to ensure equal access and opportunities for students with visual impairments. It is important for universities to comply with these regulations and work closely with their disability services offices to ensure that students with visual impairments receive the necessary support and accommodations, including the use of screen readers, to facilitate their academic success.

Conclusion

In summary, the findings show that screen readers have an essential impact on the independence and academic success of college and graduate students with VI. The findings indicate that students prefer to use JAWS as an assistive technology tool for accessing information for their academic courses, reading, and writing for various reasons. Firstly, students use JAWS because most of the classroom materials are available in electronic format. Secondly, JAWS provides faster access to classroom materials for students. Thirdly, JAWS offers these students the ability to navigate a document more quickly, easily, and efficiently, on a par with their sighted peers. Fourthly, JAWS removes barriers between students with VI and their classmates and professors by offering opportunities to work on the same document. Lastly, JAWS gives access to all the opportunities provided by a computer, and it does not require using additional or different devices as an assistive technology tool. Also, the findings show that students encounter barriers such as a lack of training about screen readers, inaccessible content, lack of knowledge about accessibility, and technical issues related to screen readers. Last but not least, university faculty members should be trained in providing accessible classroom materials, including accessible PDFs, screen reader-compatible websites, and digital classroom documents. The results show that no matter how many disadvantages there may be regarding the use of screen readers for students with VI, all students believed that screen readers are definitely useful assistive technology tools for removing barriers for individuals with VI in their academic and social lives.

Limitations

Firstly, the small number of participants is from a population of students at a single university whose views may not fully reflect the experiences of all higher education students with VI. In addition, only one undergraduate student with VI was included the study. Therefore, the results may not be generalizable to students with VI at other institutions. Secondly, all participants have different life stories until they reach university. Depending on the age at which they started using screen readers and had access to a computer or laptop, their perceptions about using screen readers may differ. Thirdly, the participants did not have sufficient time to meet on two separate dates to conduct the interview; thus, the researcher conducted the two parts of each interview on the same day for each participant. However, according to Seidman (2013), at least two interview series on two different days would provide more in-depth information. Finally, almost all of the participants primarily use JAWS and VoiceOver on iPhone. If the study included participants who use other screen readers (e.g., VoiceOver on Mac, NVDA), it may provide a basic summary of the experiences of each screen reader. Therefore, possible future extensions of the study should focus on examinations of other screen readers.

Recommendations for Education

Accessibility and use of screen readers are two essential issues for college and graduate students with VI. Therefore, students should be provided with accessible documents such as electronic versions of classroom materials, accessible PDFs and websites, and software compatible with screen readers. Universities should provide accessibility training for lecturers who want to better serve students with VI because faculty members have an essential role in delivering accessible documents to students with VI. Thus, the findings may help faculty members consider the needs of students with VI in creating accessible classroom materials for them. This study could also be useful for improving universities' information technology services. For example, the services may educate their technical services staff about screen readers to provide professional services for students with VI.

Recommendations for Future Research

1. The research may be replicated using a larger sample size of both college and graduate students with VI who use different screen readers.
2. Conducting the same research in developing countries such as Turkey may have an impact on the results due to differences in technology use and accessibility. Therefore, research may be replicated in other countries.
3. The participants in this study were students with VI who are students in the social sciences; future research may be conducted with students with VI who study in other areas such as science and engineering in order to evaluate the differences.
4. The participants in this study were students with VI who are students in the social sciences; future research may be conducted with students with VI who study in other areas such as science and engineering to evaluate the differences.
5. Future research should focus on how to educate family members of students with VI about using screen readers so that they might better support their children.

Since graduate students with VI specified that they did not obtain adequate training about screen readers, future research should address whether elementary and middle school students with VI receive sufficient training about screen readers.

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