



Self-Determination in English Learning among Visually Impaired Students: The Role of an AI-Based Braille Audio Dictionary

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Abstract: This study aims to analyze the self-determination of visually impaired students in learning English through the use of a Braille dictionary equipped with Artificial Intelligence (AI)-based audio, viewed from the perspective of Self-Determination Theory (SDT), which includes autonomy, competence, and relatedness. The research employed a qualitative approach with a case study design. Data were collected through interviews with visually impaired students, teachers, and parents and analyzed using thematic analysis through coding procedures. The findings indicate that the competence dimension appeared most dominantly, followed by autonomy, which reflects increased learner independence through the use of assistive technology. The improvement in competence was mainly influenced by the natural and clear AI-generated pronunciation, which enabled students to repeatedly listen to, imitate, and self-correct English pronunciation independently. In addition, the ease of accessing audio through the integrated Braille dictionary supported students' confidence and learning autonomy. Meanwhile, relatedness emerged through interactions with teachers and parents, although it was relatively limited. These findings suggest that the Braille dictionary with AI-based audio has the potential to enhance accessibility, learner independence, and English learning abilities among visually impaired students, thereby supporting more inclusive learning practices.

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Introduction

Inclusive education emphasizes equal access and meaningful participation for all learners, including students with special educational needs (Putri et al., 2026). In Indonesia, this commitment is reflected in Minister of National Education Regulation No. 70 of 2009 and Law No. 8 of 2016 on Persons with Disabilities, which align with global inclusion agendas promoted by UNESCO and the United Nations, particularly Article 24 of the CRPD concerning inclusive education without discrimination. Similarly, UNESCO (2009) highlights that inclusive education must be flexible, learner-centered, and responsive to diversity to ensure meaningful participation for all students. Therefore, both national and international frameworks position inclusive education as a collective effort to create equitable, accessible, and technologically supportive learning environments for every learner.

However, the implementation of inclusive education still faces major challenges, especially the limited availability of adaptive and accessible learning media for students with visual impairments (Nasir et al., 2024). In English learning, students often depend heavily on teachers because instructional materials remain predominantly visual and less supportive of

vocabulary learning and pronunciation practice (Rossiani et al., 2022; Simanjuntak et al., 2025). The limited use of multisensory media also reduces students' independence, confidence, and motivation in learning (Wardhani, 2015; Guanoluisa et al., 2022).

Multisensory learning approaches integrating auditory and tactile modalities are considered effective for visually impaired learners because they improve comprehension, memory retention, and learning independence (Nordin et al., 2024). This approach is supported by Dual Coding Theory (Paivio, 1986), the Zone of Proximal Development (Vygotsky, 1978), and Self-Determination Theory (SDT) (Deci & Ryan, 2000), which emphasize the importance of environmental support and the fulfillment of autonomy, competence, and relatedness in learning motivation.

Recent advances in Artificial Intelligence (AI) provide new opportunities for inclusive English learning through adaptive and interactive technologies (Apriliana, 2025). A Braille dictionary integrated with AI-based audio combines tactile Braille access with natural English pronunciation, enabling students to learn vocabulary and pronunciation more independently (Rossiani et al., 2022). Compared with conventional Text-to-Speech technologies, AI-generated audio offers clearer pronunciation, more natural prosody, and more interactive speech output (Faisol, 2013; Hakim et al., 2025). Through this media, students can regulate their learning pace (autonomy), improve vocabulary mastery and pronunciation (competence), and strengthen social interaction (relatedness) (Andić et al., 2024).

However, previous studies mainly focused on the technical effectiveness of Braille dictionaries and AI audio systems. While Rossiani et al. (2022) discussed Braille dictionaries as assistive media and Hakim et al. (2025) emphasized the accuracy of AI-generated pronunciation, this study specifically examines the psychological impact of AI-assisted learning through the perspective of Self-Determination Theory. The novelty of this study lies in exploring how the integration of tactile Braille with AI-generated audio influences visually impaired students' autonomy, competence, and relatedness in English learning.

