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From Touch to Literacy: Multisensory and Collaborative Pathways to Braille Readiness

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Abstract:
This study examined teaching strategies for developing readiness skills among Braille beginners in special pre-primary schools. Braille readiness requires tactile, motor, auditory, spatial, cognitive, and communicative foundations before literacy begins. Yet limited curricula, materials, support, and contextual evidence may weaken preparation. A qualitative phenomenographic design involved three special pre-primary schools. Data from 30 participants were collected through interviews, focus groups, and observations, then analyzed thematically. First, structured and individualized instruction strengthened tactile tracking, listening, memory, confidence, and independence. Direct teaching, additional time, questioning, repetition, and feedback supported differentiated progression. Second, multisensory and experiential activities developed tactile discrimination, concept formation, spatial awareness, and motor coordination. Real objects, songs, movement, and role-play linked experience with Braille symbols. Third, collaborative learning promoted cooperation, orientation, problem-solving, and social-emotional readiness. Its effectiveness depended on motivated teachers, materials, assistive technologies, flexible timetables, manageable class sizes, individualized support, and parental involvement. The study conceptualizes Braille readiness as an ecological capability emerging from instructional, sensory, relational, and institutional conditions. The findings inform curriculum development, teacher preparation, resource allocation, and inclusive early-literacy planning.

INTRODUCTION

Early literacy is a fundamental pathway to educational participation, independence, and social inclusion, making effective preparation for braille literacy a matter of societal importance. For children with visual impairments, access to written language cannot depend solely on auditory information because literacy requires direct engagement with symbols, spelling, punctuation, and text structure. Research shows that braille proficiency is connected with educational and functional outcomes, while technology is increasingly explored as a complement to explicit braille instruction (Hoskin et al., 2024; McDonnall et al., 2025). Early childhood inclusion programs further demonstrate that specialized instruction can strengthen participation and development when learning environments intentionally respond to visual impairment (Jacko et al., 2021). Therefore, preparing children to acquire braille should be understood not as a narrow special-education concern, but as an equity issue that shapes later access to curriculum, communication, autonomy, and meaningful participation.

This societal importance is urgent during the pre-primary years because readiness for braille depends on competencies that develop before reading begins. Tactile sensitivity, positional perception, hand coordination, listening, concept development, and exploration enable children to interpret raised-dot patterns efficiently. Evidence indicates that reading patterns and sensory processing influence tactile reading accuracy, while multisensory approaches can support learners who experience difficulty with tactile-spatial processing (Chen et al., 2023; Mendoza, 2023). Studies of multimodal materials show that children with visual impairments benefit when information is designed through coordinated haptic and auditory channels rather than through visually derived representations alone (Valente et al., 2024). Consequently, early readiness instruction is important because weaknesses at this stage may accumulate into slower decoding, reduced confidence, restricted curriculum access, and dependence on others. Strengthening readiness therefore creates a foundation for equitable literacy development and schooling.

Despite this importance, children with visual impairments encounter educational systems insufficiently prepared to provide individualized, accessible, and developmentally appropriate instruction. Across sub-Saharan Africa, barriers include shortages of specialist expertise, inaccessible learning materials, weak support systems, and environments that do not consistently translate inclusive policy into classroom practice (Le Fanu et al., 2022). Teacher-related barriers are consequential because effective inclusion requires technical competence and confidence in responding to distinctive learning needs of pupils with visual impairment (Watermeyer et al., 2024). Research also demonstrates that access is compromised when physical environments, institutional arrangements, and community attitudes remain unsupportive from the earliest stages of formal schooling (Vanderpuye et al., 2024). These challenges suggest that braille beginners may enter formal literacy instruction without systematic preparation, creating disparities between learners who incidentally acquire visual information and learners who require deliberately structured tactile and auditory experiences.

