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Usability Evaluation of A Braille Tactile Audio Device (B.T.A.D.)

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ABSTRACT

This research investigates the assessment of the BTAD (Braille Tactile Audio Device) concerning its physical attributes, sound weight, texture, and learnability. Employing a descriptive research design, the study thoroughly examines the usability of the BTAD. Nine purposely selected participants from Cebu, Philippines, individually utilized the BTAD to evaluate it using a researcher-developed questionnaire. The analysis revealed six principal themes: affirmative observations regarding the physical attributes of the BTAD, negative observations regarding its physical characteristics, amplification of sound volume, portability aspect of the BTAD, texture consistency, and ease of manipulation. Findings indicate a mixture of satisfaction and areas for improvement among users, particularly highlighting volume concerns, which are crucial for visually impaired individuals dependent on auditory cues. Consequently, the study recommends enhancing the volume and durability of the device. Future researchers are urged to consider user feedback and prioritize suggested improvements to develop a more refined and functional BTAD.

Keywords: BTAD, Braille Tactile Audio Device, usability evaluation, descriptive research, visually impaired, auditory cues, volume enhancement, device durability.

INTRODUCTION

To blind individuals, learning to read and write in braille is as essential as print literacy is for sighted people. Braille literacy opens up a world of learning, leisure, and employment opportunities. Children must learn how to read and write in braille directly from certified teachers who are aware of the importance of braille in fostering literacy. Most learners receive braille instruction from instructors of students with visual impairments (TVI), with support from teachers who are usually solely accustomed to print. One of the most significant challenges for students learning braille is having sufficient access to a TVI.

Low literacy regarding Braille: Visual impairments are present everywhere in the world. However, only a few people have access to technology and education in braille. Based on research done by R.M. Sheffield. In 1992, for instance, the U.S. In a letter outlining its final funding objectives, the Department of Education noted that the percentage of pupils who read braille was falling. In 1965, 48 percent of all blind and visually impaired students were braille readers. This has decreased to 12% by 1989 (p. 14289). The article highlights the alarming trend of falling braille literacy rates among blind and visually impaired people. Furthermore, there are obstacles to effective instruction for traditional braille learning. In response to these challenges, this study attempts to comprehensively evaluate the Braille Tactile Audio Device

(B.T.A.D.), an innovative assistive device that aspires to increase braille literacy and accessibility. Our objectives include assessing the B.T.A.D complete usability testing, obtaining input from blind and visually impaired persons to comprehend their inclinations and encounters, and contrasting the efficiency of the apparatus with conventional braille instruction techniques. Therefore, this study aims to enhance the B.T.A.D.'s usability and accessibility for a wide range of users by utilizing the information gathered from this usability test to guide iterative design modifications. By achieving these goals, we want to address the unique issues facing braille education and enhance braille literacy and accessibility.

Learning Braille should be made easier and more participative with the help of the Braille Tactile Audio Device (BTAD). Its six dots, which are arranged in two columns to resemble various Braille letters, may be combined in many ways by users. Users may quickly obtain auditory feedback by hitting these dots and hearing the relevant Braille letter spoken out. The device is then turned on by pressing the red button. This feature improves the connection between dot combinations and Braille letters and provides quick mistake correction. This feedback loop helps users learn more effectively by allowing them to correct errors and solidify their understanding of Braille. As users improve their accuracy and proficiency in Braille over time, the Braille Writing Assistance Device (BTAD) is an important aid for those learning the tactile writing system.We pay close attention to elements like button positioning and menu layout while testing the usability. We make sure that information is effectively communicated via touch, sound, and Braille so that people can understand and interact with it.

The World Health Organization (WHO) estimates that there are 285 million visually impaired individuals globally, with 90% residing in developing nations. In the Philippine context, it has a total population of 100,981,437, according to the August 1, 2015 Census. Nevertheless, the statistical data for individuals with disabilities relies on the 2010 Census, which reveals that approximately 16 out of every thousand people in the country have disabilities, accounting for 1.57 percent of the total population. The estimated population of individuals with blindness or visual impairment in the Philippines is roughly 500,000, with a significant majority of them belonging to the impoverished and uneducated segments of society.

According to the data provided by Resources for the Blind Inc. (RBI), around 40,000 individuals who are blind or visually impaired are currently of school age. Although the Philippines boasts a highly developed education system with a significant enrollment rate for children, historically, only a tiny proportion of blind individuals have had the opportunity to enroll. By 1990, the total number of visually impaired pupils enrolled in nationwide schools was 300, with a predominant concentration in metropolitan residential schools designed explicitly for people who are blind. Although education is vital for individuals, and there is a strong correlation between proficiency in Braille and academic achievement, higher income, and employment, Braille literacy in underdeveloped nations could be much higher. Currently, the percentage of visually challenged children in underdeveloped countries being educated in Braille is less than 3%; one area of the world particularly impacted by Braille illiteracy is the Philippines.

In the Philippines, up to four percent of people are blind or visually impaired. Braille is a tactile phonetic alphabet system that enables people who are blind or visually impaired to read through touch. Braille is crucial for social and economic opportunity and has been linked to higher employment rates, education, financial self-sufficiency, and self-esteem. The World Health Organization estimates that 180 million people are blind or visually impaired worldwide, 90 percent of whom live in developing countries. Braille literacy is decreasing, and the American Foundation for Blindness has declared a Braille literacy crisis. In 2009, they estimated that only 10 percent of children who are blind or visually impaired were learning to

read and write due to the misconception that Braille is isolating or stigmatizing, a historical emphasis on print instruction, and a lack of qualified teachers.

