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Advantages of Using Refreshable Braille Devices at Work

Michele C. McDonnall, Ph.D., CRC

Director and Research Professor

The National Research & Training Center on Blindness & Low Vision

Mississippi State University

PO Box 6189, Mississippi State, MS 39762

662-325-2001

m.mcdonnall@msstate.edu

<https://orcid.org/0000-0002-0942-1210>

Jamie Boydston, Ph.D.

Research Scientist I

The National Research & Training Center on Blindness & Low Vision

Mississippi State University

PO Box 6189, Mississippi State, MS 39762

662-325-2001

jboydstun@colled.msstate.edu

<https://orcid.org/0000-0003-1855-2965>

Anne Steverson, M.S.

Research Associate III

The National Research & Training Center on Blindness & Low Vision

Mississippi State University

PO Box 6189, Mississippi State, MS 39762

662-325-2001

asteverson@colled.msstate.edu

<https://orcid.org/0000-0003-0067-4438>

Corresponding author:

Michele McDonnall

m.mcdonnall@msstate.edu

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Abstract

Introduction: The purpose of this study was to increase our understanding of how and why people utilize refreshable braille devices on the job and the perceived benefits of using these devices at work.

Methodology: Data for this study was obtained from a survey about assistive technology (AT) use in the workplace. The sample consisted of 110 workers who reported using a refreshable braille display or refreshable braille notetaker on the job. Ten survey items were utilized to address this study's five research questions. Data analyses included descriptive statistics and analysis of variance.

Results: Most people reported multiple sources of encouragement for using refreshable braille devices and identified multiple benefits to using the devices over audio output alone. A large majority considered their refreshable braille device to be important, very important, or essential to accomplishing their work tasks. Types of work tasks devices were most helpful for were (a) reading and comprehension, and (b) proofreading and editing.

Discussion: Refreshable braille device users perceive many advantages to utilizing their devices, and most consider them important for their work. The devices may be particularly valuable for jobs that involve the most helpful work tasks identified by participants.

Application for Practitioners: Our study indicates that refreshable braille devices can be important to success at work, particularly for certain jobs. Given that braille skills are required to effectively utilize these devices, our findings support the importance of

having the opportunity to learn braille and become familiar with refreshable braille devices at any age.

Advantages of Using Refreshable Braille Devices at Work

Braille remains essential for literacy among people who are blind or have low vision. As a tactile system based on raised dot patterns within a six-dot cell, braille provides direct access to information and allows users to engage with spelling, grammar, formatting, and the conventions of written language that auditory content cannot provide (Marshall & Moys, 2020; Rempel, 2022). Research has shown that braille usage is linked to positive outcomes, including higher employment rates (Bell & Mino, 2013; Ryles, 1996; Silverman & Bell, 2018), greater earnings (Bell & Mino, 2013), and higher subjective well-being (Silverman & Bell, 2018). Alongside traditional paper braille, braille readers often depend on complementary technologies, such as audiobooks, screen readers, and refreshable braille devices, which collectively enhance access to information, while only the braille devices maintain the distinct advantages of tactile literacy (Marshall & Moys, 2020).

Refreshable braille devices are a type of portable assistive technology that converts digital text into tactile braille using movable pins, allowing blind and visually impaired individuals to access digital content from computers, smartphones, and other devices. These refreshable braille devices, which include braille displays, braille notetakers, and smart displays, electronically raise and lower pins to show up to 84 characters on a single line, constantly changing with cursor movement. Refreshable braille technology offers several advantages over paper braille, including portability, space efficiency, faster access to information, and the ability to provide access to any electronic text. The technology originated in the 1950s with early prototypes using perforated paper tapes and plastic belts, but by the 1970s, it had evolved to paperless

braille machines (American Printing House for the Blind, 2024). This innovation paved the way for the 1979 release of the Versabrilie, a portable device featuring a 20-cell display that functioned as a notetaker, reading machine, and computer terminal.