In Tanzanian special pre-primary schools, the concern is not simply whether braille is taught, but how teachers prepare beginners to become ready for braille. Within the study context, teachers reportedly work without a specific curriculum for braille beginners and therefore employ varied strategies to develop tactile discrimination, fine-motor coordination, listening, spatial awareness, orientation, and pre-braille literacy. This context can produce uneven instructional sequences, differing practice, and inconsistent use of tactile materials across classrooms. Comparable Tanzanian evidence at later school levels shows that teachers' perceptions and practices influence participation of pupils with visual impairment, reinforcing context-sensitive instructional decisions (Anselimus & Kisanga, 2025). Meanwhile, digital braille research demonstrates that learners' performance can vary according to device characteristics and literacy environment (McCarthy et al., 2023). The field phenomenon therefore concerns variability in teacher-selected strategies before formal braille literacy is securely established.

Recent scholarship has advanced braille teaching through complementary directions. Technology-focused reviews have examined digital tools intended to facilitate braille literacy, but evidence remains small and heterogeneous, limiting conclusions about which technologies improve children's learning (Hoskin et al., 2024). Intervention research shows that structured, sequenced training with enjoyable activities and reinforcement can improve braille reading and writing among elementary learners (Abu Shokhedim, 2024). Other work demonstrates that interdisciplinary experiences can

strengthen braille proficiency and content learning when literacy is embedded in meaningful activity (Farrand et al., 2025). Digital reading studies report that refreshable braille displays can support reading and comprehension practice (D'Andrea et al., 2023). However, these studies primarily emphasize formal literacy, school-age learners, interventions, or technologies after braille instruction has begun. They provide less evidence about how teachers systematically cultivate readiness competencies among beginners before conventional braille reading and writing.

Another limitation concerns fragmented treatment of component skills that precede fluent braille literacy. Studies examining braille performance often focus on reading accuracy, reading speed, writing errors, or proficiency after learners have acquired basic braille knowledge (Chen et al., 2023; Aslan, 2025). Emerging multisensory research demonstrates that auditory-haptic experiences can be engaging and reveal differences in sensory preferences among children with blindness or visual impairment (Föcker et al., 2025). Early inclusion research also highlights social participation, peer interaction, and empathy as dimensions of development for young children with visual impairment (Futterer et al., 2023). Nevertheless, these lines of inquiry remain insufficiently integrated into a pedagogical account of readiness instruction in pre-primary settings. A research gap therefore persists regarding which teacher-initiated strategies build tactile, motor, auditory, spatial, conceptual, and motivational readiness, how those strategies are implemented, and how teachers perceive their effectiveness.

The state of the art proposed in this study is a grounded analysis of teaching strategies used specifically to enhance learning-readiness skills among braille beginners before braille literacy becomes established. Rather than treating braille instruction as direct teaching of letters, contractions, or reading fluency, the study conceptualizes readiness as an integrated developmental system involving tactile discrimination, fine-motor coordination, listening, spatial understanding, orientation, concept formation, communication, and sustained engagement. Its novelty lies in connecting these competencies to pedagogical decisions made by teachers in Tanzanian special pre-primary schools, where guidance for braille beginners remains limited. This focus matters because interventions introduced after reading difficulties appear may address symptoms rather than instructional foundations from which difficulties emerge. By documenting how readiness is cultivated in classrooms, the study can identify transferable practices, implementation constraints, and areas requiring curriculum guidance, teacher preparation, materials, or support.

Accordingly, the research problem is that there is insufficient knowledge about teaching strategies used to enhance learning-readiness skills among braille beginners in Tanzanian special pre-primary schools and how those strategies respond to learners' tactile, motor, auditory, spatial, and cognitive needs. The study argues that effective braille preparation is most likely when teachers deliberately combine structured tactile exploration, fine-motor activities, listening and language exercises, orientation experiences, repeated guided practice, meaningful literacy exposure, and individualized support rather than relying on isolated or improvised techniques. Examining these practices will clarify what teachers do, why they select these strategies, and what conditions enable or constrain implementation. The expected contribution is a framework for strengthening pre-braille pedagogy, informing teacher education and curriculum development, and supporting consistent early literacy preparation so braille beginners enter formal reading and writing with stronger readiness, confidence, independence, and capacity to participate.