Meaningful and deep learning offers substantial benefits, including enhanced conceptual understanding, the ability to transfer knowledge to new contexts, and active engagement in the learning process (Biggs & Tang, 2011). It also supports the development of independence, self-confidence, and self-regulation—competencies that are particularly critical for learners with visual impairments (Wehmeyer et al., 2017). Furthermore, deep learning enables learners to construct meaning reflectively, allowing them not only to memorize language but also to use English functionally and contextually in everyday life (Entwistle & Peterson, 2004 ; Niemiec & Ryan, 2009).

The integration of AI-based audio with Braille dictionaries aligns with SDT because it allows students to independently access, repeat, and regulate learning according to their needs and pace (Deci & Ryan, 2000; Wehmeyer et al., 2017). Braille supports tactile exploration, while AI-generated audio provides immediate pronunciation and vocabulary access, encouraging learning independence and confidence (UNESCO, 2020). These features contribute to the fulfillment of autonomy, competence, and relatedness among visually impaired learners (Deci & Ryan, 2000 ; Niemiec & Ryan, 2009).

Self-determination also involves the ability to make choices, set goals, and regulate learning decisions in everyday contexts (Wehmeyer, 2005), which is essential for sustained learning (Howard et al., 2021 ; Niemiec & Ryan, 2009). Importantly, self-determination is not solely an internal attribute but can be developed through supportive learning environments and interactions (Wehmeyer, 2005). Thus, it can be inferred that self-determination emerges from the dynamic interaction between individual capacities and



conducive environmental supports, including accessible, adaptive, and inclusive educational technologies such as AI-enhanced Braille dictionaries.

The use of an AI-integrated Braille dictionary contributes to the fulfillment of the three psychological needs underlying self-determination (Deci & Ryan, 2000). First, in terms of autonomy, the media enables learners to regulate their learning pace, choose learning times, and independently access vocabulary through QR code-based audio. Second, in terms of competence, the integration of Braille and audio enhances understanding of vocabulary meaning and pronunciation, thereby increasing learners' confidence. Third, in terms of relatedness, improved learning outcomes facilitate better interaction with teachers, parents, and peers in both academic and social contexts. These three dimensions collectively contribute to the development of self-determination among visually impaired students in English language learning. Based on this background, the present study aims to analyze the self-determination of visually impaired students in English language learning through the use of a Braille dictionary integrated with AI-based audio. This study contributes theoretically to SDT and inclusive education research and practically to the development of adaptive, technology-based learning media for students with visual impairments.

Research Method

This study employed a qualitative approach (Creswell, 2018) with a case study design (Yin, 2009) to explore the experiences of visually impaired students in learning English through a Braille dictionary integrated with AI-based audio. The research was conducted at special schools (SLBN) in Rasau Jaya and Mempawah. Participants included six visually impaired junior and senior high school students, supported by two English teachers and six parents as informants.

Preliminary observations and informal teacher interviews conducted at SLBN Rasau Jaya on February 27, 2025, revealed that several visually impaired students showed interest in learning English despite their visual limitations. This interest reflects aspects of self-determination, including learners' self-regulation and motivation (Howard et al., 2021). Data were collected through semi-structured in-depth interviews (Patton, 2002; Sugiyono, 2013) with students and Focus Group Discussions (FGDs) (Nyumba et al., 2018) with teachers and parents. Data collection followed an eight-session English learning intervention using the AI-enhanced Braille dictionary. Interviews and FGDs were conducted during the fourth and eighth sessions, each lasting 2×40 minutes.

The AI technology used in this study was ElevenLabs. The Braille dictionary integrated AI-generated audio through QR codes placed beside Braille entries. Students scanned the QR codes using smartphones with screen-reader accessibility features to access pronunciation audio generated by ElevenLabs. This system enabled students to listen to natural English pronunciation independently while reading Braille text tactually, without requiring embedded hardware.

