An Extensive Review of Existing Assistive Braille Devices for Deafblindness

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Abstract: Deafblindness is represented by a minority of the world's population. Due to this, innovations that cater to them are limited. Additionally, research about the disability is lacking, making communication with deafblind people difficult, especially without the proper assistive devices. People who are deaf and blind simultaneously struggle to communicate with others, including fellow deafblind people and the non-deafblind, since they only have access to limited methods of communication. They commonly communicate through tactile fingerspelling, which is not always a viable communication method. This study aims to conduct extensive research about the existing assistive communication devices for deafblindness. This research will help deafblind people be more known in society through their language and devices and communication techniques that help them communicate and interact with others. Furthermore, this research could help the deafblind community choose which assistive device is most suitable for them to use. The key findings of this research revolved around the created rubric, which includes seven criteria. The devices that scored exemplary for each criterion include V-Braille for portability, Braille Printer for accessibility, V-Braille and Screen Braille Communicator for adaptability, Screen Braille Communicator for learnability and user-friendliness for deafblind people, and Braille Printer and Screen Braille Communicator for learnability and user-friendliness for non-deafblind people. However, despite the devices having an edge among each other, it was concluded that the usefulness of each existing assistive device depends on the user and their belongingness to their respective group of deafblind population.

Key Words: communication; assistive devices; Braille; deafblindness

1. INTRODUCTION

Deafblind people may struggle to communicate with fellow deafblind and abled people as they commonly communicate through tactile fingerspelling, which is not always a viable communication method. Being deafblind is an ordeal concerning communication because they usually communicate through tactile fingerspelling. Through technological advancements, developers and researchers have created and designed assistive aids for deafblind people to interact with others better.

To define, deafblindness pertains to the condition wherein a person experiences severe limitation in two of the human senses – visual and auditory (Gaspar, Rebelo, & Dijk, 2017). There is a slight chance that it could be acquired early on, but it will be frequent upon aging. In an article by Jaiswal et al. (2018), they proposed that there are three groups in the deafblind population: Group 1 consisting of people who are congenitally deafblind—those who developed deafblindness before language, Group 2 consisting of those who acquired both sensory disabilities as they age or those who had one sensory impairment (auditory or visual) by birth, and then

developed the second sensory impairment (auditory or visual) as they age, and Group 3 consisting of those who acquire deafblindness or hearing and visual impairments due to old age.

While great endeavors are already conducted to give light to deafblind communication, social awareness is still not developed. The concept and research about deafblindness are limited in society as Jaiswal, et al. (2018) asserted. This limit raises the thought that although there are many researched methods for deafblind people to communicate, it is still difficult and inefficient because not all people are familiar with their communication methods.

The present study aimed to create a review article by conducting extensive research about the existing assistive communication devices made for those who are deafblind. At least 100 credible scholarly articles were collected in creating a review article that can compare and contrast some of the known assistive devices. Assessment of the said devices was also conducted using two analytic rubrics. The focus of this research revolved around deafblindness alone and assistive devices related to this disability. Only articles published in databases and those from medical journals were included in the review. Furthermore, only V-Braille, Braille Printer or Embosser, and Screen Braille Communicator were included for the devices compared.

2. METHODOLOGY

2.1 Collection of Scholarly Articles

Discussing the process, sites such as IEEExplore, Science Direct, Google Scholar, and more were explored to find literature related to deafblindness. Medical-related journals such as Journal of Pediatric Nursing, Journal of Disability Research, and Journal of Visual Impairment were also considered. Specific keywords including deafblind, deafblind communication, and communication devices were used to ensure the great relevance of the articles. These were used to search, collect, and give ideas about the different methods and devices that aid deafblind people in communicating. Each journal article was then saved for reading and examination later, as this is the next step to take in doing the extensive review.

Keeping track of the scholarly articles collected was vital for the research objective to be adequately achieved. A Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram was used to transparently determine the number of articles accumulated for the research paper; however, some modifications were made as some processes were not feasible in the study, such as identifying data sources other than credible online databases.

2.2 Writing About the Different Subtopics of Deafblindness

Deafblindness is a rare disability, which is why not much research about it has been done. In addition, it is a broad topic wherein many aspects and degrees may be beyond the current study's scope. Because of this, gathering more information and expounding on deafblindness as a topic with the use of several subtopics was significant after collecting at least 100 scholarly articles. These topics include deafblindness, social awareness, assistive communication techniques, Braille communication devices, and the manufacturing of communication devices.

Deafblindness as a subtopic gave a preview of its broad field as a research topic. Social awareness defined people's knowledge about the disability, while assistive communication techniques, Braille communication devices, and their manufacturing were essential for the context of the existing assistive devices to be compared later on.

2.3 Rubric Development for Assessment of Assistive Devices for Deafblindness

Upon reviewing at least 100 scholarly articles and writing about the different deafblind subtopics, rubrics were then made to assess the assistive devices discussed in the research paper. These rubrics included standards for comparisons and other factors that give them the edge among other devices. As a result, there were two rubrics formulated, one for the deafblind and another for non-deafblind people.

2.4 Making the Systematic Review

With the scholarly articles collected and the rubrics formulated, the systematic review was the next step taken. In doing the systematic review, the articles were carefully assessed using the rubrics developed. Comparison and contrast were also utilized to further analyze the featured differences of the

devices from each other, supported by related literature to assure credibility.

2.4.1 Comparing and Contrasting Assistive Braille Communication Devices

According to Ramirez-Garibay et al. (2014), the Braille system is one of the most commonly used systems by the deafblind community. Hence, the chosen devices were all associated with that system.

The first device used in comparing and contrasting was V-Braille. According to Caporusso et al. (2014), V-Braille uses touchscreen and vibration on a standard mobile phone; thus, it can be said that it is a software application. The use of vibration is possible through vibration motors or micro-vibrators that are attached to the device. These tiny motors have an imbalanced weight that moves, causing vibration during operation (Bandodkar et al., 2014). The screen is divided into six parts, mimicking the six dots in a Braille cell. When one of the six regions of the screen is touched, it vibrates. The strong intensity of the vibration indicates a raised pin. A picture of V-Braille can be seen in Appendix 7.1.

The second was the Braille Printer or Embosser, which embosses text on Braille paper. Although this is a very effective way of communicating and educating the deafblind community, existing Braille printers cost multiple times more expensive than regular printers (Chowdhury et al., 2018). Braille printers are usually used for educational purposes for the benefit of deafblind and blind students. Please see Appendix 7.2 for a picture of the Braille Printer or Embosser.

Lastly, as developed by Chris Lagarde and several Braille institutes, the Screen Braille Communicator is lightweight and portable. It enables the sensory impaired persons to conduct two-way communication between them and someone who is non-disabled (Mississippi State University, 2005). For this device to work, the sighted person will input what they have to say using a QWERTY keyboard, making the eight-cell Braille display's pegs protrude to make the deafblind understand what the sighted person is saying (Ingraham, 2007). Ingraham's paper also stated that the deafblind person would communicate via the Perkins-style keyboard, which is derived from the Perkins Brailler (Southern, Clawson, Frey, Abowd & Romero, 2017), and the sighted person will understand it through the present small LCD screen. Appendix 7.3 shows a picture of the Screen Braille Communicator.

The rubrics formulated were used to assess these chosen Braille assistive devices. The different parameters on the rubrics rated each device, and conclusions were made through each criterion.