RESEARCH METHODS

This study used a qualitative approach with a phenomenographic design to examine how teachers, head teachers, and former braille beginners experience and understand the teaching of learning readiness skills in special pre-primary schools. Phenomenography was appropriate because it identifies variations in how individuals perceive a phenomenon rather than testing hypotheses or causal relationships. Teaching readiness skills involves complex experiences influenced by pedagogical knowledge, classroom practices, institutional conditions, and learners' backgrounds. The design therefore helped identify collective categories of understanding related to readiness preparation before formal braille literacy instruction (Tight, 2022). Qualitative research is also valuable in inclusive education because learning experiences are shaped by social, cultural, and institutional factors (Braun et al., 2021).

The study was conducted in three special pre-primary schools in the Iringa, Dodoma, and Tabora regions of Tanzania. The schools were purposively selected because they provide specialized education for children with visual impairments and have experience preparing beginners for braille literacy. The study involved 30 participants: three head teachers, six specialist teachers, and 21 former braille beginners. Head teachers and teachers were purposively selected based on their professional knowledge and involvement in braille preparation. In contrast, former braille beginners were selected through convenience sampling to provide retrospective accounts of their early learning experiences. These sampling methods are commonly used to recruit information-rich participants in qualitative educational research (Campbell et al., 2020; Busetto et al., 2021).

Table 1. Participants' Characteristics and Identification Codes

Research Site	Participant Category	Sampling Strategy	Identification Code	Number of Participants	Total
School M	Head Teacher	Purposive sampling	HTM	1	
	Specialist Teachers	Purposive sampling	MT1–MT2	2	
	Former Braille Beginners	Convenience sampling	MP1–MP7	7	**10**
School F	Head Teacher	Purposive sampling	HTF	1	
	Specialist Teachers	Purposive sampling	FT1–FT2	2	
	Former Braille Beginners	Convenience sampling	FP1–FP7	7	**10**
School B	Head Teacher	Purposive sampling	HTB	1	
	Specialist Teachers	Purposive sampling	BT1–BT2	2	
	Former Braille Beginners	Convenience sampling	BP1–BP7	7	**10**
Total				**30 Participants**	**30**

Data were collected through semi-structured face-to-face interviews, focus group discussions (FGDs), and classroom observations. Interviews with head teachers and specialist teachers explored instructional strategies, challenges, and considerations in developing readiness skills. FGDs with former braille beginners examined their early instructional experiences and transition into formal education. Classroom observations,

supported by checklists and field notes, documented teaching practices, learning activities, teacher-student interactions, and instructional materials. Combining these methods enabled methodological triangulation by comparing participants' accounts with observed practices, thereby strengthening the credibility and depth of the findings (Carter et al., 2021).

The data were analyzed using the six-phase thematic analysis framework developed by Braun and Clarke (2006). The process included data familiarization, initial coding, theme development, theme review, theme definition, and final interpretation. Interview transcripts, FGD data, and observation notes were coded to identify patterns related to teaching strategies, readiness skills, instructional challenges, and contextual influences. A phenomenographic perspective guided the analysis by emphasizing variations in participants' experiences and understandings. The analysis was conducted iteratively to maintain transparency, researcher reflexivity, and clear connections between the evidence and its interpretation (Braun & Clarke, 2021).

Ethical principles were maintained to protect participants' rights, privacy, and well-being. Research approval was obtained from relevant educational authorities, and participants were informed about the study's purpose, voluntary participation, and right to withdraw without consequences. Confidentiality was maintained through coded labels, including HT for head teachers, T for teachers, and P for former braille beginners. Special attention was given to respectful and anonymous representation because the study involved individuals with visual impairments and professionals in specialized educational settings. These procedures supported ethical compliance while preserving the authenticity of participants' experiences (Mertens, 2021).

RESULTS AND DISCUSSION

Results

Structured and Individualized Instruction Enhances Braille Learning Readiness

Structured and individualized instruction was identified as a sequence of teaching practices adapted to the readiness levels of Braille beginners. Teachers adjusted content, pace, repetition, feedback, and learning time through direct teaching, additional instructional sessions, and oral questioning. Direct teaching involved demonstrations, physical or verbal guidance, and the gradual introduction of Braille symbols from simple dot patterns to more complex letters and additional time allowed learners to repeat difficult tasks, while oral questioning helped teachers assess understanding and connect tactile experiences with verbal concepts. These practices supported learners according to their tactile, motor, auditory, cognitive, and emotional needs rather than requiring them to progress at the same pace.