The research instruments were developed based on the three dimensions of Self-Determination Theory (Deci & Ryan, 2000): autonomy, competence, and relatedness. Data were analyzed using thematic analysis (Braun & Clarke, 2019; Kiger & Varpio, 2020) through coding, theme development, theme review, and interpretation of findings. These stages were not necessarily conducted in a strictly linear sequence, but were revisited and modified as needed to ensure that the resulting themes accurately reflected the overall content and meaning of the data obtained (Salam, 2024). The credibility of the data was ensured through source and time triangulation by comparing interview and FGD data from students, teachers, and parents across different stages of the study.

Braille and English words	Braille for Indonesian translation	Definition	Illustrative examples
(architect)	(arsitek)	(a person who makes plans and drawings to design buildings like houses, schools, and hospitals)	(My uncle is an architect. He designs buildings.)
(scan here)	(scan here)	(scan here)	(scan here)

Figure 1. Braille Dictionary Equipped with Artificial Intelligence–Based Audio

Results and Discussion

This study aimed to analyze the self-determination of students with visual impairments in English language learning through the use of a Braille dictionary equipped with Artificial Intelligence (AI)-based audio, based on the perspective of Self-Determination Theory (SDT) (Deci & Ryan, 2000), which comprises three core dimensions: autonomy, competence, and relatedness. Recent studies have emphasized that SDT remains highly relevant for understanding motivation in inclusive, and technology-mediated learning environments (Ryan & Deci, 2017; Reeve, 2024).

The analysis was conducted through a coding process applied to interview transcripts from students, parents, and teachers in order to identify expressions that represented these three dimensions. The findings are consistent with previous research showing that assistive technology can significantly enhance students' motivation and engagement when it supports psychological needs (Al-azawei et al., 2016; Ok & Rao, 2019).

Table 1. Main Themes Identified from the Interview Data

SDT Dimension	Code	Main Finding	Example Excerpt
Autonomy	Sense of control in learning	Students tended to make repeated attempts when encountering difficulties in using learning devices.	<i>"At first, I try again, and if it still does not work, then I look for another way."</i>
Autonomy	Freedom to choose learning methods	Students selected learning tools such as dictionaries, audio, or digital applications according to their preferences.	<i>"We can listen to the pronunciation of the words through the audio."</i>
Autonomy	Preference for learning methods	Students perceived audio-based learning as helpful for understanding vocabulary.	<i>"It is easier because I can hear the pronunciation of the word."</i>
Autonomy	Confidence in learning	Teachers helped increase students' confidence to try and engage in learning activities.	<i>"The teacher helps me, so I feel more confident to try."</i>
Competence	Ability to understand the material	The instructional media provided comprehensive vocabulary information.	<i>"The information is more complete; all the words are there."</i>

Competence	Ease of learning English	Audio pronunciation supported students in understanding how words are pronounced.	<i>"We can listen to the pronunciation of the words."</i>
Competence	Learning barriers	Technical difficulties were encountered, such as the audio not functioning properly.	<i>"Sometimes the sound does not work."</i>
Competence	Intensity of practice	Students practiced by repeatedly listening to and imitating pronunciation.	<i>"Listening to the pronunciation of the words several times."</i>
Competence	Role of the teacher	Teachers provided additional explanation and instructional support.	<i>"The teacher helps explain it."</i>
Relatedness	Teacher support	Teachers assisted students in understanding the learning materials.	<i>"The teacher helps during learning."</i>
Relatedness	Learning preference	Some students preferred to study independently due to limited peer support.	<i>"There is no friend or family member helping yet."</i>
Relatedness	Classroom learning activities	Students used the instructional media during classroom learning activities.	<i>"We listen to the pronunciation of the words."</i>
Relatedness	Relationship with the teacher	Teachers encouraged students to become more confident.	<i>"The teacher makes me feel more confident."</i>
Relatedness	Suggestions for strengthening connectedness	Students expressed the need for greater social support in the learning process.	<i>"There is still no one helping at home."</i>

Table 2. Frequency of Occurrence of Each Dimension

SDT Dimension	Students (6 students)	Parents	Teachers	Total
<i>Autonomy</i>	29	12	5	46
<i>Competence</i>	30	16	12	58
<i>Relatedness</i>	16	9	6	31