3. RESULTS AND DISCUSSION

3.1 Collected 100 Scholarly Articles

A part of the research objectives was to accumulate at least 100 articles related to deafblindness that would be significant for the systematic review. Appendix 7.4 shows the PRISMA diagram of the collection of at least 100 scholarly article.

From this diagram, the identification of articles through databases and journals using the keywords above took place first. By adding all the number of articles or studies found through searching each of the keywords, the number of records identified sums up to 950,093. On the other hand, the number of articles identified through other sources such as university libraries amounted to only 147,537 articles. Adding these would give us a total of 1,097,630 records identified.

Out of these articles, this research has only initially utilized 149 for the abstract screening to determine whether each article should have been included in the review. This is due to some factors considered in the screening process, including prioritizing the papers containing the greatest number of keywords and excluding existing duplicates of other articles. Around 10 articles were excluded from the abstract screening; hence, only 139 articles make it through the eligibility of full-text articles assessment. After thorough review and reading, 37 studies were excluded due to insufficient information for the thought-up ideas, other articles being more insightful, and other papers being out of the study's scope and limitation.

As a result, 102 scholarly articles total were found relevant to the research topic and within the scope and limitations of the study. Therefore, only these articles were included in the extensive review. For a more transparent view of these numbers, the breakdown of searches per database and other

searches as well as the total number of articles collected can be seen in Appendix 7.5.

3.2 Created Rubrics for the Assessment of Existing Assistive Devices

Rubrics contain detailed grading logic represented by numbers, formulae, generic quality words, graphics, or symbols. The quality levels indicate the level of a particular criterion which can be determined by the qualitative judgment of the author (Dawson, 2015). The kind of rubric used in the study is an analytic rubric, which aimed to check the device's efficacy per criterion, in contrast with the holistic type of rubric that applies all the criteria before checking (Brookhart, 2013). An analytic rubric was the most beneficial between the two as it showed the exact differences of the set standards and detailing exactly what to look for, further enhancing the ending interpretation after the assessment (Saxton et al., 2012).

The criteria, including portability, accessibility, adaptability, learnability, and user-friendliness, were thought of from the findings from the interview conducted with Mr. Edgardo Garcia, the President of Deafblind Support Philippines, and from existing literature that delves into the assistive devices that the study is comparing. Each criterion has four performance levels—exemplary, good, adequate, and limited—that categorize the devices' differences from each other. According to Dawson (2015), rubrics can have detailed grading logic using numbers, formulae, generic quality words, or may even use graphics or symbols. He also added that the quality levels explain what a criterion looks like at a particular level and can be made using the qualitative judgment of the author. Additionally, an odd number of levels were not used as this can lead to consistent neutral ratings that would make the results vague because it would not indicate a clear stand for that specific criterion. According to University of Reading (2018), analytic rubrics may not have numeric values and may have equal weights; however, discussions about the reasons for grading devices must be and is included. Table 1 and Table 2 show the created rubrics.

Table 1. Existing Assistive Devices Assessment Rubric for Deafblind People

Criteria	Exemplary	Good	Adequate	Limited
Portability	The device is very portable and can be taken around with great ease.	The device is portable and can be taken around with minimal issues.	The device is portable enough and can be taken around if desired with effort.	The device is hardly portable or not portable at all.
Accessibility	The device can easily be obtained by deafblind people around the world.	The device can be obtained by deafblind people around the world.	The device can be obtained by deafblind people around the world with some difficulty.	The device is unattainable or can be attained with difficulty.
Adaptability	The device can be used in any day-to-day situations easily.	The device can be used in most day-to-day situations.	The device can be used in some day-to-day situations.	The device can only be used in specific situations.
Learnability	The device is very easy to learn for deafblind people.	The device is easy to learn for deafblind people.	The device is hard to learn or easy to learn but may present challenges for deafblind people.	The device is very hard to learn for deafblind people.
User-friendliness	The device is very easy to use for deafblind people.	The device is easy to use for deafblind people.	The device is hard to use or easy to use but may present challenges for deafblind people.	The device is very hard to use for deafblind people.

Table 2. Existing Assistive Devices Assessment Rubric for Non-Deafblind People

Criteria	Exemplary	Good	Adequate	Limited
Portability	The device is very portable and can be taken around with great ease.	The device is portable and can be taken around with minimal issues.	The device is portable enough and can be taken around if desired with effort.	The device is hardly portable or not portable at all.
Accessibility	The device can easily be obtained by deafblind people around the world.	The device can be obtained by deafblind people around the world.	The device can be obtained by deafblind people around the world with some difficulty.	The device is unattainable or can be attained with difficulty.
Adaptability	The device can be used in any day-to-day situations easily.	The device can be used in most day-to-day situations.	The device can be used in some day-to-day situations.	The device can only be used in specific situations.
Learnability	The device is very easy to learn for non-deafblind people.	The device is easy to learn for non-deafblind people.	The device is hard to learn or easy to learn but may present challenges for non-deafblind people.	The device is very hard to learn for non-deafblind people.

Criteria	Exemplary	Good	Adequate	Limited
User-friendliness	The device is very easy to use for non-deafblind people.	The device is easy to use for non-deafblind people.	The device is hard to use or easy to use but may present challenges for non-deafblind people.	The device is very hard to use for non-deafblind people.

3.3 Assessment of the Existing Assistive Devices Using the Created Rubrics

Using the rubrics formulated, each device was categorized based on their level of performance—exemplary, good, adequate, or limited per criterion. The first three components of the two rubrics can be used for both deafblind and non-deafblind people; hence, the results were the same, and they were constituted in one interpretation. The summary of the ratings of each devices using the formulated rubric for deafblind people can be seen on Appendix 7.6 while the ratings using the formulated rubric for non-deafblind people can be seen on Appendix 7.7.

3.3.1. Portability (Deafblind & Non-Deafblind)

Discussing the rubric parameters, a portable device would allow users to go to different locations while retaining the ability to communicate with ease. V-Braille was rated exemplary as this is an application that can be installed in a hand-held device, making it easy to bring this device from one place to another. Screen Braille Communicator was rated good as it was designed for portability. However, it is still sizable enough that consumers would still need to use a bag to carry it around. The Braille printer was rated as limited as it is too big for the user to move around. This device also requires electricity, which may not always be available.

3.3.2. Accessibility (Deafblind &Non-Deafblind)

An accessible device allows more users to communicate among themselves since it is easily obtainable. This criterion only discusses how easy a device is to obtain and does not tackle devices' affordability since it is hard to gauge due to different countries having different currency values. The Braille printer was rated as exemplary as there are many manufacturers of this device, and the device can be easily found online. V-Braille was rated as good. It was easily obtainable in the Google Play Store; however, it was not available in the Apple App Store. Some phones also may not be compatible with it as it requires touchscreen and vibrations. The Screen Braille was rated as adequate because customers would still have to contact the developer and manufacturer, Chris Lagarde, to conduct a transaction, and is only shipped to European Countries, making the device difficult to obtain for non-European Countries.

3.3.3. Adaptaility (Deafblind & Non-Deafblind)

The adaptability of a device depends on its capability to be used in almost all situations, including specific occurrences. V-Braille and Screen Braille Communicator were rated as exemplary as they are useful in everyday communication and nearly any scenario. On the other hand, the Braille printer was rated as limited because it is used primarily for printing purposes only by manufacturing companies to print braille textbooks. Unlike this device, V-Braille and Screen Braille Communicator already contain a Braille system and display. V-Braille uses vibrations to aid the deafblind, while Screen Braille Communicator has a keyboard with a Braille display where the user places their fingers on the keyboard. Therefore, it can be said that the Braille printer is impractical to use for communication, unlike V-Braille and Screen Braille. Furthermore, when power outages occur, the Braille printer cannot be used for it requires a power outlet to work. Its dependence on electrical outlets makes it inflexible.