Despite their usefulness, most refreshable braille devices show only a single line of text at a time, which can hinder quick scanning and review compared to braille embossed on paper. Recent innovations have addressed this limitation through the development of multiline braille displays, such as the Monarch, developed by the American Printing House for the Blind in collaboration with HumanWare. The Monarch features a 10-line by 32-cell display capable of rendering both braille text and tactile graphics, thereby enabling users to access spatially complex content like tables, code, and mathematical notation (American Printing House for the Blind, 2025). It also supports multiline output from screen readers such as JAWS and NVDA, making tasks like programming and document editing more intuitive tactile experiences. However, cost remains a significant barrier to the widespread adoption of refreshable braille devices (Martiniello et al., 2022). Prices typically vary based on the number of characters displayed, storage capacity, and the availability of additional features such as integrated notetaking capabilities (American Foundation for the Blind, n.d.). Mid-price options range from approximately \$1,600 to \$7,000, while high-end models start at \$10,000. A few budget-friendly options retail for under \$1,000 and offer basic functionality at a lower price point (Orbit Research, n.d.), potentially expanding access to those with a limited budget. Although a small qualitative study found that refreshable braille displays were preferred for workplace and academic reading and editing (Marshall & Moys, 2020), little is known about their use at work. A recent study of assistive technology (AT) in the workplace

found that nearly two-thirds of legally blind participants used braille at work, while slightly more than half used refreshable braille technology (Authors, 2024a). Users reported that refreshable braille devices were used for work tasks such as taking notes in meetings (82.9%), making formal presentations (64.4%), or using a computer to access the internet, use email, or create documents (55.4%). Employers were more likely to purchase braille displays, whereas braille notetakers were more often purchased by the individual user. Additionally, the study found that refreshable braille technology users were more likely to possess higher braille skills, with those having proficient braille skills being 11.63 times more likely than those with moderate skills to use refreshable braille devices at work. Refreshable braille technology users were also more likely to have experienced the onset of blindness before age 5, be totally blind, and have no additional disabilities. Based on these findings, we wanted to learn more about how people started using refreshable braille devices and why they use them at work.

Therefore, the purpose of this study was to increase understanding of how and why people utilize refreshable braille devices on the job and the perceived benefits of using these devices at work. We addressed the following research questions (RQs):

- 1) When and how did workers who use refreshable braille devices begin using them?
- 2) Why and how do refreshable braille device users utilize these devices at work?
- 3) How important are refreshable braille devices to users in accomplishing their work tasks?

- 4) Are the following factors associated with the importance of refreshable braille devices at work: (a) age of beginning to learn braille, (b) age of introduction to a refreshable braille device, or (c) number of years using a device?
- 5) What work tasks are refreshable braille devices most helpful for?

Methodology

This study derives from a longitudinal survey research project, conducted between 2020 to 2025, examining assistive technology (AT) use in the workplace. The larger project, referred to as the AT in the Workplace study, focused on learning about AT use on the job for people who are blind or have low vision, including identifying challenges with AT use at work and changes in workplace AT use over time. Eligibility for study participation included (1) being blind or having low vision, (2) being 21 years or older, (3) living in the United States or Canada, (4) using AT on the job, and (5) intending to work four or more years. The project involved implementing four surveys, one per year between 2021 and 2024, with the same group of employed participants. The authors' university's Institutional Review Board for the Protection of Human Subjects determined this study to be exempt from oversight.

Data Collection

This study uses data from the research project's third survey, conducted between September and December 2023. Researchers developed the survey to address several topic areas of interest to the project, including topics incorporated in each survey (e.g., AT used on the job, challenges with AT, and adoption of new AT), and survey-specific topics such as how participants learned braille, refreshable braille device use at work, remote sighted assistance app use at work, and participants' work environments. We

invited our project's national advisory board members and technology company partner representatives to review the survey to provide feedback about the questions. After revisions based on this feedback, several blind advisory board members and colleagues pilot-tested the survey to ensure its accessibility and clarity. We made additional revisions to the survey based on feedback received. The survey consisted of multiple-choice and open-ended questions. Most participants completed the survey online via Qualtrics, while the remainder completed the survey via phone with a researcher. Participants received a small electronic gift card after survey completion.