The initial interpretation of the findings indicates that the competence dimension emerged as the most dominant aspect in the data. This aligns with prior studies indicating that assistive technologies, including audio-based and AI-supported tools, often directly enhance learners' perceived competence by improving access to content and clarity of instruction (McNicholl et al., 2019; Hersh, 2008). In addition, the autonomy dimension also appeared quite strongly, as evidenced by students' ability to independently access learning media and regulate their own learning process. This supports Reeve's (2024) findings, which argues that autonomy-supportive environments foster self-regulated learning behaviors, particularly when learners are given meaningful choices.

In contrast, the relatedness dimension appeared relatively less frequently. This finding is consistent with research suggesting that technology-based learning, while beneficial for independence, may reduce opportunities for social interaction if not intentionally designed to include collaborative elements (Al-Jarf, 2026).

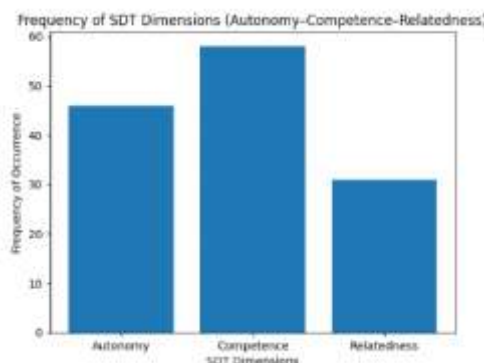


Figure 2. Comparison of Frequency of Occurrence across Dimensions

The graph shows that the competence dimension appeared most frequently, followed by autonomy and relatedness. This indicates that the learning experience was mainly associated with students' improved ability and confidence in learning English. Students reported that the media helped them understand vocabulary, pronunciation, and memorize words more easily, as reflected in statements such as *"I know the meaning now"* (S2), *"the pronunciation is detailed and clear"* (S4), and *"it is easier to remember with Braille"* (S1).

The autonomy dimension was also prominent, as students independently used dictionaries, Braille, screen readers, and digital applications to support learning. Several students explained that they often practiced independently and selected learning methods suited to their needs. In contrast, the relatedness dimension occurred less frequently, indicating that social interaction in learning remained limited. Although teachers and parents provided support, several students preferred studying independently because they felt more focused when learning alone. Overall, these findings suggest that AI-assisted learning media primarily strengthened competence and autonomy, while the social interaction aspect still requires further pedagogical support (Bond et al., 2021).

Autonomy

Based on the interview findings, the autonomy dimension was reflected in students' independent learning behavior. Several students reported that they frequently searched for word meanings independently using dictionaries or digital devices. One student stated that they *"quite often open it repeatedly to look for words"* (S1) and used the dictionary *"every day"* (S1). Other students also showed freedom in choosing learning modalities that suited their needs. For example, one student explained that *"audio is better than a screen reader"* (S2), while another stated that they *"prefer the version with Braille so [they] can know the spelling"* (S4). These findings indicate that students were able to regulate their own learning strategies, consistent with studies showing that assistive technology can strengthen learner autonomy (Ok & Rao, 2019; Al-azawei et al., 2016).

The findings further suggest that the AI-based audio enhanced students' sense of control over learning. The natural pronunciation generated through ElevenLabs enabled students to replay audio independently, adjust their learning pace, and engage in self-correction. Unlike conventional Text-to-Speech (TTS) systems, which are often robotic and monotonous (Faisol, 2013), the AI-generated audio provided more natural prosody and clearer pronunciation, creating a more flexible and engaging learning experience. Within the framework of Self-Determination Theory (SDT), this flexibility is important because autonomy develops when learners feel they have meaningful choices and control over their learning activities (Ryan & Deci, 2017).