3.3.4. Learnability (Deafblind)

In learnability, a device needs to be made in such a way that it would be easy for users to learn its functions. A device that users can immediately apply their Braille knowledge to would be of more use to them as devices that they would still need to invest time to adapt to. Screen Braille communicator was rated as exemplary as the device uses braille bumps to conduct communication between users. Meaning, users who know Braille can easily understand how to use the device. Meanwhile, V-Braille was rated as adequate. Although it also uses a Braille cell's general concept, it uses vibrations instead of the usual bumps, so users would still have to learn to read Braille through vibrations. The Braille printer was rated as limited since deafblind people would still need to learn how to operate it, including operating devices such as a laptop to print.

3.3.5. Learnability (Non-Deafblind)

Similarly, the learnability for non-deafblind people for screen Braille communicator and V-Braille were rated the same. This is because screen Braille communicator uses braille bumps to conduct

communication between users, which means that users who know Braille can easily understand how to use the device. V-Braille was rated for the same reasons as the learnability for deafblind people. On the other hand, Braille printer functions similarly to a regular printer, allowing users to apply their knowledge of operating a regular printer simply.

3.3.6 User-friendliness (Deafblind)

A user-friendly device allows users to maximize its capabilities during regular use by being built so that it makes usage convenient. Screen Braille Communicator was rated as exemplary for deafblind people because it already has a Braille display on its keyboard. This makes it easier for deafblind people to use since they can easily feel the Braille display on the keyboard. V-Braille was rated as adequate because deafblind people may find it challenging to adapt the device since it uses vibrations instead of the usual bumps. Lastly, the Braille printer was rated good, for a lot is needed to be done just in setting up the printer. A separate device such as a computer monitor is required to be connected to enable the device to print; thus, it makes it too complicated for deafblind people to operate it.

3.3.7. User-friendliness (Non-Deafblind)

For the non-deafblind people, the Braille printer and Screen Braille Communicator are easy to use and operate; therefore, these devices were rated as exemplary. The Screen Braille Communicator would be easy to use for non-deafblind people because it does contain not only a Braille display on its keyboard but also the letters of the alphabet. V-Braille was rated as adequate as it is hard to use for non-deafblind people since not everyone is well-versed in Braille or knows how to interpret the vibrations produced by this device.

3.3.8. Overall Assessment

Given the rubric assessment and respective explanations of each, the final tally of the ratings of the devices provides a preview of the excellence of each device. For V-Braille, it garnered a total of two exemplary, one good, four adequate, and none for limited in terms of the devices' ratings in each respective rubric component. Three exemplary and four limited were the overall ratings that the Braille printer has accumulated. Lastly, Screen Braille Communicator garnered the most exemplary ratings with five specifically, and it also was rated with one good and one adequate. Visibly, the Screen Braille Communicator performed the best overall because it garnered the least limited ratings and the most exemplary ones. Although this gives an overview of the overall performance of the devices, the effectiveness of each device still varies per user as every deafblind person is unique with their experiences and specific needs from the technologies' functions.

4. CONCLUSIONS

Summing up the key findings, this study concludes that each device has its own edge among others depending on the criterion. The devices that scored exemplary for each criterion include V-Braille for portability, Braille Printer for accessibility, V-Braille and Screen Braille Communicator for adaptability, Screen Braille Communicator for learnability and user-friendliness for deafblind people, and Braille Printer and Screen Braille Communicator for learnability and user-friendliness for non-deafblind people. Each device may have its advantage over other devices due to its number of functions; however, it must be concluded that the usefulness of each existing assistive devices depends on the user and their belongingness to their respective group of the deafblind population. For future researches, the study recommends making a Technology Acceptance Model and converting the subjective rubric into a numerical one to see the differences better.

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6. REFERENCES

Abed, A. T. (2020). A novel coplanar antenna butterfly structure for portable communication devices: a compact antenna with multioperating bands. *IEEE Antennas and Propagation Magazine*, *62*(3), 83–89. https://doi.org/10.1109/map.2020.2964524

Abdallah, E. & Fayyoumi, E. (2016). Assistive technology for deaf people based on Android platform. *Procedia Computer Science, 94*. 295–301. https://doi.org/10.1016/j.procs.2016.08.044

Arbes, L. A., Baybay, J. M., Turingan, J. E., & Samonte, M. J. (2019). Tagalog text-to-Braille translator tactile story board with 3D printing. *IOP Conference Series: Materials Science and Engineering*, *482*, 012023. https://doi.org/10.1088/1757-899x/482/1/012023

Anderzén-Carlsson, A. (2015). CHARGE syndrome—a five case study of the syndrome characteristics and health care consumption during the first year in life. *Journal of Pediatric Nursing*, *30*(1), 6–16. https://doi.org/10.1016/j.pedn.2014.09.008

Anthony, T. L. (2016). Early identification of infants and toddlers with deafblindness. *American Annals of the Deaf*, *161*(4), 412–423. https://doi.org/10.1353/aad.2016.0034

Arato, A., Markus, N., & Juhasz, Z. (2014). Teaching Morse language to a deaf-blind person for reading and writing SMS on an ordinary vibrating smartphone. *Lecture Notes in Computer Science*, 393–396. https://doi.org/10.1007/978-3-319-08599-9_59

Asghar, M., Lupin, S., Shoaib, S., & Excell, P. (2020). Design and analysis of compact antenna for 5G communication devices. *2020 IEEE Conference of Russian Young Researchers in Electrical and Electronic Engineering (EIConRus)*. https://doi.org/10.1109/eiconrus49466.2020.9039525

Anderzen-Carlsson, A. (2017). A qualitative evaluation of the National Expert Team regarding the assessment and diagnosis of deafblindness in Sweden. *Scandinavian Journal of Disability Research*. 19(4), 362-374. https://doi.org/10.1080/15017419.2016.1268972

Ask Larsen, F., & Damen, S. (2014). Definitions of deafblindness and congenital deafblindness. *Research in Developmental Disabilities*, *35*(10), 2568–2576. https://doi.org/10.1016/j.ridd.2014.05.029

Ask Larsen, F. & Dammeyer, J. (2016). Communication and language profiles of children with congenital deafblindness. *British Journal of Visual Impairment*, *34*(3), 214–224. https://doi.org/10.1177/0264619616651301

Bandodkar, M., & Chourasia, V. (2014). Low cost real-time communication Braille hand-glove for visually impaired using slot sensors and vibration motors. *Journal of Information and Communication Convergence Engineering,* 8, 973-980

Barden, O. (2018). Building the mobile hub: mobile literacies and the construction of a complex academic text. *Literacy*, *53*(1), 22–29. https://doi.org/10.1111/lit.12137

Başçiftçi, F., & Eldem, A. (2016). An interactive and multi-functional refreshable Braille device for the visually impaired. *Displays*, *41*, 33–41. https://doi.org/10.1016/j.displa.2015.11.001

Bendixen, T., Costain, K., Damen, S., Einarsson, V., Gibson, J., Gullvik, T., et al. (2020). Revealing hidden potentials assessing cognition in individuals with congenital deafblindness. Nordic Welfare Centre.