Former Braille beginners described direct teaching as essential for mastering basic Braille configurations. One participant explained, "The teacher guided me in writing full cell dots 1, 2, 3 and 4, 5, 6 on the whole page, then letters a–j. I wrote each letter in a single day until I managed to master all of them" (FGD with former Braille beginner, MP2, 21 March 2024). Another participant reported, "My teacher guided me in those days to write Braille letters using a plate with a lot of holes and small sticks that I put in those holes. I remember I started with the letters a–j. Although it was challenging for me, the teacher took the time to guide me until I was able to perform the task successfully" (FGD with former Braille beginner, FP4, 27 August 2024). These experiences show that dividing Braille learning into manageable stages reduced tactile and cognitive demands while

strengthening dot recognition, finger positioning, hand coordination, and the use of Braille-writing devices.

Teachers also emphasized the importance of flexible instructional time and continuous assessment. One teacher stated, "The extra time as a strategy also helps Braille beginners learn some concepts within a sufficient timeframe, allowing for repetition and learning in chunks. After lunch, it was easier to employ a variety of teaching strategies and materials because there was no time limit" (Interview with teacher, FT1, 28 August 2024). Another explained, "We decided to use extra time after class hours because, among the seven pupils who are blind, four of them were very slow in learning, even with repetition in class" (Interview with teacher, FT2, 28 August 2024). Oral questioning was similarly used to assess comprehension and develop listening skills. A teacher noted, "I found that asking oral questions helped my pupils become better listeners. Sometimes, I created a game where I asked questions in a low voice, and the pupil who listened carefully and answered correctly received a small gift" (Interview with teacher, MT1, 19 March 2024). Individualized instruction therefore involved adjusting time, repetition, task complexity, reinforcement, and teacher support according to learners' responses.

Classroom observations confirmed that structured instruction remained responsive to individual differences. Teachers used predictable routines such as finger exercises, tactile warm-ups, textured Braille charts, object-matching activities, and demonstrations of finger placement. Learners who initially depended on guidance gradually positioned their fingers, identified shapes, assisted peers, and attempted tasks independently. Teachers supported this progress through modelling, guided practice, oral questioning, immediate correction, and the gradual reduction of assistance. Overall, structured and individualized instruction improved Braille readiness by aligning learning demands with learners' developmental capacities. Readiness emerged not merely from exposure to Braille materials, but through deliberate scaffolding that connected tactile exploration, motor control, auditory comprehension, conceptual understanding, and growing learner independence.

Table 2. Interview Evidence on the Influence of Structured and Individualized Instruction

Informant position	Interview excerpt	Indicator
Former Braille beginner, MP2	"The teacher guided me in writing full cell dots 1, 2, 3 and 4, 5, 6 on the whole page, then letters a–j. I wrote each letter in a single day until I managed to master all of them."	Sequential instruction; guided practice; mastery of Braille dot configurations
Former Braille beginner, FP4	"My teacher guided me in those days to write Braille letters using a plate with a lot of holes and small sticks that I put in those holes.... The teacher took the time to guide me until I was able to perform the task successfully."	Concrete modelling; individualized guidance; persistence until task mastery
Teacher, FT1	"The extra time as a strategy also helps Braille beginners learn some concepts within a sufficient timeframe, allowing for repetition and learning in chunks."	Extended instructional time; repetition; chunking of complex content
Teacher, FT2	"We decided to use extra time after class hours because, among the seven pupils who are blind, four of them were very slow in learning, even with repetition in class."	Differentiated pacing; responsiveness to learner variation; additional support
Former	"It was difficult to grasp some of the concepts in class.	Remedial support;

Braille beginner, MP1	Most of the time, my teacher used the extra time to teach me, usually after normal class hours."	individualized pacing; reinforcement beyond regular lessons
Former Braille beginner, MP4	"My fingers were not able to get a sense at their tips; therefore, it took time for me to know the Braille dots. My teacher taught me after class hours."	Tactile-processing difficulty; extended practice; development of fingertip sensitivity
Teacher, MT1	"Asking oral questions helped my pupils become better listeners…. The pupil who listened carefully and answered correctly received a small gift."	Auditory attention; listening comprehension; motivational reinforcement
Teacher, FT1	"I always teach by asking questions, especially after giving them tactile items to explore. Once they understand the features of the tactile objects, they can answer questions confidently."	Formative assessment; connection between tactile and verbal knowledge; learner confidence