Sample

For this study, the sample was the 110 participants who responded to survey questions about using refreshable braille devices at work. The majority (95.5%) of participants were from the United States. Their average age was 47.15 (SD=12.44), and they were predominantly white, female, and totally blind. Table 1 presents detailed and additional participant characteristics. Most participants began learning braille at a young age; the average age was 8.93 (SD=8.62) but ranged from 2 to 47. Two participants did not provide information about their braille learning age.

Variables

All study variables were based on responses to specific survey questions, with the exception of one variable that was calculated based on responses to two questions (as described below). Participants were asked to report their exact age when two events occurred: "How old were you when you began learning braille?" and "At what age did you begin using a refreshable braille device?" We calculated the number of years

participants had used a refreshable braille device by subtracting their refreshable braille device age from their age on the date they completed the survey.

Participants responded to the question “Who introduced you to your first refreshable braille device?” by selecting one from six possible response options: (a) A TVI (teacher of students with visual impairments), (b) An AT specialist, (c) A vocational rehabilitation counselor, (d) An orientation & mobility instructor, (e) Other rehabilitation professional, and (f) Other (please specify). In addition to reporting who introduced them to refreshable braille devices, participants answered, “Who encouraged you to use a refreshable braille device?” They could select all that applied from the same six response options for those who introduced them to refreshable braille devices, with three additional response options: Family member(s), Friend(s), and Teacher(s) who were not TVIs. We created a tenth category (No one else/myself) from the write-in responses.

Responding to the question “Why do you use a refreshable braille device?” participants chose all that applied from eight possible options, which are listed in Table 3. Participants also reported how they use their device in their work environment by answering the following questions: “What device(s) do you use your refreshable braille device with for work?” (select all that apply: Computer, Smartphone, Tablet, as a Stand-alone notetaker using the built-in features) and “How are you using your refreshable braille device in terms of information output and input?” (select one: Reading braille on the display [output], Using the braille keyboard [input], Both input and output).

Participants rated the importance of their refreshable braille device at work in response to the question: “How important is your refreshable braille device to

accomplishing your work tasks?” Response options ranged from Essential to Not Important. Participants had the opportunity to list up to three tasks in response to the question, “What three work tasks is your refreshable braille device most helpful for, compared to using speech output alone?”

Data Analysis

We used SAS 9.4 for all statistical analyses. We used descriptive statistics (i.e., frequencies and means) to report sample demographics and examine RQs 1-3. For RQ 4, we used one-way analysis of variance (ANOVA) to analyze the relationship between the importance of refreshable braille devices at work and (a) participants’ age when they began learning braille, (b) their age when introduced to refreshable braille devices, and (c) the number of years using a refreshable braille device.

For RQ 5, two of the authors reviewed the open-ended responses about work tasks that devices were most helpful for, and agreed on nine codes that adequately captured almost all tasks listed by participants. Then, all authors independently assigned codes to the participant responses. Finally, the authors compared their codes assigned to each response, and any disagreements were discussed by reviewing and clarifying codes until a consensus was reached. The coded responses were input into SAS to generate frequencies for each code.

Results

Of the 110 participants who reported using refreshable braille devices at work, 48.2% used a braille notetaking device, while 81.8% used a refreshable braille display. Nearly one-third, 30.0%, used both devices, 18.2% used only a braille notetaking device, and 51.8% used only a refreshable braille display.

RQ 1: When and How Workers Began Using Refreshable Braille Devices

Participants reported first using a refreshable braille device between the ages of 5 and 55, with many beginning use before age 20 (40.9%). When asked who introduced them to their first device, the most frequently selected responses were TVIs and AT specialists, each selected by 31.8% of participants. Other sources included friends (8.2%), vocational rehabilitation counselors (6.4%), and other rehabilitation professionals (4.6%). Additionally, 17.3% of participants indicated some other source, with many specifying their workplace.

Participants identified a variety of individuals who encouraged them to use a refreshable braille device. The number of sources of encouragement ranged from one to seven, although only one person identified seven distinct sources. A majority selected either one (43.6%) or two (23.6%) sources. Table 2 presents the number and percentage of refreshable braille device users who indicated each source, with 8.2% reporting some other source not listed.