Bertucco, M., & Sanger, T. D. (2018). A model to estimate the optimal layout for assistive communication touchscreen devices in children with Dyskinetic Cerebral Palsy. *IEEE Transactions on Neural Systems and Rehabilitation Engineering*. 26(7), 1371–1380. https://doi.org/10.1109/tnsre.2018.2840445

Bieling, T., Martins, T., & Joost, G. (2016). Internet of Everyone – Tools for Empowerment. *Graduate Journal of Social Science*. 12(2), 96-107.

Björk, M., Wahlqvist, M., Huus, K., & Anderzén-Carlsson, A. (2020). The consequences of deafblindness rules the family: Parents' lived experiences of family life when the other parent has deafblindness. *British Journal of Visual Impairment*. https://doi.org/10.1177/0264619620941895

Boas, D. C., Ferreira, L. P., de Moura, M. C., Maia, S. R., & Amaral, I. (2016). Analysis of interaction and attention processes in a child with congenital deafblindness. *American Annals of the Deaf*. 161(3), 327–341. https://doi.org/10.1353/aad.2016.0025

Bracken, M., & Rohrer, N. (2014). Using an adapted form of the Picture Exchange Communication System to increase independent requesting in deafblind adults with learning disabilities. *Research in Developmental Disabilities*. 35(2), 269–277. https://doi.org/10.1016/j.ridd.2013.10.031

Brophy, T. S. (2012). Writing effective rubrics. Institutional Assessment Continuous Quality Enhancement Series, 1-9. http://web.cse.ohio-state.edu/~soundarajan.1/abet/writing_effective_rubrics_guide_v2.pdf

Brookhart, S. M. (2013). *How to create and use rubrics for formative assessment and grading*. ASCD

Bruce, S. M., Bashinski, S. M., Covelli, A. J., Bernstein, V., Zatta, M. C., & Briggs, S. (2018). Positive behavior supports for individuals who are deafblind with Charge syndrome. *Journal of Visual Impairment & Blindness*, *112*(5), 497–560. https://doi.org/10.1177/0145482x1811200507

Byaruhanga, I. (2019). State of special education in DR Congo: The deafblind perspective. *British Association of Teachers of the Deaf Magazine*, *4*. https://www.batod.org.uk/wp-content/uploads/2020/01/Special-education-in-DR- Congo-Byaruhanga.pdf

Caporusso, N., Trizio, M., & Perrone, G. (2014). Pervasive assistive technology for the deaf-blind need, emergency and assistance through the sense of touch. *Pervasive Health*, 289–316. https://doi.org/10.1007/978-1-4471-6413-5_12

Caspo, A., Wersényi, G., & Jeon, M. (2016). A survey on hardware and software solutions for multimodal wearable assistive devices targeting the visually impaired. *Acta Polytechnica Hungarica*, *13*(5), 39–63. https://doi.org/10.12700/aph.13.5.2016.5.3

Csapó, Á., Wersényi, G., Nagy, H., & Stockman, T. (2015). A survey of assistive technologies and applications for blind users on mobile platforms: a review and foundation for research. *Journal on Multimodal User Interfaces*, *9*(4), 275–286. https://doi.org/10.1007/s12193-015-0182-7

Chambers, K., Moore, K., & Ramey, C. (2019). Developing Confident and Competent DeafBlind Interpreters. Open Oregon. https://openoregon.pressbooks.pub/interpretingstudies/chapter/developing- confident-and-competent-deafblind-interpreters/

Chowdary, K. (2017). *Braille Language Using Arduino*. C# Corner. https://www.c-sharpcorner.com/article/braille-language-using-arduino/

Chowdhury, D., Haider, M. Z., Sarkar, M., Refat, M., Datta, K., & Fattah, S. A. (2018). An intuitive approach to innovate a low cost Braille embosser. *International Journal of Instrumentation Technology*, *2*(1), 1. https://doi.org/10.1504/ijit.2018.090858

Correa-Torres, S. M., & Bowen, S. K. (2016). Recognizing the needs of families of children and youth who are deafblind. *American Annals of the Deaf*, *161*(4), 454– 461. https://doi.org/10.1353/aad.2016.0037

Damen, S., Janssen, M. J., Ruijssenaars, W. A. J. J. M., & Schuengel, C. (2015). Communication between children with deafness, blindness and deafblindness and their social partners: an intersubjective developmental perspective. *International Journal of Disability, Development & Education*, 62(2), 215–243. https://doi.org/10.1080/1034912X.2014.998177

Damen, S., Prain, M., & Martens, M. (2020). Video-feedback interventions for improving interactions with individuals with congenital deaf blindness: a systematic review. *Journal of Deafblind Studies on Communication*, *6*(1). https://doi.org/10.21827/jdbsc.6.36191

Dammeyer, J. (2011). Mental and behavioral disorders among people with congenital deafblindness. *Research in Developmental Disabilities*, *32*(2), 571–575. https://doi.org/10.1016/j.ridd.2010.12.019

Dammeyer, J. (2015). Deafblindness and dual sensory loss research: Current status and future directions. *World Journal of Otorhinolaryngology*, *5*(2), 37. https://doi.org/10.5319/wjo.v5.i2.37

Dammeyer, J. Marschark, M., & Zettler, I. (2018). Personality traits, self-efficacy, and cochlear implant use among deaf young adults. *The Journal Deaf Studies and Deaf Education, 23*(4). 351–359. https://doi.org/10.1093/deafed/eny022

Dawson, P. (2015). Assessment rubrics: towards clearer and more replicable design, research and practice. *Society for Research into Higher Education.* https://doi.org/10.1080/02602938.2015.1111294

Deafblind Support Philippines. (n.d.). *In Facebook Deafblind Support Philippines*. Facebook. https://www.facebook.com/dbsph

Deming, P., & Johnson, L. L. (2019). An application of Bandura's Social Learning Theory: A new approach to deafblind support groups. *JADARA*, *42*(4), 203–209. https://repository.wcsu.edu/jadara/vol42/iss4/5

Devi, V. A. (2017). Conversion of speech to braille: interaction device for visual and hearing impaired. *2017 Fourth International Conference on Signal Processing, Communication and Networking (ICSCN)*. https://doi.org/10.1109/icscn.2017.8085740

Edwards, T. (2014). From compensation to integration: Effects of the pro-tactile movement on the sublexical structure of

Tactile American Sign Language. *Journal of Pragmatics, 69*. 22–41. https://doi.org/10.10.1016/j.pragma.2014.05.005

Ehn, M., Anderzén-Carlsson, A., Möller, C., & Wahlqvist, M. (2019). Life strategies of people with deafblindness due to Usher syndrome type 2a - a qualitative study. *International Journal of Qualitative Studies on Health and Well-Being*, *14*(1), 1656790. https://doi.org/10.1080/17482631.2019.1656790

Felder, J. (2018). The gap between education and adult life for people with congenital deafblindness. University of Toronto. https://tspace.library.utoronto.ca/handle/1807/94014

Fernández-Valderas, C., Macías-Seda, J., & Gil-García, E. (2017). Experiences of deafblind people about health care. *Enfermería Clínica*, *27*(6), 375–378. https://doi.org/10.1016/j.enfcli.2017.03.011

Garcia, E. (2014, April 19–21). *Persons with Disabilities: Status in the Philippines* [Paper presentation]. 1st International Conference of Public Librarians, Cebu City, Philippines.