The evidence presented in Table 1 demonstrates a consistent relationship between differentiated instructional support and the progressive acquisition of Braille-readiness competencies. Former Braille beginners primarily described instruction in terms of concrete learning experiences: writing dot configurations, manipulating adapted materials, receiving repeated guidance, and practising beyond regular instructional hours. Their accounts provide experiential evidence that early Braille learning involved substantial tactile and motor demands. In particular, the testimony of MP4 indicates that limited fingertip sensitivity affected the speed with which Braille-dot positions could be recognized. The provision of additional time therefore functioned as an accessibility mechanism rather than merely an extension of the school timetable. It compensated for differences in tactile processing, motor control, memory, and prior experience, enabling learners to engage with instructional tasks under conditions appropriate to their individual readiness.

The accounts of FT1, FT2, and MT1, supported by classroom observations, revealed a recurring instructional pattern consisting of teacher modelling, guided performance, repetition, immediate feedback, oral questioning, and gradual independence. Teachers adjusted content, pace, task complexity, and learning time according to learners' performance, while oral questions strengthened attentive listening and assessed comprehension. Additional time and repeated practice reduced pressure on slower learners, improved tactile discrimination, Braille-dot recognition, tool manipulation, and verbal understanding, while also increasing confidence and participation. As competence developed, teachers progressively reduced assistance, allowing learners to initiate and complete tasks more independently. Overall, Braille readiness emerged through a cyclical process of assessment, instructional adaptation, supported practice, consolidation, and progressive autonomy.

Multisensory and Experiential Learning Develops Sensory, Motor, and Communication Skills

Multisensory and experiential learning was operationally identified in the field as an instructional approach that enabled Braille beginners to acquire knowledge and skills through direct engagement with real objects, tactile materials, sounds, bodily movements, role-play activities, and songs. Rather than relying predominantly on verbal explanation, teachers created opportunities for learners to touch, manipulate, compare, classify, smell, listen to, and physically respond to objects and situations encountered in

their immediate environment. In practice, this approach included exploring stones, seeds, fabrics, household utensils, geometric shapes, textured surfaces, animal sounds, and classroom objects, as well as participating in songs involving clapping, body movement, and directional actions. These experiences were considered multisensory because they simultaneously engaged touch, hearing, smell, movement, and verbal communication. They were experiential because learners developed concepts through active participation and direct encounters rather than through abstract descriptions alone.

Interview evidence indicated that the use of real objects and tactile materials strengthened the sensory and motor foundations required for Braille literacy. One teacher stated: "Different strategies used to teach Braille beginners laid the foundations for reading, writing, and listening skills and helped them to read using one or two hands in a straight line. Exploring real materials helped to strengthen their fingers, as well as the use of a slate and a stylus." (Interview with teacher, BT2, 20 May 2024)

This account indicates that interaction with concrete materials was not merely used to make classroom activities more enjoyable. Rather, it functioned as preparatory training for the tactile and motor demands of Braille reading and writing. Manipulating objects of different shapes, sizes, weights, and textures enabled learners to strengthen their fingers, coordinate the movements of both hands, and develop sufficient fingertip sensitivity to distinguish subtle tactile variations. The reference to reading "in a straight line" further suggests that experiential activities contributed to the development of hand-tracking patterns, spatial directionality, and controlled lateral movement. These competencies are essential because Braille beginners must learn to move their fingers systematically across raised-dot configurations without applying excessive pressure or losing their position on the line.