RQ 2: Why and How Workers Utilize Refreshable Braille Devices

Participants selected reasons for using a refreshable braille device. These results are presented in Table 3. Not shown in the table is a subset of participants (20.0%) who reported some other reason, such as its usefulness with coding. The number of reasons selected per participant ranged from one (7.3%) to seven (10.9%), with a large majority (78.2%) selecting four or more reasons.

Participants reported using their refreshable braille device with various technologies: computers (76.4%), smartphones (52.7%), and tablets (10.0%). Additionally, 65.5% used their refreshable braille device as a stand-alone notetaker

using built-in features. While 17.3% only used their refreshable braille device paired with a computer and 13.6% used it exclusively as a stand-alone notetaker, the most frequent combination was using the refreshable braille device with a computer, a smartphone, and as a stand-alone notetaker (26.4%). Other common combinations included (a) paired with a computer and as a stand-alone notetaker (12.7%) and (b) paired with a computer and smartphone (11.8%). In terms of input and output methods, 55.5% of participants reported using their refreshable braille device for both braille input and output, 41.8% used the device for braille output only, and 2.7% used the braille keyboard for input only.

RQ 3 & 4: Importance of Refreshable Braille Devices and Associated Factors

Participants rated the importance of their refreshable braille device in accomplishing work-related tasks. The majority (85.5%) considered their refreshable braille device to be important, very important, or essential. Full results are presented in Table 4. To examine whether certain factors were associated with the perceived importance of refreshable braille devices in accomplishing work tasks, one-way ANOVAs were conducted. A significant association was found between perceived importance and the age at which participants began learning braille, $F(3, 104) = 15.98$, $p < .001$. Additionally, the number of years participants had used a refreshable braille device was significantly associated with perceived importance, $F(3, 106) = 4.89$, $p = .003$. No statistically significant association was found between perceived importance and age of introduction to refreshable braille devices, $F(3, 106) = 2.06$, $p = .109$. Table 5 presents the means and standard deviations for each factor by perceived importance.

RQ 5: Refreshable Braille Device Most Helpful Work Tasks

Participants were also asked to provide the three work tasks for which their refreshable braille device was most helpful compared to using speech output alone. Table 6 presents the percentage of tasks in each category (out of 325 tasks reported by 110 participants). A miscellaneous category (not shown in the table) included tasks that did not fit into the categories shown ($n=4$, 1.2%).

Discussion

In this study, we investigated several research questions to improve our understanding of the use of refreshable braille devices in the workplace. We explored how people began using them, the benefits of utilizing them, and their perceived importance to accomplishing work tasks. Study participants were introduced to refreshable braille devices by various people, with TVIs and AT specialists being the most common source. The age of first introduction ranged widely, but it concentrated at younger ages, with more than 40% being introduced before age 20. Most people reported multiple sources of encouragement for utilizing refreshable braille devices, with AT specialists and friends being the most common, followed closely by TVIs. Family members and vocational rehabilitation counselors were also common sources of encouragement. However, several people indicated they didn't receive any encouragement from others but were self-motivated to use the device.

Almost all participants identified multiple reasons for using a refreshable braille device at work. The most common reasons were the ability to utilize the device in noisy environments, the ability to easily access details about large numbers and spelling, and increased efficiency versus using audio alone, all of which were reported by more than three-quarters of users. More than three-quarters of users identified four or more

reasons, suggesting that most perceive a broad array of benefits to using their refreshable braille devices at work.

Most people utilized their refreshable braille device with a computer and as a stand-alone device, and, perhaps surprisingly, more than half used their device with their smartphone. Although refreshable braille device users may not utilize their devices for all computer-related work tasks (McDonnall, Sessler-Trinkowsky, et al., 2024), almost all users considered the devices important to accomplishing their work. Participants' rating of importance was strongly associated with the age they began learning to read braille, which suggests that greater familiarity or comfort with braille, and perhaps braille reading speed, allows refreshable braille device users to get the most benefit from their devices. The length of time the person used a refreshable braille device was also associated with perceived importance, which may be related to increased skill with the device that originates from more years of use.