Gaspar, T., Rebelo, A., & van Dijk, J. (2017). An Interdisciplinary Approach of Deaf blindness. *Asian Journal of Multidisciplinary Studies*, *5*(3), 108–114. https://www.researchgate.net/publication/321967036_An_Interdisciplinary_Approach_of_Deaf_blindness

Guerreiro, J., Gonçalves, D., Marques, D., Guerreiro, T., Nicolau, H., & Montague, K. (2013). The today and tomorrow of Braille learning. *Proceedings of the 15th International ACM SIGACCESS Conference on Computers and Accessibility - ASSETS 13*, *71*, 1–2. https://doi.org/10.1145/2513383.2513415

Haakma, I., Janssen, M., & Minnaert, A. (2016a). Intervening to improve teachers' need-supportive behaviour using Self-Determination Theory: Its effects on teachers and on the motivation of students with deafblindness. *International Journal of Disability, Development and Education*, *64*(3), 310–327. https://doi.org/10.1080/1034912x.2016.1213376

Haakma, I., Janssen, M., & Minnaert, A. (2016b). Understanding the relationship between teacher behavior and motivation in students with acquired deafblindness. *American Annals of the Deaf*, *161*(3), 314–326. https://doi.org/10.1353/aad.2016.0024

Haakma, I., Janssen, M., & Minnaert, A. (2017). The influence of need-supportive teacher behavior on the motivation of students with congenital deafblindness. *Journal of Visual Impairment & Blindness*, *111*(3), 247–260. https://doi.org/10.1177/0145482x1711100305

Harmon, A. (2018). *Braille*. Salem Press Encyclopedia.

Hartshorne, T. S., & Schmittel, M. C. (2016). Social-emotional development in children and youth who are deafblind. *American Annals of the Deaf*, *161*(4), 444–453. https://doi.org/10.1353/aad.2016.0036

Hassan, M. (2019, June 27). *Modern Usage of Braille in Today's Society*. Vocalink Global. https://vocalinkglobal.com/modern-usage-braille/

Hersh, M. A. (2013). Deafblind people, stigma and the use of communication and mobility assistive devices. *Technology and Disability*,

25(4), 245–261. https://doi.org/10.3233/tad-130394

Hovaldt, H. B., Lund, R., Lehane, C. M., & Dammeyer, J. (2019). Relational strain in close social relations among older adults with dual sensory loss. *British Journal of Visual Impairment*, *37*(2), 81–93. https://doi.org/10.1177/0264619619833421

Hussain, M. A., Ahsan, K., Iqbal, S., & Nadeem, A. (2019). Supporting deafblind in congregational prayer using speech recognition and vibro-tactile stimuli. *International Journal of Human-Computer Studies*, *123*, 70–96. https://doi.org/10.1016/j.ijhcs.2018.11.002

Illinois University Library. (n.d.). Determine if a source is scholarly. Undergraduate Library. https://www.library.illinois.edu/ugl/howdoi/scholarly

Ingraham, C. L. (2007). Transition planning for students who are deafblind: coaching from students, parents and professionals. PEPNet-South.

Jaiswal, A., Aldersey, H., Wittich, W., Mirza, M., & Finlayson, M. (2018). Participation experiences of people with deafblindness or dual sensory loss: A scoping review of global deafblind literature. *PLOS ONE*, *13*(9). https://doi.org/10.1371/journal.pone.0203772

Jaiswal, A., Aldersey, H. M., Wittich, W., Mirza, M., & Finlayson, M. (2019). Meaning and experiences of participation: a phenomenological study with persons with deafblindness in India. *Disability and Rehabilitation*, *42*(18), 2580–2592. https://doi.org/10.1080/09638288.2018.1564943

Jaiswal, A., Kumar, U., & Paul, A. (2018). Why deafblindness research is necessary in India. *The Magazine of Deafblind International*, *60*, 47–52

Jaiswal, A., Aldersey, H. M., Wittich, W., Mirza, M., & Finlayson, M. (2019). Using the ICF to identify contextual factors that influence participation of persons with deafblindness. *Archives of Physical Medicine and Rehabilitation*, *100*(12), 2324– 2333. https://doi.org/10.1016/j.apmr.2019.03.010

Kamenopoulou, L. (2012). A study on the inclusion of deafblind young people in mainstream schools: key findings and implications for research and practice. *British Journal of Special Education*, *39*(3), 137–145. https://doi.org/10.1111/j.1467-8578.2012.00546.x

Kelleher, S. (2016). Smart Braille display for the blind. Arduino Project Hub. https://create.arduino.cc/projecthub/sean_2050221/smart-braille-display-for-the- blind-b761aa

Kent, D. (2012). *What is Braille?* Enslow Publishers, Inc.

Kway, E. H., Salleh, N. M., & Majid, R. A. (2010). Slate and stylus: An alternative tool for Braille writing. *Procedia - Social and Behavioral Sciences*, *7*, 326–335. https://doi.org/10.1016/j.sbspro.2010.10.045

Lamont, B. (2013). Deafblind UK expands operations in Northern Ireland to further reduce isolation and enhance the lives of older deafblind people. *Working with Older People*, *17*(4), 164–169. https://doi.org/10.1108/wwop-09-2013-0023

Lagarde, C. (2008). Screen Braille Communicator - communication device for the deafblind.

Lagarde Communication. http://www.lagardecommunication.com/deafblind/screenbraillecommunicator_en.html

Lehane, C. M., Dammeyer, J., Hovaldt, H. B., & Elsass, P. (2016). Sexuality and well- being among couples living with acquired deafblindness. *Sexuality and Disability*, *35*(2), 135–146. https://doi.org/10.1007/s11195-016-9470-8

Lexico Dictionaries. *Vibrotactile*. Lexico Dictionaries. https://www.lexico.com/en/definition/vibrotactile

Linares-Espinós, E., Hernández, V., Domínguez-Escrig, J.L., Fernández-Pello, S., Hevia, V., Mayor, J., Padilla-Fernández, B., Ribal, M.J. (2018). Methodology of a systematic review. *Actas Urológicas Españolas (English Edition)*, *42*(8), 499– 506. https://doi.org/10.1016/j.acuroe.2018.07.002

Ling, J., Watson, P., Sutton, D., & Quinn, B. (2017). Developing awareness of deafblindness in health and social care provision for older people. *Dbl Review*, *59*, 27–32. https://sure.sunderland.ac.uk/id/eprint/7735/

Lipson, C. (2011). Cite Right, Second Edition: A Quick Guide to Citation Styles--MLA, APA, Chicago, the Sciences, Professions, and More (Chicago Guides to Writing, Editing, and Publishing) (Second ed.). University of Chicago Press.

Macgavin, B., Edwards, T., & Gorlewicz, J. (2021). A protactile-inspired wearable haptic device for capturing the core functions of communication. *IEEE Transactions on Haptics*, 1. https://doi.org/10.1109/toh.2021.3076397

Makharoblidze, T. (2019). Georgian tactile alphabet (GeoLorm). *Bull. Georg. Natl. Acad. Sci.*, *13*(2), 108–114.