A second interview revealed that role-play extended multisensory learning beyond object manipulation by placing learners in socially and linguistically meaningful situations. A teacher explained: "Role-play strategy helps the Braille beginner to improve the listening and speaking skills necessary for reading. I used to give them different short stories. Some of them narrated the stories themselves in class, and some I read from different children's books. Meanwhile, role-play allows Braille beginners to practise Braille skills in realistic situations, such as navigating a store or reading a menu. We used to visit the library, the kitchen store, and another store with a variety of things such as clothes, soap, shoes, and mattresses." (Interview with teacher, FT2, 28 August 2024)

The statement demonstrates that role-play connected language development, sensory exploration, movement, and practical problem-solving. Through listening to stories, retelling events, taking conversational turns, and simulating daily activities, learners practised receptive and expressive communication in meaningful contexts. Visiting familiar locations and interacting with everyday objects also enabled learners to connect spoken words with physical referents. For example, words such as soap, shoes, clothes, or mattress became meaningful because learners could touch, identify, compare, and discuss the actual objects. The researcher therefore interpreted role-play as a bridge between concrete sensory experience and symbolic literacy. It supported the transition from recognizing objects through touch to understanding that those objects could also be represented through spoken language and, subsequently, through Braille symbols.

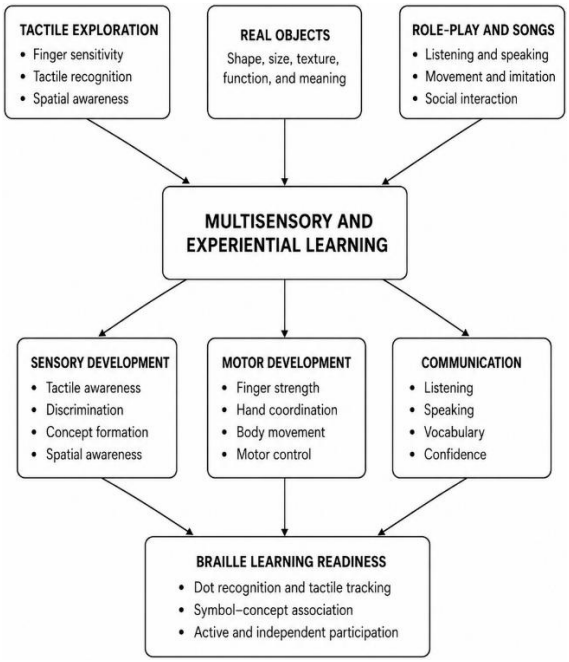

Figure 1. Thematic Network of Multisensory and Experiential Learning in Developing Braille Readiness

Figure 1 illustrates a sequential relationship between instructional strategies and Braille learning readiness among beginners. The use of real objects, tactile exploration, role-play, and songs creates multisensory engagement by activating touch, hearing, movement, smell, and verbal interaction. This engagement facilitates key developmental processes, including sensory discrimination, concept formation, spatial awareness, fine and gross motor coordination, and language development. As these competencies improve, learners demonstrate greater confidence, more active participation, and increased independence in exploring learning materials. Collectively, these outcomes strengthen the foundational abilities required for Braille literacy, particularly tactile tracking, dot recognition, and the association between concrete concepts and Braille symbols.

Classroom and out-of-class observations showed that teachers used varied multisensory and experiential activities, including sorting stones, seeds, fabrics, household objects, and coins; exploring tactile boxes and Braille-cell models; completing puzzles; joining nature walks; and participating in songs and movement exercises. Although learners initially needed verbal prompts and physical guidance, repeated practice improved their ability to distinguish textures, locate and sort objects, trace raised patterns, coordinate both hands, follow instructions, and describe sensory characteristics. These activities demonstrated that tactile awareness, motor coordination, language, memory, spatial understanding, and confidence developed together. Overall, Braille readiness extended beyond exposure to raised dots and required direct experiences that helped learners connect physical objects with verbal concepts, coordinated movement, and symbolic representation.

Table 3. Ideal Influence of Multisensory and Experiential Learning on Braille Readiness

Informant position	Interview excerpt	Indicator
Teacher, BT1	"Braille beginners are expected to acquire a wide range of skills, including listening and speaking, as well as	Integration of auditory, communication, tactile, and