The associations between (a) age of learning braille and (b) length of time using a device and the workplace importance of refreshable braille devices do not mean that people who learn braille at an older age cannot or should not use refreshable braille devices at work. Perceived importance was not associated with age when they began using a refreshable braille device, suggesting that these devices can be adopted at any age and be helpful to one's work.

Refreshable braille devices may be particularly valuable for jobs that involve the most helpful work tasks identified by participants. For example, people in jobs that require reading a large amount of text or proofreading and editing written materials may particularly benefit from the use of these devices. Coding was another work task

identified by several participants as especially important to perform with refreshable braille devices. Based on respondents' feedback, it seems that performing some jobs may be challenging, or they may be performed less efficiently, without a refreshable braille device. Because youth in school typically do not know their exact career path, it is important for every student to have the opportunity to utilize refreshable braille devices, as this may open opportunities to successfully pursue any job of interest in the future.

Despite the benefits that participants reported from using refreshable braille devices, many users indicated in the first survey of the AT in the Workplace Study that they would benefit from receiving training on utilizing their device (McDonnall, Steverson, Sessler Trinkowsky, et al., 2024), which may stem from the fact that many users never received formal training on how to use their device (McDonnall, Steverson, & Boydstun, 2024). This suggests that additional training could allow many current users to obtain even more benefit from their refreshable braille devices. Obtaining such training may be challenging for individuals who are currently employed, both in terms of who would provide it and in finding time to receive it.

Other research associated with the AT in the Workplace study indicated that some people would like to use refreshable braille devices at work but don't have access to them (Authors, 2025). Many people indicated they cannot afford this technology. It is also a technology that needs to be replaced on a regular basis; it was the most often purchased AT during the almost five-year span evaluated in the larger study (Authors, 2025). The present study documents the value of refreshable braille devices in the

workplace, but their high cost limits their availability to people who could benefit from them.

Limitations

Limitations of this study should be recognized. Our sample is small, and we do not know how representative it is of the entire population of blind workers who utilize refreshable braille devices. Thus, we do not know how well the results generalize to the entire population. In addition, our study is based on survey responses. There are several potential biases associated with survey data, particularly response error. Participants may provide inaccurate information, intentionally or unintentionally. This could arise from recall issues, lack of interest or attention to survey questions, or misinterpretation of survey questions.

Application for Practitioners

Our study indicates that refreshable braille devices can be important to success at work, particularly for certain jobs. Of course, for someone to benefit from using a refreshable braille device, braille skills are a prerequisite. Many people who did not use refreshable braille devices at work indicated it was because they could not read braille, could not read braille efficiently enough to use such devices, or had never been introduced to the devices (Authors, 2025). Our findings indicate the importance of having the opportunity to learn braille and become familiar with refreshable braille devices, at any age. Adults who experience vision loss should be provided the opportunity to learn braille, and professionals can encourage them to do so. Refreshable braille devices should be made available to those who do learn braille.

Blind children and youth should learn braille – the younger, the better – and have access to refreshable braille devices while in school. It is important to note that using a braille notetaker must not replace learning how to utilize a traditional computer with a screen reader, as computer skills will likely be needed on the job (McDonnall, Steverson, Sessler Trinkowsky, et al., 2024). Adding a refreshable braille device as an input or output option for the computer-screen reader combination would be ideal. Although not a focus of this study, it is possible that refreshable braille devices can assist youth in accomplishing their schoolwork more efficiently, particularly given the high importance of reading and comprehension to learning. Braille and refreshable braille device skills may provide additional opportunities upon graduation, supporting youth in their ability to work efficiently and pursue any job of interest.

The results of this study can be used to advocate for braille instruction and exposure to refreshable braille devices in schools for youth and in training centers for adults. In addition, practitioners and families should advocate for the school system or vocational rehabilitation to purchase devices for consumers and provide adequate training to help them utilize the devices to their full potential.