Conceptual Framework

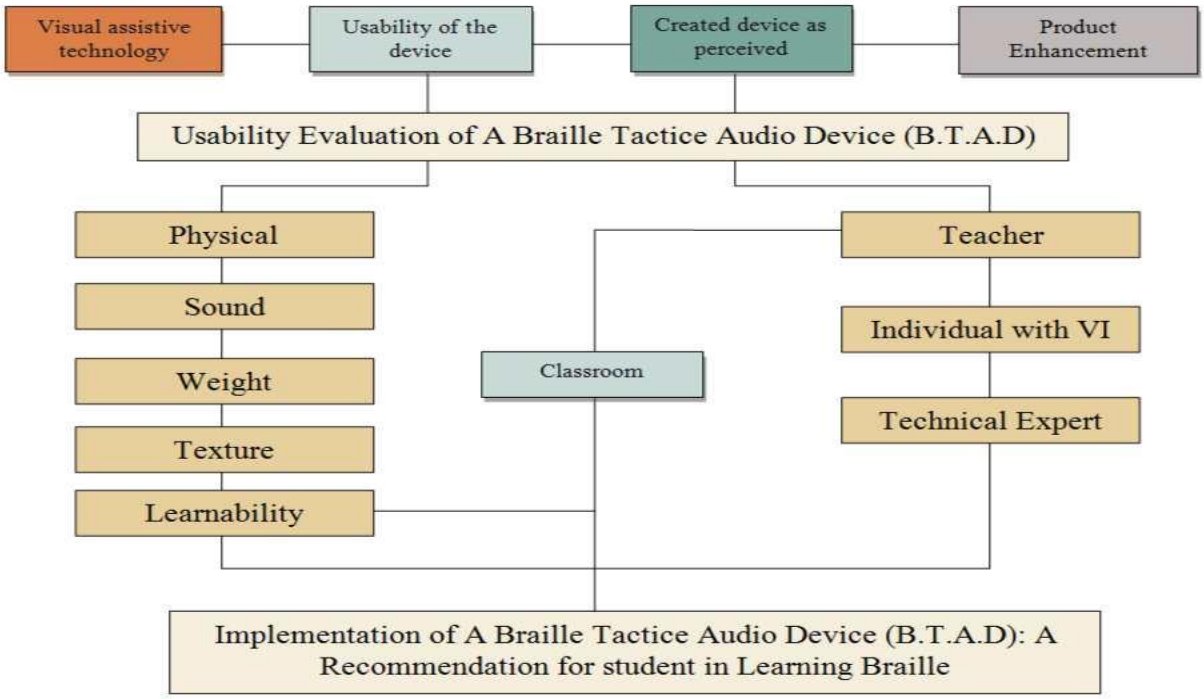


Figure 1. Conceptual Framework of the Study

Investigating the possibilities of visual assistive technology is part of developing a usability evaluation for the BTAD (Blind and Visually Impaired Assistive Device) product. Physical characteristics, including texture, weight, sound, and learnability, are all considered when assessing a device's usability. The study aims to determine the device's efficacy by collecting opinions from teachers, visually impaired people, and technological specialists. Finding opportunities for product improvement will be the main emphasis of this evaluation.

Statement of the Problem

This study will explore the usability assessment of the BTAD product. Specifically, this study aims to answer the following questions:

1. Based on the published journals, what visual assistive technology may be created?
2. What is the usability of the device in terms of the following:

1.1 Physical
1.2 Sound
1.3Weight
1.3 Texture
1.4 Learnability

3. What is the score of the created device as perceived by the following judges on the:

3.1 Teacher
3.2 Individuals with Visual Impairment
3.3 Technical Expert

4. Based on the evaluation, what product may be enhanced?

REVIEW OF RELATED LITERATURE

According to research by Khan et al. (2019), Braille reading is crucial for visually impaired people to achieve their educational goals; giving blind kids access to Braille instruction dramatically raises their literacy rates and academic achievement, which in turn results in improved educational outcomes and more chances for postsecondary education. Similarly, Ibrahim et al. (2023) stress the value of Braille reading in promoting learning and understanding, pointing out that Braille readers outperform non-Braille readers regarding phonological awareness and language proficiency. Visually impaired children must be prepared for future work and success through braille literacy. The association between successful work outcomes in adulthood and proficiency in Braille is highlighted by research conducted by Sheffield et al. (2022). Early Braille mastery increases a child's chances of becoming independent and financially stable as an adult by fostering the development of critical literacy, communication, and problem-solving abilities that are highly prized in the workforce.

Low literacy about Braille

Visual impairments are present in all parts of the world. However, only some have access to braille education and technology. Based on a study by Sheffield, R.M. et al. (2022) stated that in 1992, the U.S. Department of Education wrote about declining numbers of braille readers as part of its final funding priorities, saying: "In 1965, nearly half—48 percent—of all blind and visually impaired students read [b]raille. By 1989, this had dropped to 12 percent" (p. 14289).

According to World Health Organization (WHO) research, 36 million of the estimated 253 million visually impaired individuals worldwide are blind. A sizable fraction of these people need help getting access to technology and education adapted to their needs, especially those who use Braille as their primary language of communication and education. Lack of access to assistive technology and Braille instruction exacerbates the educational and employment disparities that visually impaired individuals experience, limiting their opportunities for social engagement and economic empowerment (World Health Organization, 2019).

Affordability

Many of the blind people, especially those from developing nations, are deprived of the necessary easy-to-use, inexpensive electronic Braille equipment. As the result of the research by Sultana et al. (2018) the cost of electronic braille could vary from the range of $500 to $2,000, something that presents a financial barrier for the acquisition. An additional option of cheaper Braille assistive devices can be more profitable, especially in the areas where these devices are extra affordable. The prohibiting factor of Refreshable Braille devices, however, is most usually the expensive cost that keeps them out of the reach of this majority population, that is reported in the Journal of Assistive Technologies (Journal of Assistive Technologies, n.d.). As stated by Kahn and others (2019), there is an insufficiency of low-priced Braille tool kits in educating the visually impaired and consequently, the latter cannot attain literacy in the developing world, thus propelling the high rates of illiteracy.

Evaluation of existing electronic Braille systems in terms of functionality and cost

Current instructional materials for Braille include Do-it-yourself material. The Professional Development and Research Institute on Blindness recommends that educators and parents utilize household items, like egg cartons and cupcake tins, to create enlarged Braille cells for children to explore (Gadiraju et al., 2021) This tells us that there is a need for instructional materials especially for children who wish to learn Braille.