	tactile and fine motor skills. These skills are essential because reading and writing are performed using the fingers, while much information is accessed through listening."	fine motor competencies
Teacher, BT2	"Exploring real materials helped to strengthen their fingers, as well as the use of a slate and a stylus."	Finger strength, tactile readiness, and manipulation of Braille-writing tools
Teacher, FT2	"Role-play strategy helps the Braille beginner to improve the listening and speaking skills necessary for reading."	Listening comprehension, expressive communication, and meaningful language use
Teacher, BT2	"We exposed Braille beginners to various animal and bird sounds through recorded songs and role-play activities, where they imitated the sounds they heard."	Auditory discrimination, imitation, memory, and active participation
Former Braille beginner, MP4	"The teacher gave us many different pieces of cloth with different textures to sort and put in different baskets that looked alike. Sometimes, she gave us sandpaper with different textures and asked us to distinguish the differences."	Tactile discrimination, classification, comparison, and fingertip sensitivity
Former Braille beginner, FP2	"The teacher gave us various objects with different shapes, such as wooden objects, rubber balls, and plastic stars, to explore using our hands. We were then asked to group them based on their shape or texture."	Shape recognition, object classification, fine motor coordination, and concept development
Teacher, MT1	"I used to prepare wooden boards with different shapes inside, like puzzles…. At first, it took 25 to 30 minutes, but after a few days, they managed to arrange them within 5 to 8 minutes."	Spatial awareness, problem-solving, improved accuracy, and task efficiency
Teacher, BT2	"I would ask a pupil to feel each item and then sort them into groups based on texture or size…. With repeated practice and guidance, they became more confident and accurate."	Repeated tactile practice, sensory comparison, accuracy, and learner confidence

The evidence presented in Table 2 demonstrates that multisensory and experiential learning influenced Braille readiness through several mutually reinforcing developmental domains. The accounts of BT1 and BT2 show that tactile, auditory, motor, and communicative abilities were not treated as separate instructional outcomes. Instead, they were developed through integrated activities in which learners listened to instructions, manipulated objects, described sensory characteristics, and used their fingers and hands to complete practical tasks. The repeated references to finger strength, tactile discrimination, object classification, and tool manipulation indicate that direct sensory experiences provided the motor and perceptual foundations required for the accurate recognition and production of Braille symbols. In this sense, real objects functioned as preliminary literacy resources because they trained learners to explore systematically, compare details, sustain tactile attention, and coordinate purposeful hand movements.

The data indicate that multisensory learning improved learners' performance, confidence, and independence by integrating tactile perception, movement, language, cognition, and emotion. The reduction in wooden-puzzle completion time from approximately 25-30 minutes to 5-8 minutes reflected gains in spatial memory, problem-solving, motor planning, and task familiarity, while sorting, role-play, and songs strengthened analytical touch, auditory attention, verbal expression, and social participation. A consistent pattern emerged in which learners progressed from direct

sensory exposure to conceptual understanding and then to symbolic learning, as experiences with texture, size, shape, temperature, and spatial position supported later recognition of Braille patterns. Teachers initially provided demonstrations, verbal prompts, and physical assistance, but repeated practice, questioning, and feedback gradually enabled learners to perform tasks more accurately and with less support. Because many activities used familiar objects and everyday situations, the approach also developed practical knowledge, communication, environmental awareness, and functional independence, showing that Braille readiness was closely connected to broader daily-life competencies.

Collaborative and Supportive Learning Environments Promote Holistic Readiness

Collaborative and supportive learning environments were operationally identified in the field as educational settings in which Braille beginners learned through peer interaction while receiving adequate pedagogical, material, institutional, and family support. Collaborative learning was manifested through paired and small-group activities, peer tutoring, shared tactile exploration, collective problem-solving, guided mobility exercises, and turn-taking during Braille-related tasks. A supportive learning environment, by contrast, referred to the enabling conditions that allowed these collaborative practices to function effectively, including the availability of relevant instructional materials and assistive technologies, competent and motivated teachers, flexible curricula and timetables, manageable teacher-learner ratios, individualized educational support, appropriate learning spaces, and parental involvement. Holistic readiness was therefore understood not only as preparation for decoding and producing Braille symbols, but also as the development of communication, cooperation, confidence, orientation, problem-solving, independence, and social-emotional competence.