The autonomy dimension was also evident in students' confidence in using English. One student stated that they felt *"more confident speaking in English"* (S5), while another

explained that although they felt *“a little shy, it is okay because [they] can try again”* (S6). Repeated access to AI-generated pronunciation appeared to reduce students’ fear of making mistakes and encouraged them to practice English more independently. According to Dalton (2017), flexible learning environments that allow students to choose modalities aligned with their needs can significantly enhance autonomy and engagement, particularly for students with disabilities.

These findings were reinforced by parents and teachers. One parent stated that their child *“studies independently”* and *“uses a mobile phone”* to support learning (P1), while another explained that they *“leave it to the child”* in choosing learning methods (P2). Similarly, teachers reported that students could *“access the material on their own”* (T1). Overall, the findings indicate that the integration of AI-based audio and Braille media strengthened students’ learning autonomy by promoting independence, flexibility, and confidence in English learning (Cheon et al., 2019; Reeve, 2024).

Competence

Based on the interview findings, the competence dimension emerged as the most dominant finding. Students reported that the instructional media helped them better understand English vocabulary and pronunciation. One student stated that the media were *“very helpful”* and made them *“know the meaning”* (S1), while another explained that the pronunciation audio was *“detailed and clear”* (S3). In addition, one student reported that Braille made it *“easier to remember the letters”* (S4). These findings indicate that the integration of Braille and AI-based audio supports students’ comprehension and memory retention.

The strong emergence of competence appears to be influenced by the characteristics of the AI-generated audio developed through ElevenLabs. Compared with conventional Text-to-Speech (TTS) systems, which are often robotic and monotonous (Faisol, 2013), the AI-generated audio provided more natural pronunciation, clearer prosody, and smoother articulation. This enabled students to imitate pronunciation more accurately and confidently. From the perspective of Self-Determination Theory (SDT), competence develops when learners experience mastery and effectiveness in learning tasks (Ryan & Deci, 2017). The AI-generated pronunciation allowed students to repeatedly access accurate pronunciation independently, strengthening their confidence and learning capability.

Teachers also observed significant improvement in students’ pronunciation ability. One teacher stated that a student’s pronunciation was so accurate that *“even some university students might not be able to imitate pronunciation as well as that student”* (T1). This finding suggests that the increased competence was influenced not only by the availability of audio but also by the linguistic quality and realism of the AI-generated speech. These findings support previous studies showing that digital assistive technologies can improve comprehension and skill acquisition among visually impaired learners (McNicholl et al., 2019; Mayer, 2002).

However, several challenges were also identified. One student explained that the *“audio depends on the internet connection”* (S5), while one parent reported that the *“mobile phone was not sufficient to scan the QR code”* (P2). These findings indicate that the effectiveness of AI-assisted learning media remains dependent on technological infrastructure and device accessibility (Al-Jarf, 2026).

Despite these limitations, students demonstrated strong engagement in learning by repeatedly practicing pronunciation, opening the dictionary, and independently searching for word meanings. Overall, the findings indicate that AI-assisted Braille media effectively

strengthened students' competence in English learning through accessible, natural, and repetitive pronunciation support.

Relatedness

Based on the interview findings, the relatedness dimension emerged through teacher support, peer interaction, and family involvement in the learning process. Several students stated that teachers helped them understand the material. One student explained that the teacher *"helped find the letters"* (S3), while another reported receiving praise such as *"good job"* (S6). Teachers also encouraged students to *"keep trying and not be afraid of making mistakes"* (T2). These positive interactions contributed to students' confidence and emotional engagement in learning, consistent with studies emphasizing the importance of teacher–student relationships in fostering motivation and well-being (Roorda et al., 2017).

The AI-based audio also indirectly supported relatedness by reducing students' anxiety in speaking English. The natural pronunciation generated through ElevenLabs enabled students to repeatedly practice pronunciation independently before participating in classroom interaction, making them more confident in communicating with teachers and peers.

Social connectedness was also reflected in peer interaction. Some students stated that they *"sometimes practice together with friends"* (S4) and *"sing English songs together in class"* (S1). However, several students preferred independent learning because it felt *"more comfortable to study alone"* (S5), while another stated that *"there is still no one helping at home"* (S2). One parent also admitted that they *"cannot always assist because of limited English ability"* (P3), although parents still tried to provide internet access and learning support (P1).