The study also tells us that while visually impaired students may prefer auditory learning, the standard for literacy is still Braille competency. Blind students who are braille readers and have no additional disabilities have better phonological awareness than print readers. (Arum et al., 2021)

Students with visual disabilities require various opportunities to explore and study learning material through alternative senses other than visual input, such as tactile and audio (Lintangsari & Emaliana, 2020). Combining these two senses allows students to explore and study more efficiently. The identified strengths from the research studies suggest that technologies designed and selected for applications in braille literacy education for children and youth should provide real-time auditory and tactile feedback and enable independent study/practice and editing of work. Additionally, technologies should be easy to use, motivational, and engaging. (Hoskin et al., 2020) By providing real-time feedback, the student will have the opportunity to learn more. Memory of a blind person gives them orientation, mobility, learning, communication, and socialization. There are many things visually impaired children can learn and memorize. Repetition, either the necessary actions or exercises, may be the critical tool that functions not only for memorizing but also for understanding and learning (Ibrahim et al., 2023)

Based on a study by Hoskin, E. R. et al. 2024, The identified strengths from the research studies suggest that technologies designed and selected for applications in braille literacy education for children and youth should provide real-time auditory and tactile feedback and enable independent study/practice and editing of work. Additionally, technologies should be easy to use, motivational, and engaging (Hoskin, E. R., Coyne, M. K., White, M. J., Dobri, S. C., Davies, T. C., & Pinder, S. D. (2024). Effectiveness of technology for braille literacy education for children: a systematic review. *Disability and Rehabilitation: Assistive Technology*, *19*(1), 120-130.)

Problems in learning Braille in a traditional way

The foundation for people with visual impairments to access information and education is braille literacy. Still, many obstacles stand in the way of efficiently providing braille instruction, as multiple studies have clarified. Concerning statistics regarding students' retention of braille literacy were found in the preliminary results of Swenson's (2008) A.B.C. Braille Study. According to the study, only about half of the pupils who were followed from kindergarten to the third or fourth grade continued to read at a grade level. This emphasizes how difficult it is for students to maintain their braille literacy skills over time. Keil (2004) underscores the need for more research on braille literacy instruction, especially for students with visual impairments and learning disabilities. The report also emphasizes the need for extensive training programs that provide instructors and support staff for the visually impaired with the skills they need to address the diverse literacy demands of their pupils when it comes to teaching braille in a traditional way.

Additionally, Klein (2021) highlights how important it is to bridge the communication and comprehension gaps between T.V.I.s and visually impaired pupils while teaching Braille.

Physical

One line of study and development has been the usability of the Braille Tactile Audio Device (B.T.A.D.) about the physical sub-variable for assistive technology for the visually impaired. In several projects, researchers have looked into alternative approaches to traditional Braille. These include interactive audio-tactile system, or tactile system with audio annotations. A first step towards the development of mobile audio-tactile systems for graphics was taken by work carried out. (Griffin et al., 2020) brings to mind an important issue about audio-tactile feedback: how they can be used in combination with other systems given that this leads to the need for more creative solutions such as the use of QR. codes for text

incorporated in tactile images to improve visually impaired users' access to information. (Melfi et al., 2020) Interactive audio-tactile devices are more efficient and user-friendly for visually impaired people than traditional Braille text. They offer faster tactile graphic exploration and are more compactly informative than conventional forms of information (Zeinullin & Hersh, 2022), physical usability for devices like B.T.A.D. should locally incorporate tactile, auditory, and interactive elements to achieve true multimedia access sheets

Sound

Visually impaired people are extremely accurate in detecting tactile input even on their feet (Griffin et al., 2020). Sound classification has been a major subject in B.T.A.D which recognizes environmental sounds. In addition, Piczak (2015) developed an ecological sound dataset and highlighted the importance of accurately categorizing such sounds for assistive devices' effectiveness. This highlights the importance of incorporating modern sound classification techniques into B.T.A.D in order to enhance its usability among visually impaired users. Moreover, Mesaros, Heittola, and Virtanen (2016) looked at measures for polyphonic sound event recognition and this study may serve as a guide for a smooth and accurate auditory feedback mechanism in B.T.A.D by detecting and classifying overlapping events within the system. Therefore, sophisticated techniques of detecting sound occurrence will help optimize the usability of B.T.A.D as well as improve auditory experience in the user's own ears.

Weight

According to research, blind people find interactive audio-tactile devices—like the B.T.A.D.—to be easier to use than standard tactile devices with Braille text (Brock & Jouffrais, 2015). The Braille Tactile Audio Device (B.T.A.D.)'s weight has a big impact on how usable it is since people with visual impairments might find it easier to use and more portable with a lighter design. Research has shown that consumers choose lighter-weight gadgets because they provide more comfort during extended usage and lessen the user's physical strain.

Texture

Texture is highly significant to the usefulness of the Braille Tactile Audio Device (B.T.A.D.) specifically for users who rely on touch. Texture is integral in influencing how well a user reads and understands information communicated through the tactile interface, thus proving its importance in the overall usefulness of this device. The authors presented "Texture Transformer Network" (Yang et al., 2020) as one of such methods. This state-of-the-art way of understanding texture underscores how instrumental it can be in improving the entire user experience both in haptic interfaces like B.T.A.D. or digital ones including visual forms. As witnessed by Cao et al., (2018), correct identification of a range of textures comprising Braille letters, enhances haptic perception and surface texture recognition using B.T.A.D. Looking at the concept from the B.T.A.D.'s standpoint, it is apparent that any alteration made to tactile surface might have significant repercussions for this device's users as well as its designers and manufacturers and its impact to the visually impaired people.

Teacher

As per the findings of Brock et al.'s research (2015), visually impaired people can use interactive geographic maps with ease. This finding is particularly relevant in evaluating B.T.A.D. as it means that having interactive features enhance its usability among blind or low vision individuals. For example, the B.T.A.D could be made more appropriate to meet the needs of users with visual impairments like teachers of visually impaired students by integrating touch-sensitive controls and audio feedback options. These attributes allow the device to assess the quality of images by using perception-based characteristics. Even

though the study focused on visual pictures, perception-based evaluation can be used in usability assessment of assistive devices like B.T.A.D. In particular, assessing how well it delivers instructional materials to visually impaired pupils in academic settings involves gathering information from teachers about their experiences using it (Venkatanath et al., 2015). The teacher's feedback is highlighted as an important factor to the device and its enhancement that could be benefited by the visually impaired students. The integration of assistive technologies into classrooms has a lot to do with what teachers think about how usable tools such as the B.T.A.D are.