Martens, M. A., Janssen, M. J., Ruijssenaars, W. A., Huisman, M., & Riksen-Walraven, J. M. (2016). Fostering emotion expression and affective involvement with communication partners in people with congenital deafblindness and intellectual disabilities. *Journal of Applied Research in Intellectual Disabilities*, *30*(5), 872– 884. https://doi.org/10.1111/jar.12279

Mathos, K. K. & Pollard, R. Q. (2015). Capitalizing on community resources to build specialized behavioral health services together with persons who are deaf, deafblind or hard of hearing. *Community Mental Health Journal*, *52*(2), 187–193. https://doi.org/10.1007/s10597-015-9940-y

Matsuda, Y. & Isomura, T. (2010). Teaching of emotional expression using finger Braille. *2010 Sixth International Conference on Intelligent Information Hiding and Multimedia Signal Processing*. https://doi.org/10.1109/iihmsp.2010.96

Matsuda, Y. (2015). Development of emotion teaching interface for Finger Braille Emotion Teaching System. *2015 7th International Conference on Intelligent Human-Machine Systems and Cybernetics*, 180–184. https://doi.org/10.1109/ihmsc.2015.196

Matsunaga, T. (2020). Clinical genetics, practice, and research of deafblindness: From uncollected experiences to the national registry in Japan. *Auris, Nasus, Larynx*, *48*(2), 185–193. https://doi.org/10.1016/j.anl.2020.08.017

McDonnall, M. C., & Cmar, J. L. (2018). Experiences of young adults with deafblindness after high school. *Journal of Visual Impairment &*

Blindness, *112*(4), 403–410. https://doi.org/10.1177/0145482x1811200407

Moore, A. (2017). *Exploring McGurk effect through Tadoma method Of speech perception* (Honors Theses). https://digitalcommons.salemstate.edu/honors_theses/143/

Mousa, A., Hiary, H., Alomari, R., & Alnemer, L. (2013). Smart Braille system recognizer. *IJCSI International Journal of Computer Science Issues*, *10*(6), 52– 60. https://www.ijcsi.org/papers/IJCSI-10-6-1-52-60.pdf

Nelson, C., & Bruce, S. M. (2016). Critical issues in the lives of children and youth who are deafblind. *American Annals of the Deaf*, *161*(4), 406–411. https://doi.org/10.1353/aad.2016.0033

Newton, M., & Melhart, B. E. (2001). Implementation of object-oriented protocol agents in communication devices. *Proceedings of the 8th Annual IEEE International Conference and Workshop On the Engineering of Computer Based Systems-ECBS 2001*. https://doi.org/10.1109/ecbs.2001.922428

Nicholas, J. (25 September 2020). Cognitive assessment of children who are deafblind: Perspectives and suggestions for assessments. *Frontiers in Psychology*, *11*. https://doi.org/10.3389/fpsyg.2020.571358

Nicolau, H., Guerreiro, J., Guerreiro, T., & Carriço, L. (2013). UbiBraille: Designing and evaluating a vibrotactile Braille - reading device. *Proceedings of the 15th International ACM SIGACCESS Conference on Computers and Accessibility*. https://doi.org/10.1145/2513383.2513437

Nielsen, G. (2012). *103 Haptic Signals, a reference book* [E-book]. https://www.fddb.dk/media/6643/103-haptic-signals-english-pdf-book.pdf

Oaklandcac. (2013). Facts about OUSD's students with disabilities. Oakland Unified School District. http://oaklandcac.pbworks.com/w/page/59627544/Facts%20About%20OUSD%27s%20Students%20with%20Disabilities

Ohtsuka, S., Tomizawa, T., Hasegawa, S., Sasaki, N., & Harakawa, T. (2013). Introduction of a wireless body-Braille device and a self-learning system. *2013 IEEE 2nd Global Conference on Consumer Electronics (GCCE)*. https://doi.org/10.1109/gcce.2013.6664872

Okamoto, A., Nambu, M., Miyoshi, S., & Sakajiri, M. (2010). Dialog support for deafblind persons by conveying backchannels through vibration. *Lecture Notes in Computer Science*, 686–689. https://doi.org/10.1007/978-3-540-70540-6_99

Olson, N. & Maceviciute, E. (2020). Information worlds of people with deafblindness. *Proceedings of ISIC, the Information Behaviour Conference, Pretoria, South Africa, 28-30 September, 2020*. Information Research, 25(4). https://doi.org/10.47989/irisic2012

Omar, R., Peng, W., Ishak, W., Saat, N., & Knight, V. (2019). Profile and quality of life of children with dual sensory impairment or deafblindness in visually impaired special centres. *Jurnal Sains Kesihatan Malaysia*, *17*(02), 157–163. https://doi.org/10.17576/jskm-2019-1702-18

Overbeek, M. M., Sterkenburg, P. S., Kef, S., & Schuengel, C. (2015). The effectiveness of VIPP-V parenting training for parents of young children with a visual or visual- and-intellectual disability: study protocol of a multicenter randomized controlled trial. *Trials*, 16(1). https://doi.org/10.1186/s13063-015-0916-6

Ozioko, O., & Hersh, M. (2015). Development of a portable two-way communication and information device for deafblind people. *Studies in health technology and informatics, 217*, 518–525.

Ozioko, O., Taube, W., Hersh, M., & Dahiya, R. (2017). SmartFingerBraille: A tactile sensing and actuation based communication glove for deafblind people. *2017 IEEE 26th International Symposium on Industrial Electronics (ISIE)*. https://doi.org/10.1109/isie.2017.8001563

Omugur, J. P. (2016). Effects of teachers' use of communication techniques on activities of daily living for learners with deafblindness in selected primary schools, Uganda. Kenyatta University Institutional Repository. http://ir-library.ku.ac.ke/handle/123456789/10886

Page, M. J., Moher, D., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo- Wilson, E., McDonald, S., . . . McKenzie, J. E. (2021). PRISMA 2020 explanation and elaboration: updated guidance and exemplars for reporting systematic reviews. *BMJ*, n160. https://doi.org/10.1136/bmj.n160

Palmatier, R. W., Houston, M. B., & Hulland, J. (2017). Review articles: purpose, process, and structure. *Journal of the Academy of Marketing Science*, *46*(1), 1–5. https://doi.org/10.1007/s11747-017-0563-4

Parker, A. T., & Ivy, S. E. (2014). Communication development of children with visual impairment and deafblindness. *Current Issues in the Education of Students with Visual Impairments*, 101–143. https://doi.org/10.1016/b978-0-12-420039-5.00006-x

Parker, A. T., & Nelson, C. (2016). Toward a comprehensive system of personnel development in deafblind education. *American Annals of the Deaf*, *161*(4), 486–501. https://doi.org/10.1353/aad.2016.0040

Paul, A., Dash, B., & Sharma, S. (n.d.). Technology for deafblind people. Sense International India. Retrieved from https://static.aminer.org/pdf/PDF/000/240/165/research_on_a_finger_braille_communicator.pdf

Peltokorpi, S., Daelman, M., Salo, S., & Laakso, M. (2020). Effect of tactile imitation guidance on imitation and emotional availability. A case report of a mother and her child with congenital deafblindness. *Frontiers in Psychology*, *11*. https://doi.org/10.3389/fpsyg.2020.540355

Perfect, E., Jaiswal, A., & Davies, T. C. (2018). Systematic review: Investigating the effectiveness of assistive technology to enable internet access for individuals with deafblindness. *Assistive Technology*, *31*(5), 276–285. https://doi.org/10.1080/10400435.2018.1445136

Perkins School for the Blind, International Council on English Braille, & Library of Congress. National Library Service for the Blind and

Physically Handicapped. (2013). *World Braille Usage* (3rd ed.). UNESCO

Petroff, J. G., Pancsofar, N., & Shaaban, E. (2019). Postschool outcomes of youths with deafblindness in the United States: Building further understandings for future practice. *Journal of Visual Impairment & Blindness*, *113*(3), 274–282. https://doi.org/10.1177/0145482x19860005

Prain, M. I., McVilly, K. R., & Ramcharan, P. (2011). Being reliable: issues in determining the reliability and making sense of observations of adults with congenital deafblindness? *Journal of Intellectual Disability Research*, 56(6), 632– 640. https://doi.org/10.1111/j.1365-2788.2011.01503.x