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Table 1*Sample Characteristics*

Variable	<i>n</i>	%
Sex		
Female	61	55.5
Male	49	44.6
Race		
Asian	6	5.5
Black/African American	4	3.6
White	92	83.6
Mixed or other race	8	7.3
Hispanic/Latinx ethnicity		
Yes	11	10.0
No	99	90.0
Vision level		
Totally blind	88	80.0
Legally blind with minimal functional vision	19	17.3
Legally blind with some functional vision	3	2.7
Age at vision loss		
Preschool (Age 0-4)	90	81.8
K-12 (Age 5-18)	12	10.9
Post-school (Age 19+)	8	7.3
Non-visual disability		

Yes	32	29.1
No	78	70.9
Education level		
Less than a bachelor's degree	27	24.5
Bachelor's degree	41	37.3
Graduate or professional degree	42	38.2
Braille skill		
Minimal	4	3.6
Moderate	7	6.4
Proficient	99	90.0

Note. $N = 110$.

Table 2*Who Encouraged Use of a Refreshable Braille Device*

Variable	<i>n</i>	%
AT specialist(s)	48	43.6
Friend(s)	44	40.0
TVI(s)	41	37.3
Vocational rehabilitation counselor(s)	29	26.4
Family member(s)	26	23.6
Teacher(s) who were not TVIs	14	12.7
No one else/myself	13	11.8
Other rehabilitation professional(s)	11	10.0
Orientation & mobility instructor(s)	10	9.1

Note. *N* = 110. AT = Assistive Technology. TVI = Teachers of Students with Visual Impairments.

Table 3*Reasons for Using a Refreshable Braille Device*

Variable	<i>n</i>	%
It allows me to use my device in noisy environments.	93	84.6
It allows me to easily access details about large numbers and spelling.	88	80.0
It is more efficient than using only audio.	85	77.3
It allows me to attend to other conversations and audio while reading information in braille.	78	70.9
It allows me to easily access details about formatting and paragraph settings.	61	55.5
Braille is my preferred mode of reading and accessing information.	53	48.2
Other reason	22	20.0
I require access in a format other than audio.	19	17.3

Note. *N* = 110.

Table 4*Importance of Refreshable Braille Device to Accomplishing Work Tasks*

Variable	<i>n</i>	%
Essential	52	47.3
Very important	24	21.8
Important	18	16.4
Moderately important	7	6.4
Somewhat important	8	7.3
Not important	1	0.9

Note. *N* = 110.

Table 5*Factors Associated with Importance of Refreshable Braille Device at Work*

Variable	<i>n</i>	<i>M</i>	<i>SD</i>
Age when participant began learning braille ^a			
Essential	52	5.8	3.2
Very important	24	6.8	5.1
Important	16	11.9	8.7
Less than important	16	19.4	14.6
Number of years using a refreshable braille device ^b			
Essential	52	23.2	9.3
Very important	24	24.2	9.0
Important	18	19.3	10.2
Less than important	16	14.3	8.1
Age when participant began using a refreshable braille device ^b			
Essential	52	23.2	11.9
Very important	24	25.1	11.5
Important	18	28.9	14.1
Less than important	16	30.9	14.0

Note. ^a*N* = 108. ^b*N* = 110.

Table 6*Work Tasks Refreshable Braille Devices Are Most Helpful For*

Work Task Category	% Tasks ^a	% Participants ^b
Reading and Comprehension: reading various materials such as emails, long documents, numbers, and names; for some people, particularly when attention to detail is needed	24.6	43.6
Proofreading and Editing: proofreading text, checking spelling and formatting, verifying numbers, and ensuring the accuracy of information	20.3	45.5
Notetaking and Organization: taking notes during meetings or phone calls; organizing or referencing notes or other information	16.3	37.3
Presenting and Teaching: delivering presentations, facilitating meetings, and teaching	10.8	30.9
Task Management and Multitasking: performing tasks simultaneously, such as accessing information while in a meeting; accomplishing tasks efficiently; and creating schedules	8.0	21.8
Data Entry and Processing: entering data into systems, compiling information, working with data and spreadsheets, and accessing and storing information	7.7	19.1
Writing and Composition: creating documents, emails, visual materials, and writing music in braille	5.5	14.5

Coding, programming, and testing: creating or checking code 4.0 10.0
and testing accuracy or accessibility

Training/Working with Students: training students on or helping 1.5 3.6
them with braille devices

Note. ^a*N* = 325. ^b*N* = 110.