Individuals with Visual Impairment

Simon et al. (2015) studied an auditory multiclass brain-computer interface that employs natural stimuli and can be used for various purposes in the future. This interface was tested on a disabled person and healthy users, who helped to evaluate it as a useful tool. Such research is important because of the fact that it demonstrates the role and value of natural stimuli for usability testing of B.T.A.D. The conclusions made in this study could be used to assess how intuitive or realistic an experience a visually impaired user is likely to have with the B.T.A.D. Therefore, studies exploring the usability and functionality of interactive audio-tactile maps like those found in B.T.A.D have demonstrated their success rate concerning such users (Sokolowski & Fialka-Moser, 2012). These devices combine auditory annotations with tactile input and show positive results regarding navigation improvement and spatial skills development in users. Combining audio features with tactile devices can provide blind people with more engaging learning experiences that are both interesting and memorable (Brock & Jouffrais, 2015).

Technical Expert

The Usability Evaluation of Braille Tactile Audio Devices (B.T.A.D.) includes several studies on its components for visually impaired people. According to studies, interactive audio-tactile devices can be more useful for blind people than traditional tactile maps with Braille text but with the additional factor of the technical expert's advice, suggestions and validation. Furthermore, haptic memory and auditory cues have been identified as critical for visually impaired users to decode tactile-graphic information effectively.

METHODOLOGY

Research Design

In order to fully investigate the use of the Braille Tactile Audio Device (BTAD), a descriptive study design was selected. Without changing factors, descriptive research enables thorough investigation and characterization of current events (Babbie, 2016).

Research Environment

The research was conducted within the captivating and diverse area of Cebu, a province nestled in the Central Visayas region of the Philippines. According to the 2020 Census, Cebu boasts a substantial population, with approximately 3,325,385 individuals. This populace is dispersed across six urban centers and 44 municipalities that constitute the province. The provincial capital, Cebu City, is the provincial capital. The demographic density of Cebu presents an advantageous scenario for targeting the subject of inquiry in this study.

Research Subject

The study employed a convenience sampling methodology to identify suitable research subjects. Babbie (2016) defines *convenience sampling* as selecting individuals or elements for a sample based on their accessibility and proximity to the researcher rather than through random selection or adherence to specific

criteria. This approach is commonly utilized when the researcher seeks to maximize efficiency and feasibility in subject recruitment, particularly in studies conducted within real-world settings or with limited resources (Babbie, 2016).

All nine participants selected for this study, comprising four visually impaired individuals, three teachers, and two technical experts, will actively contribute their perspectives and experiences. Specifically, the visually impaired participants, teachers, and technical experts will share their insights following their engagement with the BTAD (Braille Tactile Audio Device). This collaborative approach ensures a comprehensive exploration of the subject matter, incorporating diverse viewpoints and experiences.

Research Instrument

All essential materials were procured from established and reputable suppliers to ensure the quality and reliability of the study's resources. A researcher-developed Likert scale questionnaire served as the primary tool for evaluating user sentiments and satisfaction levels regarding the Braille Tactile Audio Device (BTAD). This questionnaire was meticulously crafted to gauge users' perceptions of the device's functionality, effectiveness, and usability.Participants were presented with a comprehensive set of 21 questions to assess the BTAD's performance and alignment with user standards. Following their interaction with the device, participants were tasked with responding to these questions using a Likert scale format, ranging from "Below Standards" to "Exceeds Standards". Furthermore, participants were encouraged to substantiate their Likert scale responses by providing additional comments in the designated remarks section, allowing for deeper insight and context.

Data Gathering Procedure

The data collection process commenced with developing a Likert scale questionnaire focusing on various attributes of the Braille Tactile Audio Device (BTAD), including its physical characteristics, sound feedback, weight, texture, and learnability. Participants were instructed to engage with the device and respond to the questionnaire. Participants were tasked with evaluating each aspect of the BTAD's features based on their personal standards and preferences. They were required to indicate whether each feature met their standards by selecting the appropriate Likert scale rating. Additionally, participants were encouraged to provide detailed comments in the remarks section to elucidate their ratings and provide further insights into their assessments.

Data Analysis

The collated qualitative data underwent thematic analysis. According to Braun and Clarke (2006), thematic analysis was considered a fundamental technique for qualitative research because it taught essential skills for conducting a variety of other qualitative research methodologies. Through the use of thematic analysis, the researchers were able to identify common themes present in the participant responses. The first stage was familiarization, in which the researchers became acquainted with the collected data. However, before evaluating the data, the researchers had to obtain a comprehensive overview of all the collected data. The data was then coded, and the researchers reviewed the transcripts of each interview to identify anything that stood out as pertinent or potentially intriguing. The researchers then examined the codes they generated, sought patterns, and began to develop themes, after which they ensured that the themes were accurate and relevant data representations. After completing the themes, it was time to identify and define each. In conclusion, the researchers documented the data analysis. Writing a theme analysis entailed an introduction that laid out the study topic, goals, and strategy, just like any other academic document.