Probst, K. M. (2017). Measuring the longitudinal communication growth of learners who are deafblind. *Theses and Dissertations*, *793*. https://doi.org/10.30707/etd2017.probst.k

Probst, K. M., & Borders, C. M. (2017). Comorbid deafblindness and autism spectrum disorder—Characteristics, Differential Diagnosis, and Possible Interventions. *Review Journal of Autism and Developmental Disorders*, *4*(2), 95–117. https://doi.org/10.1007/s40489-016-0100-2

Raanes, E., & Berge, S. S. (2017). Sign language interpreters' use of haptic signs in interpreted meetings with deafblind persons. *Journal of Pragmatics*, *107*, 91–104. https://doi.org/10.1016/j.pragma.2016.09.013

Ramirez-Garibay, F., Olivarria, C. M., Eufracio Aguilera, A. F., & Huegel, J. C. (2014). MyVox—Device for the communication between people: blind, deaf, deaf-blind and unimpaired. *IEEE Global Humanitarian Technology Conference (GHTC 2014)*. https://doi.org/10.1109/ghtc.2014.6970330

Ranjbar, P., & Stenström, I. (2013). Monitor, a Vibrotactile Aid for Environmental Perception: A Field Evaluation by Four People with Severe Hearing and Vision Impairment. *The Scientific World Journal*, *2013*, 1–11. https://doi.org/10.1155/2013/206734

Rantala, J., Raisamo, R., Lylykangas, J., Surakka, V., Raisamo, J., Salminen, K., ... Hippula, A. (2009). Methods for presenting Braille characters on a mobile device with a touchscreen and tactile feedback. *IEEE Transactions on Haptics*, *2*(1), 28– 39. https://doi.org/10.1109/toh.2009.3

Republic of the Philippines Department of Education. Philippine Printing House for the Blind, & Resources for the Blind, Inc. (2013). *Instruction Manual for Filipino Braille Transcription* (1st ed.). Philippines: World Braille Foundation, The Canadian Braille Literacy Foundation, National Federation of the Blind, American Foundation for the Blind.

Roets-Merken, L., Zuidema, S., Vernooij-Dassen, M., Dees, M., Hermsen, P., Kempen, G., & Graff, M. (2017). Problems identified by dual sensory impaired older adults in long-term care when using a self-management program: A qualitative study. *PLOS One*, *12*(3), e0173601. https://doi.org/10.1371/journal.pone.0173601

Roy, A., McVilly, K. R., & Crisp, B. R. (2018). Preparing for inclusive consultation, research and policy development: insights from the field of Deafblindness. *Journal of Social Inclusion*, *9*(1), 71–88. https://doi.org/10.36251/josi.132

SAGE Publications, Inc. (n.d.). Literature review and focusing the research. SAGE Publications. https://us.sagepub.com/sites/default/files/upm- assets/98949_book_item_98949.pdf

Samir, A. (2017). *Deaf-blind Communication with 1Sheeld/Arduino*. Arduino Project Hub. https://create.arduino.cc/projecthub/skyseeker/deaf-blind-communication- with-1sheeld-arduino-bb3362

Santarelli, R. (2019). Entrega de impresora braille a la Banda Sinfonica Nacional de Ciegos. https://www.flickr.com/photos/culturaargentina/40658221513/in/photostream/

Savindu, H. P., Iroshan, K. A., Panangala, C. D., Perera, W. L., & De Silva, A. C. (2017). BrailleBand: Blind support haptic wearable band for communication using braille language. *2017 IEEE International Conference on Systems, Man, and Cybernetics (SMC)*. https://doi.org/10.1109/smc.2017.8122806

Saxton, E., Belanger, S., & Becker, W. (2012). The Critical Thinking Analytic Rubric (CTAR): Investigating intra-rater and inter-rater reliability of a scoring mechanism for critical thinking performance assessments. *Assessing Writing*, *17*(4), 251–270. https://doi.org/10.1016/j.asw.2012.07.002

Sharma, F., & Wasson, S. (2012). A speech recognition and synthesis tool: Assistive technology for physically disabled persons. *International Journal of Computer Science and Telecommunications, 3(4), 86-91.*

Shull, P. B., & Damian, D. D. (2015). Haptic wearables as sensory replacement, sensory augmentation and trainer – a review. *Journal of NeuroEngineering and Rehabilitation*, *12*(1). https://doi.org/10.1186/s12984-015-0055-z

Simcock, P. (2016a). Ageing with a unique impairment: a systematically conducted review of older deafblind people's experiences. *Ageing and Society*, *37*(8), 1703– 1742. https://doi.org/10.1017/s0144686x16000520

Simcock, P. (2016b). One of society's most vulnerable groups? A systematically conducted literature review exploring the vulnerability of deafblind people. *Health & Social Care in the Community*, *25*(3), 813–839. https://doi.org/10.1111/hsc.12317

Simcock, P. & Manthorpe, J. (2014). Deafblind and neglected or deafblindness neglected? Revisiting the case of Beverley Lewis. *British Journal of Social Work*, *44*(8), 2325–2341. https://doi.org/10.1093/bjsw/bct088

Simcock, P., & Wittich, W. (2019). Are older deafblind people being left behind? A narrative review of literature on deafblindness through the lens of the United Nations Principles for Older People. *Journal of Social Welfare and Family Law*, *41*(3), 339–357. https://doi.org/10.1080/09649069.2019.1627088

Silman, F., Yaratan, H., & Karanfiller, T. (2017). Use of Assistive Technology for Teaching-Learning and Administrative Processes for the Visually Impaired People. *EURASIA Journal of Mathematics, Science and Technology Education*, *13*(8). https://doi.org/10.12973/eurasia.2017.00945a

Singh, A., Dcvnani, S., Kushwaha, V., Mishra, S., Gupta, A., & Pandian, K. K. S. (2018). An efficient auxiliary reading device for visually impaired. *2018 International Conference on Smart City and Emerging Technology (ICSCET)*. https://doi.org/10.1109/icscet.2018.8537329

Skilton, A., Boswell, E., Prince, K., Francome-Wood, P., & Moosajee, M. (2018). Overcoming barriers to the involvement of deafblind people in conversations about research: recommendations from individuals with Usher syndrome. *Research Involvement and Engagement*, *4*(1). https://doi.org/10.1186/s40900-018-0124-0

Snyder, H. (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, *104*, 333 – 339. https://doi.org/10.1016/j.jbusres.2019.07.039

Sorgini, F., Caliò, R., Carrozza, M. C., & Oddo, C. M. (2018). Haptic-assistive technologies for audition and vision sensory disabilities. Disability and rehabilitation. *Assistive technology*, *13*(4), 394–421. https://doi.org/10.1080/17483107.2017.1385100

Southern, C., Clawson, J., Frey, B., Abowd, G., & Romero, M. (2012). MobileHCI: Human computer interaction with mobile devices and services. *Proceedings of the 14th International Conference on Human-Computer Interaction with Mobile Devices and Services*. https://dl.acm.org/doi/10.1145/2371574.2371623

Teglbjærg, J. H., Hovaldt, H. B., Lehane, C., & Dammeyer, J. (2018). Aetiologies of acquired deafblindness in a national sample. *British Journal of Visual Impairment*, *36*(2), 175–189. https://doi.org/10.1177/0264619618758352