Overall, the relatedness dimension appeared weaker than autonomy and competence as the AI-enhanced dictionary mainly supported individualized learning. These findings suggest that while AI-assisted audio improved accessibility and confidence, additional collaborative learning strategies are still needed to strengthen social interaction among visually impaired students (Al-Jarf, 2026; Garbe et al., 2020).

Interrelationship of Data across Students, Parents, and Teachers

The findings show a strong interrelationship between students' experiences, teachers' observations, and parents' perspectives regarding English learning through the AI-enhanced Braille dictionary. This triangulation strengthens the validity of the findings and highlights the importance of multiple perspectives in qualitative research (Creswell & Creswell, 2018).

In the autonomy dimension, students independently used dictionaries, Braille materials, and digital devices to learn vocabulary and pronunciation. Teachers and parents also observed increased independence in learning at school and at home. In the competence dimension, students reported better vocabulary comprehension and pronunciation, findings that were similarly observed by teachers and parents. In the relatedness dimension, students received support from teachers, peers, and parents, although peer interaction remained relatively limited.

Overall, these findings support studies emphasizing that inclusive technology-based learning should address the three core needs of Self-Determination Theory: autonomy, competence, and relatedness (Ryan & Deci, 2017; Bond et al., 2021). The comparison of perspectives among students, teachers, and parents is presented in the following table.

Table 3. Comparative Matrix of Data from Students, Parents, and Teachers

Dimension	Students	Parents	Teachers	Conclusion
Autonomy	Students engaged in independent learning using dictionaries, mobile phones, and Braille materials.	Children studied independently using mobile phones and learning applications.	The instructional media enabled students to learn independently.	Consistent
Competence	The instructional media helped students understand vocabulary and pronunciation.	Parents observed that their children learned more easily when using the media.	Teachers observed improvements in students' pronunciation skills.	Strongly consistent
Relatedness	Students interacted with teachers and peers during classroom learning activities.	Parents provided support from home.	Teachers offered support and praise throughout the learning process.	Moderately consistent

Conclusion

The findings indicate that English learning through the AI-enhanced Braille dictionary supported the fulfillment of the three basic psychological needs in Self-Determination Theory (SDT): autonomy, competence, and relatedness. Among these dimensions, competence emerged as the most dominant, as students showed improvement in understanding vocabulary, remembering words, and imitating English pronunciation through accessible media such as Braille, digital dictionaries, and AI-based audio.

Autonomy also appeared strongly, reflected in students' ability to independently choose and use learning media such as audio, Braille, and digital devices according to their needs. Meanwhile, relatedness was reflected through support from teachers, peers, and parents during the learning process. Teachers provided guidance and motivation, while parents supported learning through devices, internet access, and encouragement at home.

However, the relatedness dimension remained relatively weak, as several students preferred independent learning and experienced limited social interaction during English learning activities. Overall, the findings suggest that accessible AI-assisted learning media can effectively strengthen visually impaired students' competence and autonomy while supporting more inclusive English language learning environments.

Recommendation

The findings support Self-Determination Theory, showing that accessible AI-assisted media can strengthen autonomy, competence, and relatedness among visually impaired students in English learning. The competence dimension emerged most strongly, indicating that Braille and AI-based audio improved vocabulary comprehension, pronunciation, confidence, and learning independence.

Practically, inclusive classrooms should integrate accessible media combining Braille, AI-based audio, and digital technology. Teachers need continuous training in AI-assisted learning tools, while parental support through devices and internet access remains important. Policymakers should also improve internet infrastructure and provide specialized teacher training to ensure equitable implementation of assistive technologies.

This study also identified technical limitations, including difficulties with QR-code scanning and device compatibility issues. Therefore, future media development should include more accessible features, such as tactile QR-code markers and NFC (Near Field

Communication) technology, to simplify access to AI-generated audio for visually impaired learners.

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