Ethical Considerations

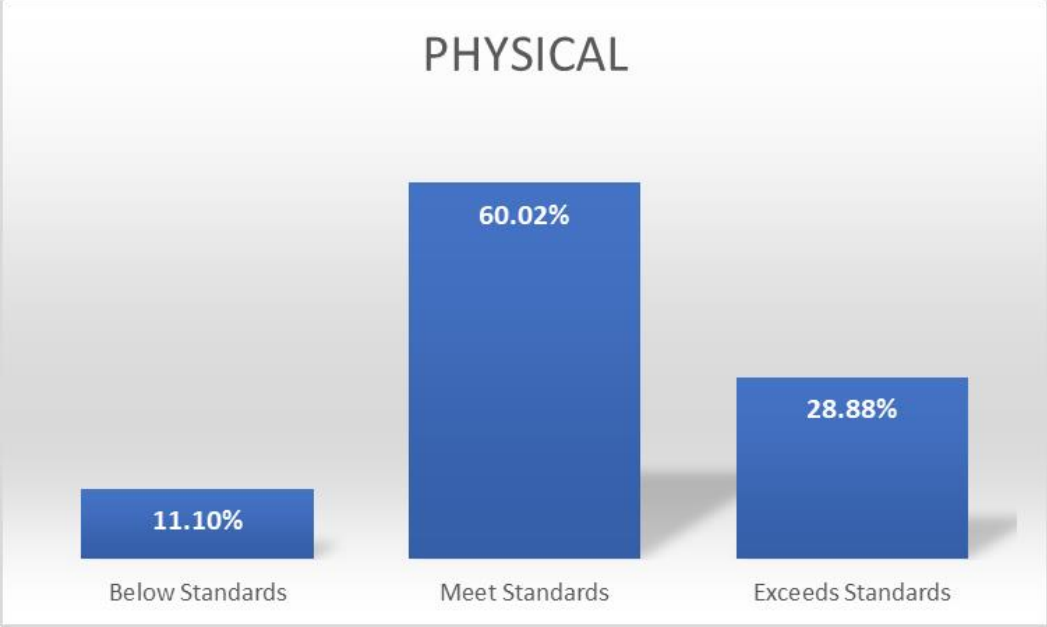
Ethical considerations were crucial in the research study to ensure the protection and well-being of participants. The researcher obtained the participants' informed agreement to participate at the interview's outset by outlining the study's importance and goal. The researchers assured that any information they provided would be kept private and no one would be named in any reporting. Furthermore, in a gesture of gratitude for their invaluable contribution, respondents were offered a modest token of appreciation, such as a Jollibee meal, as a tangible expression of acknowledgment for their time and collaboration.

RESULTS AND DISCUSSION

Table 1: Profile of the Participants

Code Name	*Classification of Research Subjects*
Participant 1	Sped Teacher
Participant 2	Sped Teacher
Participant 3	Sped Teacher
Participant 4	Electrical Engineer
Participant 5	Electrical Engineer
Participant 6	Visually Impaired
Participant 7	Visually Impaired
Participant 8	Visually Impaired
Participant 9	Visually Impaired

Findings and Translations Physical



A total of nine respondents completed the research instrument. Among them, 11.02% rated the physical aspect of the BTAD as below standards, 60.02% found it to meet their standards, and 28.88% reported that it exceeded their standards. Consequently, two themes emerged from the analysis:

Theme 1: Affirmative Observations Regarding the Physical Attributes of BTAD

This theme explores the participants' positive observations on the physical aspect of the BTAD. A study

conducted by Brown et al. (2019) emphasized that durable construction enhances the longevity of Braille audio devices and instills confidence in users, leading to increased adoption and usage. The following statements below support the theme;

" Okay ra iyang physical appearance para nako no,dili dako dili sad gamay." **- *P1***

"Sakto ras siya, satisfied ra kay di man kaayo siya dako."(Right size, I'm satisfied because it's not really big " **- *P1***

*" Wala rakoy problema sa physical niya."(I have no problem with the physical appearance)***- *P2***

"Okay-han rako sa physical appearance no" **- *P3***

"okay raman siya dili raman lisod."(It's easy, not really difficult) **- *P7***

*"Yes. The bigger the better, for easy manipulation."***- *P8***

"Okay raman nuon siya dili ra siya lisod dad on dali ra nimo ma sulod og bag if mo adto baron kag school."(Right size, not really hard to carry, easy to put it inside your bad if you're going to school) **- *P9***

The analysis for Theme 1: Affirmative Observations Regarding the Physical Attributes of BTAD highlights the positive feedback and satisfaction from the participants. The collective responses of the participants seem to portray an overall positive evaluation of BTAD's physical attributes. Observing the participant's affirmative satisfaction and lack of problematic issues or complaints suggests a positive perception of BTAD's physical appearance. Jones, S., & Smith, J. (2021) that the physical durability of Braille audio devices is crucial for ensuring their long-term usability and effectiveness in assisting individuals with visual impairments. These positive perceptions are likely to affect their attitudes toward BTAD and possibly positively influence their usage behavior or intention. Analysis reveals that participants' affirmative observance regarding the physical aspects of BTADs indicates a favorable perception, satisfaction, and recognition of practical advantages. These findings provide valuable insights into how users will perceive and evaluate BTAD based on its physical appearance, thus helpful in understanding user preferences and marketing design or product designs.

Theme 2: Negative Observations Regarding the Physical Attributes of BTAD

The physical attributes of an instructional material are essential to ensure that it will be effective for the users. Based on a study by (N Onyia, 2013), practical teaching and learning include materials that are durable, less costly, easily maintained and manipulated by students, appeal to students' interests, and develop their intellectual capacities. This theme explores the negative observations of the participants on the physical aspect of the BTAD. The following are the responses that support this theme.

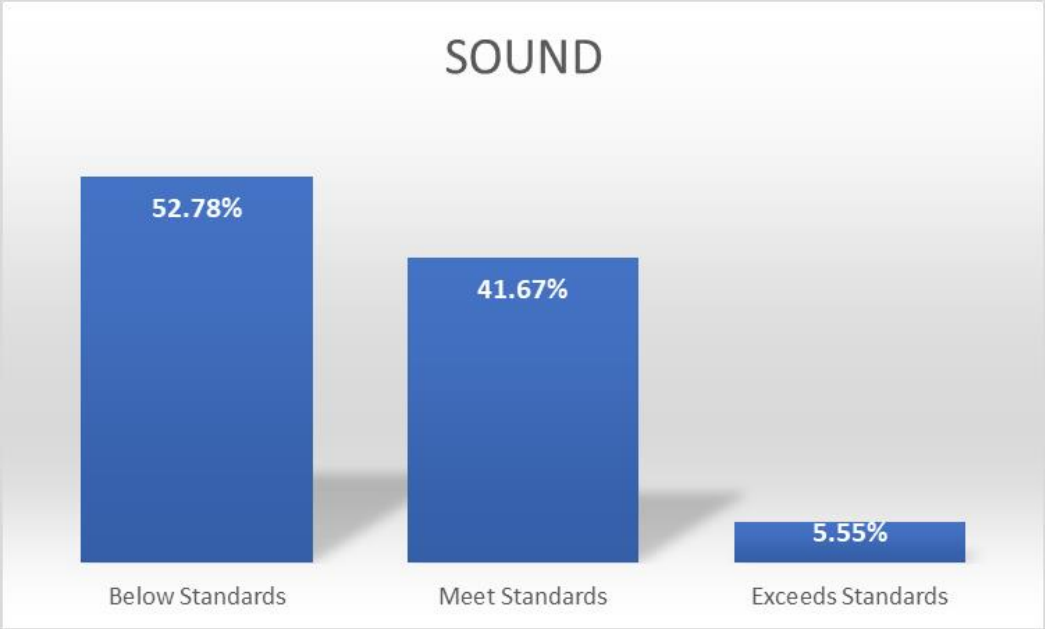
"For durability, it can be pressed, and for the setup. Sometimes mugana. The speaker is too big, and the packaging is too big for the purpose. The speaker Is protruding. The speaker should be inside. The attention is more on the speaker rather than the tactile. In the long run, there is a chance of it breaking.