Uman, L. S. (2011). Systematic reviews and meta-analyses. *Journal De L'Academie Canadienne De Psychiatrie De L'enfant Et De L'adolescent* [Journal of the Canadian Academy of Child and Adolescent Psychiatry], *20*(1), 57–59. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3024725/

UNESCO. (2013). World Braille Usage - Third Edition. Perkins International Council on English Braille. https://www.pharmabraille.com/wp-content/uploads/2014/11/World-Braille-Usage-Third-Edition-1.pdf

UNESCO. (2020, February 21). *Right to Education - UNESCO's Instruments and Monitoring*. UNESCO. https://en.unesco.org/themes/right-to-education/instruments-monitoring

University of Reading. (2018). Guidance on how to design and use rubrics. https://sites.reading.ac.uk/wp-content/uploads/sites/25/2018/10/UoR-Rubrics-guide-18-2.pdf

University of Texas. (2011). "What is a Review Article?". Life Science Library. https://web.archive.org/web/20110604191438/http://www.lib.utexas.edu/lsl/help/modules/review.html

Usakli, A. B., Gurkan, S., Gurkan, G., & Kaya, A. (2018). A novel EOG-based wireless rapid communication device for people with motor neuron diseases. *Journal of Medical Engineering & Technology, 42*(6), 420–425. https://doi.org/10.1080/03091902.2018.1531947

Wahlqvist, M., Möller, C., Möller, K., & Danermark, B. (2016). Implications of Deafblindness: The Physical and Mental Health and Social Trust of Persons with Usher Syndrome Type 3. *Journal of Visual Impairment & Blindness*, *110*(4), 245– 256. https://doi.org/10.1177/0145482x1611000404

Wang, K., Mauermayer, R. A. M., Li, L., & Eibert, T. F. (2015). A highly compact broadband near-edge antenna for low profile communication devices. *2015 9th European Conference on Antennas and Propagation (EuCAP).* In IEEE Xplore. Lisbon. https://ieeexplore.ieee.org/document/7228154

Withrow, H. (2017). Family support makes a difference with a deafblind child: Orion's Journey. ERIC. https://eric.ed.gov/?id=EJ1143218

Wittich, W., Jarry, J., Groulx, G., Southall, K., & Gagné, J.-P. (2016). Rehabilitation and research priorities in deafblindness for the next decade. *Journal of Visual Impairment & Blindness*, *110*(4), 219–231. https://doi.org/10.1177/0145482x1611000402

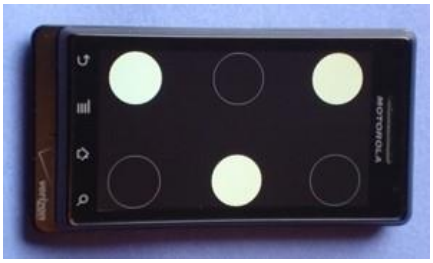
Wittich, W., & Simcock, P. (2019). Aging and combined vision and hearing loss. *The Routledge Handbook of Visual Impairment*, 438–456. https://doi.org/10.4324/9781315111353-27

Wolsey, J. A. (2017). Perspectives and experiences of deafblind college students. *The Qualitative Report*, *22*(82), 2066–2089. https://nsuworks.nova.edu/tqr/vol22/iss8/1

Wolthuis, K., Bol, G. W., Minnaert, A., & Janssen, M. J. (2019). Communication development from an intersubjective perspective: Exploring the use of a layered communication model to describe communication development in students with congenital deafblindness. *Journal of Communication Disorders*, *80*, 35–51. https://doi.org/10.1016/j.jcomdis.2019.04.001

7. APPENDIX

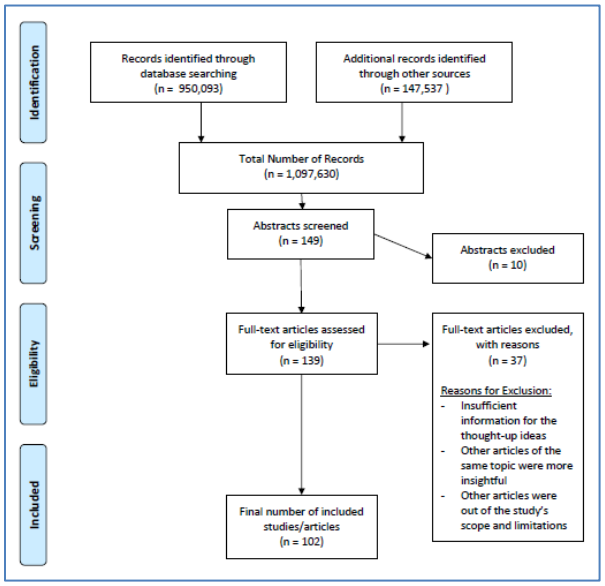
7.1. V-Braille (Jayant et al., 2010)



7.2. Braille Embosser (Santarelli, 2019)

7.3. Screen Braille Communicator (Lagarde, 2008)

7.4. PRISMA Chart of 102 Scholarly Articles



7.5. Tally of Identification of Articles Through Databases and Other Sources

TALLY OF IDENTIFICATION OF ARTICLES THROUGH DATABASES AND OTHER SOURCES			
	Deafblind communication	Communcation devices/assistive devices	Deafblind
IEEE Xplore	24	97,365	-
IOP Science	-	500	-
ScienceDirect	70	183,619	85
SpringerLink	-	345,003	128
WASET	-	5,700	-
Wiley Online Library	72	-	90
GJSS	2	-	-
ProQuest	2,922	-	-
Inderscience online	212	-	-
JSTOR	-	37,713	8
Oxford Academic	-	-	8
ResearchGate	-	95	96
ACM Digital Library	139,568	183,500	-
Vocalink	74	-	-
IOSPress	-	-	60
Sunderland	-	-	19
Minnesota state academies for the deaf and the blind	-	-	429
mississippi state universitty	-	-	115
Pattan	-	-	29
Citeseer	-	18,564	-
portland State u	-	-	114
Aminer	-	162	-
Taylor&Francis	121	77,954	139
Modestum	-	356	-
NCBI	-	-	30
ERIC	-	-	73
TQR	-	-	2
DiVA	-	-	43
sagejournals	-	-	231
OpenOregon	-	-	-
JDBSC	43	-	-
university of toronto	-	-	1390
martemeoforeningen	1	-	-
plos One	-	-	11
Frontiersin	-	-	19
ukm (malaysian)	-	-	1
bmc	831	-	3
ir-library	-	-	26
BCU (university)	-	-	9
Information researcg	-	-	1
TOTAL	143940	950,531	3159
FINAL TOTAL	1097630		

7.6. Assistive Devices' Ratings Using the Rubric Formulated for Deafblind People

Criteria	Exemplary	Good	Adequate	Limited
Portability	V-Braille	Screen Braille Communicator		Braille Printer
Accessibility	Braille Printer	V-Braille	Screen Braille Communicator	
Adaptability	V-Braille Screen Braille Communicator			Braille Printer
Learnability	Screen Braille Communicator		V-Braille	Braille Printer
User-friendliness	Screen Braille Communicator		V-Braille	Braille Printer

7.7. Assistive Devices' Ratings Using the Rubric Formulated for Deafblind People

Criteria	Exemplary	Good	Adequate	Limited
Portability	V-Braille	Screen Braille Communicator		Braille Printer
Accessibility	Braille Printer	V-Braille	Screen Braille Communicator	
Adaptability	V-Braille Screen Braille Communicator			Braille Printer
Learnability	Screen Braille Communicator Braille Printer		V-Braille	
User-friendliness	Screen Braille Communicator Braille Printer		V-Braille	