Plastic is okay; it would be better if there is an additional speaker to make the volume louder. You can add a speaker but smaller and with a greater quantity." ***-P4.***

*"Below standard because of the button size. Standard ra but the answer button needs to be labeled or what the name is. The button also needs to be bigger. The switch also needs to be bigger."****-P5.***

This means that the analysis of Theme 2, "Negative Observations Regarding the Physical Attributes of BTAD," underscores the significance of participant feedback in informing design improvements. Participants expressed concerns about durability, highlighting issues with pressing, set up, and the disproportionately large speaker and packaging. One participant suggested redirecting attention towards tactile elements and incorporating a smaller speaker to prevent potential breakage, while another noted dissatisfaction with button size and advocated for larger buttons and switches. These insights align with the assertion by Baker (2006) regarding the importance of observation as a foundational source of knowledge. Integrating user insights can lead to enhancements that better meet the needs of individuals with visual impairments, ultimately improving the overall usability and effectiveness of the BTAD.

Sound



A total of nine respondents completed the research instrument. Among them, 52.78% rated the sound aspect of the BTAD as below standards, 41.67% found it to meet their standards, and 5.55% reported that it exceeded their standards. Consequently, one theme emerged from the analysis:

Theme 3: Amplification of Sound Volume

This theme dives into the consequences and advantages of increasing the volume of sounds. Based on a study (Baba & Ojakovo, 2021), using audio materials in teaching listening comprehension is better and more effective than the traditional or classroom text. The results show that the participants would prefer the volume to be increased. The feedback provided by the participants supports these findings.

"increase the volume" **- *P1***

"kindly do something with the volume and the voice sound" - ***P2***

"Volume level is low" - ***P3***

"It would depend on who hears it. It matters on the age of the listener. It is a little on the low side, in regards to the volume" - ***P4.***

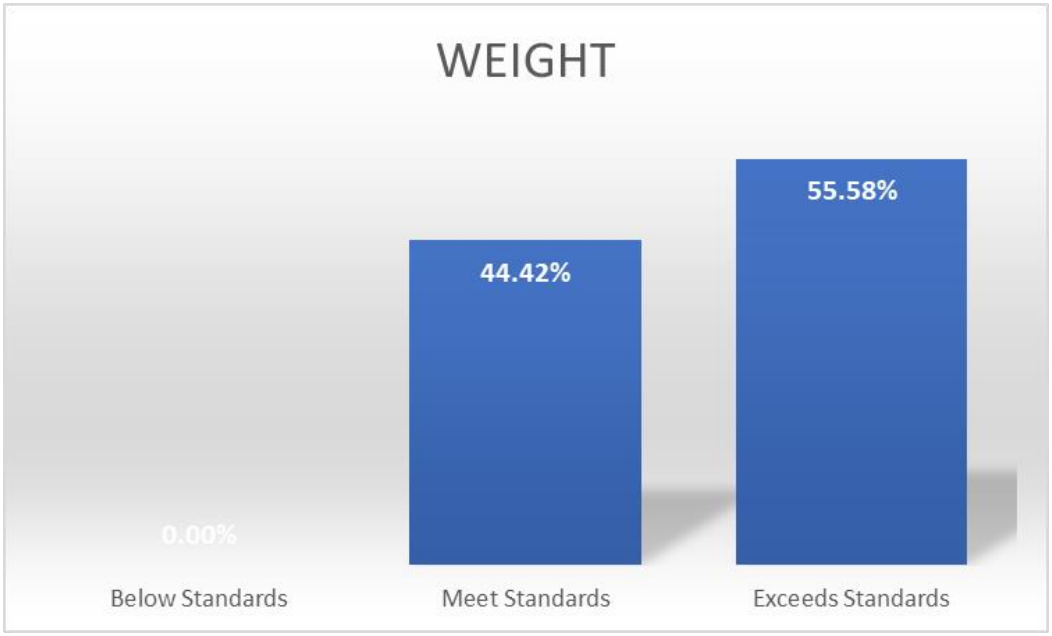
"There are no volume adjustment buttons for the device. It should be louder and there should be a way for the volume to be increased" - ***P5.***

"hinay ang sound "(The sound is low) - ***P6***
"okay ra ang sound nindot gyud og kusog² siya mg volume pa kusgan"(It is okay but it would be better if the volume was increased) - ***P7***
"Inaudible or not audible enough when buttons are pressed." - ***P8***

"Mas mapa kusgan onta gamay ang audio mas nindot onta"(Make the volume a bit louder to make it better) - ***P9***

Participants express dissatisfaction with low volume levels, suggesting increased volume and volume adjustment controls are needed. Based on a study by Castel, 2009) states that "presentation at a louder volume leads to greater perceived *fluency*, or ease of processing at encoding, which then guides." Participants collectively highlight the importance of adequate volume for better user experience, emphasizing the need for adjustments to enhance audio clarity and enjoyment. Addressing low-volume issues is crucial for improving user satisfaction and usability, potentially leading to frustration if not addressed. Implementing volume adjustments can enhance user experience and satisfaction.

Weight



Out of the nine (9) respondents who participated in the research survey, none rated the weight aspect of the BTAD (Braille Tactile Audio Device) below standards, accounting for 0.00% of the respondents. The respondents expressed satisfaction with the device's weight, highlighting that its optimal balance is light and tight enough. They appreciated its portability, noting that it can easily fit in a bag and be conveniently accessed anywhere.

Theme 4: Portability Aspect of the BTAD

The size of an object is one characteristic that usually tells the brain about its weight, and this topic explores that relationship (Buckingham & MacDonald, 2016; Flanagan, Bittner, & Johansson, 2008; Plaisier & Smeets, 2015). Larger items are frequently heavier, and this is particularly true of items made of the same material. The findings indicate that the subjects are not bothered by the BTAD's weight.The participants' responds, which follow, validated these:

"Gaan ra" (It's just right.)"- ***P4***

"It is not heavy" -***P5***

"di gaan, di sad bug at sakto lang siya mabitbit" (Not heavy, not too light, just the right size to carry.)"-***P6***

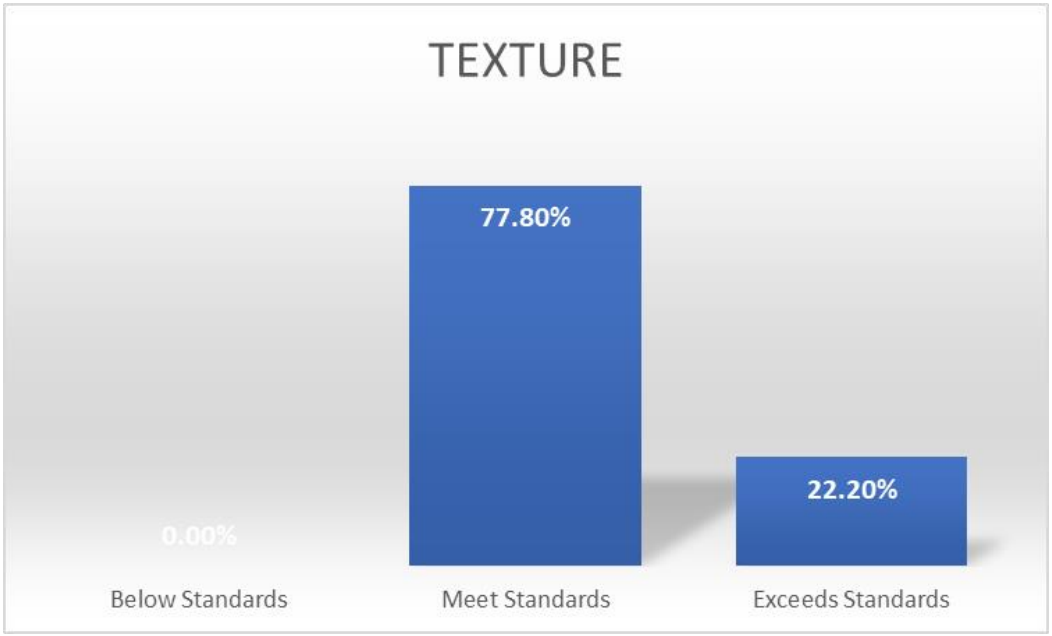
"nindot siya kay madala dala ra" (It's nice because it's portable.)-***P7***

"Satisfied, because it can fit in a bag and be accessible anywhere" -***P8***

"Para nako miss sa nindot gyud bitaw ni iyung device kay madala dala ra then dili sad siya bug at." (For me, miss, this device is really good because it's portable and not too heavy.)" -***P9***

The feedback from the participants highlights a favorable opinion of the Braille Tactile Audio Device (BTAD), emphasizing in particular that its mobility is a crucial feature. Their contentment with the device's portability demonstrates how important it is for addressing students' mobility demands in educational settings. This encouraging response is consistent with the larger emphasis that academics like Mooney (1997) and Pressman (2001) place on the importance of portability in the creation of software products. The BTAD's emphasis on portability makes it compliant with modern software design standards, guaranteeing its flexibility in a variety of settings and boosting its competitiveness in the market. It is advised that portability be given top priority in the device's design and development going forward, with its size, weight, and packaging optimized for optimal convenience. Furthermore, attention must be directed on resolving any potential portability-related issues.

Texture



A total of nine respondents completed the research instrument. Among them, 77.8% of participants indicated that the texture of the BTAD met their standards, while 22.2% reported that it exceeded their standards. Additionally, all participants reported no issues with the BTAD. Consequently, the theme "Texture Consistency of the BTAD" emerged from this analysis.

Theme 5: Texture Consistency

This theme investigates participants' perspectives regarding the tactile qualities of the BTAD (Braille Tactile Audio Device). Findings indicate that all participants were satisfied with the device's texture, with no concerns noted. Texture is pivotal in product evaluation, as it significantly impacts consumers' perceptions and can foster more favorable attitudes toward the product (Berends, 2016). The following statements represent the direct, unaltered feedback provided by the participants.

"No problem sa texture"-***P2***

"Sakto ra inyo siyang gi plastic kay if metal or wood, dilikado siya" -***P3***

"More on safety, and since I touched everything it's not that sharp" - ***P4***

"Okay ra siya , standard ang texture (It's good. The texture is standard)" - ***P5***

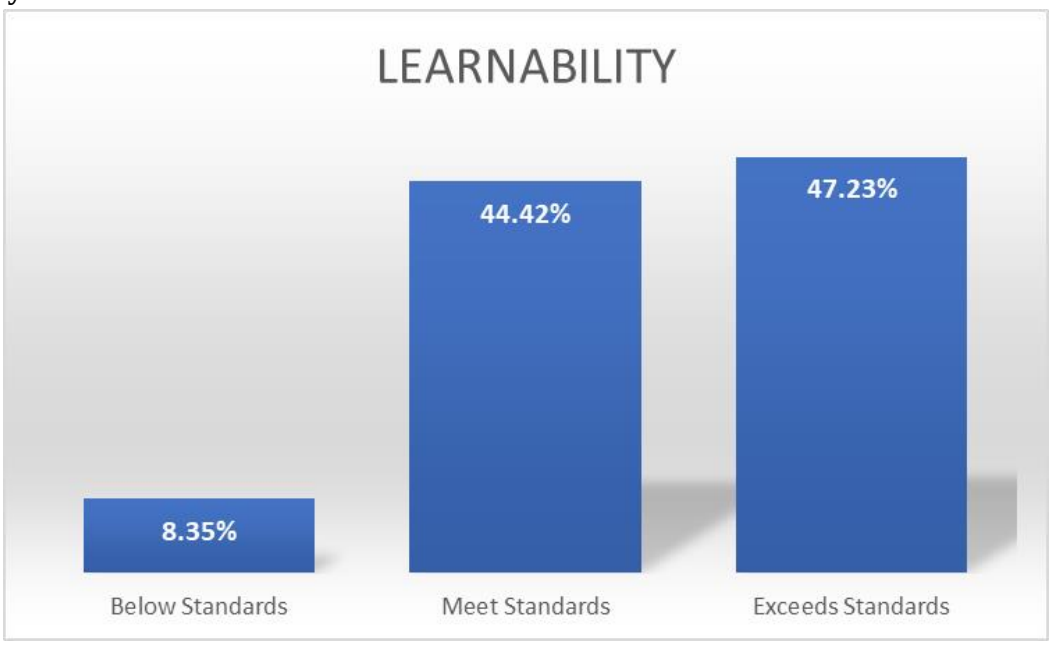
"Di ngilo sa kamot, okay ra siya sa kamot (Not irritating to the hands, it's okay to hold.) - ***P6***

No problem with texture" - ***P7***

"Nindot ra siya miss wala ray ignon rough na dapit sa device wala rasay hait bitaw okay ra siya miss gyud. (It's a good miss, there's no rough or sharp parts on the device. It's really okay, miss.)" - ***P9***

The direct responses from participants support this idea, showing primarily positive feedback about the texture of the device. A groundbreaking study discovered that making a product feel different by changing its texture can make it seem more valuable. People being willing to pay extra for a specific texture is just as crucial as creating that texture in the first place. Also, if the texture of the BTAD stays the same, users will have a satisfying experience. Therefore, researchers have decided to keep the texture of the BTAD unchanged.

Learnability



Among all the gathered data from the respective participants, 8.35% implied that the learnability of the BTAD was below their standards. In comparison, 44.42% stated that the learnability of the BTAD met their standards, and 47.23% indicated that the learnability of the BTAD exceeded their standards. With that, most of the participants in the area of learnability exceeded, implying that the device is easy to learn.

Theme 6: Ease of Manipulation

This theme underscores the ease of manipulation based on the gathered data from the selected participants. The following statement below verifies the theme.

" Once explained, I understood. Very good for prototype ." **- *P4***

"Dali raman siya ."(It's easy) **- *P6***

*"dili madali-dali og kat on ang device pero og hatagan ko nimug taas- taas na panahon makat on ra gyud, nalimot nako sa braille kay dugay nako nahunong og kat on."(The device isn't easy to learn, but if given enough time, I can definitely learn. I forgot Braille because I stopped learning it for a long time.)- **P6***

"Easy to manipulate." **-*P 7***

*"Easy to use."***- *P7***

*"The device will help me for sure in learning and because of that it's easy instruction, Its okay if it will be easy."- **P8.***

*"Dali ra siya masabtan miss kay naa naman gyud siyay audio na mo sulti sama sa gi pislit nako ang cell one of two ni sulti siya B banana again. Nindot kay ni siya sa mga bata na wala pa gyud maka kat on og ganahan maka learn braille. ."(It's easy to understand, miss, because it also has audio that speaks like when I press the cell one of two, it says 'B banana again.' It's good for children who haven't learned or want to learn Braille yet.)- **P9***

*"Ay kamao naman nuon kos mag cell sa braille miss since na tudluan sad ko ba pero nindot kay ni inyung device kay mas mapadali og remember ang mga braille code bitaw sa letter since na siyay audio." (I actually know how to use the Braille cell, miss, since I was also taught. But your device is good because it makes it easier to remember the Braille codes for letters since it has audio)- **P9***

The participants' positive responses on the ease of manipulation have implications for developing assistive technologies. It shows that the user-centered design is critical in developing effective assistive learning technologies. This feature adds usability and effectiveness to the device for learning the Braille language. A systematic review of relevant empirical studies published between 2009 and 2020 revealed that Assistive Technologies has successfully promoted inclusion and accessibility for students with disabilities. According to Smith and Johnson's (2020) research, learning is not a difficulty because anyone, including those who are visually impaired, can pick up the skills necessary to utilize these devices for communication and information access rapidly and efficiently. It follows that the educational resource successfully encourages awareness of and access to Braille education. It also implies that because of how easy it is to use, the device is best suited for novices and small kids. It also implies that the apparatus can overcome the difficulty of the Braille codes and enable the blind to receive an education. In this instance, studying Braille is appropriate with the equipment.

Conclusion and Recommendations

Conclusion

The Braille Tactile Audio Device (BTAD) study's findings provide valuable information on a range of subjects pertaining to its design and usage. The feedback made by the participants on a variety of subjects, including physical attributes, sound quality, weight, texture, and learnability, are often a mix of positive and negative comments. For instance, most participants felt that BTAD was acceptable for them in terms of physical features and also user-friendly. However, several issues with component sizes and durability were found, thus some things can be improved. Similarly, even though portability and texture consistency were valued, recommendations were made to reduce button size and increase sound loudness in order to further enhance the device's usefulness. Given that the BTAD surpasses learnability norms for a large number of the research subjects, this makes it pretty straightforward to manipulate/use. For those who are new to Braille reading or are just starting out, its usability is crucial as an assistive learning aid.

Recommendations

The study results produced several recommendations to ensure that BTAD aligns with the demands of users. First, redeveloping components prone to low durability is crucial. The identified issues with the

work of some of the BTAD's components suggest the need for redeveloping certain elements to make them more durable in the long run. As a result, the developers may manage to diminish the threat of the low importance of the issues experienced by continuous users. On the other hand, enhancing the quality of sound should also be prioritized due to the criticism voiced by the listeners on the issue. The user experience would significantly improve by increasing sound volume and implementing volume adjustment controls, especially for visually impaired individuals who depend on auditory clues. Additionally, the portability and consistency of texture should be optimized to ensure that user comfort is maintained. Even though the device was generally praised for its portability and texture consistency by participants, its size, weight, and texture should be refined consistently to attain maximum comfort and usability. With these priorities in mind during the design process, developers can boost user satisfaction even more while ensuring that the BTAD remains a versatile tool through which Braille education can be done quickly.

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