Table 4. Interview Evidence on Collaborative and Supportive Learning Environments

Interview excerpt	Indicator	Informant
"Collaborative learning is effective for Braille beginners, as it fosters an inclusive and supportive environment that enhances learning outcomes. Most of the time, they work in pairs or small groups to read Braille passages aloud, identify Braille symbols together, or solve tactile puzzles."	Peer-assisted learning, group participation, shared problem-solving, and inclusive classroom interaction.	Head teachers, HTF and HTB
"Collaborative learning encourages Braille beginners to work together, promoting social skills and teamwork. It allows Braille beginners to share materials and resources."	Cooperation, teamwork, resource sharing, and social development	Head teacher, HTM
"The presence of relevant and sufficient instructional materials, motivated and competent teachers, a specific curriculum for Braille beginners, a reasonable duration for teaching, appropriate teacher-to-learner ratios, and the availability of assistive devices are essential."	Material adequacy, teacher competence, curriculum relevance, flexible duration, manageable class size, and assistive technology	Head teachers, HTM and HTB
"Classrooms must have relevant teaching aids for Braille beginners. Teachers' self-efficacy and motivation to teach Braille beginners must be good."	Teacher motivation, professional self-efficacy, and access to instructional resources	Head teacher, HTF
"The presence of special rooms with relevant assistive technologies to allow close supervision and follow-ups one by one and the cognitive ability of the	Individualized supervision, specialized learning spaces, assistive technology, and	Teacher, FT2

Braille beginner are also factors."	responsiveness to additional disabilities	
"In my class, two blind learners require one-on-one assistance. One has mild cognitive disability, and another has speech impairments and often falls behind."	Individualized intervention, multiple disabilities, differentiated support, and teacher workload	Teacher, FT1
"Parents' involvement in providing information about their learners is crucial to allow teachers to plan for an effective Individualized Education Plan."	Parental participation, accurate learner information, and individualized educational planning	Head teacher, HTB

The interview data in Table 4 indicate that collaborative learning enhanced Braille readiness by allowing learners to develop knowledge through interaction rather than isolated practice. Activities such as paired reading, tactile puzzle-solving, sharing Braille materials, and peer assistance strengthened communication, cooperation, confidence, persistence, and Braille-related skills. More capable learners also supported peers who experienced difficulties with tactile discrimination, line tracking, orientation, and mobility by modelling strategies and providing verbal guidance. However, the effectiveness of collaboration depended on adequate teaching materials, assistive technologies, specialized teacher training, flexible instructional time, teacher motivation, and appropriate teacher-learner ratios. Limited resources and overcrowded classrooms reduced opportunities for meaningful group interaction and individualized feedback. Learner diversity also required careful consideration, as some Braille beginners had cognitive, speech, or additional disabilities that affected their participation and learning pace. These learners required differentiated tasks, specialized assessment, structured group roles, and individual support. Parental involvement was therefore essential in providing developmental and medical information needed to prepare suitable Individualized Education Plans and ensure that additional learning needs were properly addressed.

Classroom observations confirmed that collaborative activities, including paired and small-group work, supported Braille beginners in sorting objects, identifying tactile patterns, practising line tracking, and assisting peers during mobility tasks. Learners shared materials, exchanged verbal guidance, corrected mistakes, and encouraged peers, which strengthened communication, trust, responsibility, confidence, and participation. However, insufficient Braille slates, styluses, tactile cards, embossed diagrams, textbooks, and audio devices limited individual practice and often forced several learners to share one tool. Resource shortages, overcrowded classrooms, and rigid instructional arrangements also reduced teachers' ability to provide close supervision and individualized support, particularly for learners with cognitive or communication difficulties.

The findings show that holistic Braille readiness emerged from the interaction of peer collaboration, teacher expertise, adequate resources, institutional flexibility, and family involvement. Through repeated collaborative participation, learners progressed from receiving assistance to explaining tasks, solving problems, supporting peers, and working with greater independence. Nevertheless, meaningful collaboration depended on manageable class sizes, sufficient learning time, accessible materials, assistive technologies, and differentiated instruction. Learners with additional disabilities required more intensive scaffolding, specialized resources, and parental information to guide appropriate support. Thus, collaborative learning was most effective when universal peer activities were combined with targeted interventions that addressed individual learner needs.

Table 5. Ideal Influence of Collaborative and Supportive Conditions on Holistic Readiness

Informant position	Interview excerpt	Ideal influence indicator
Head teachers, HTF and HTB	"They work in pairs or small groups to read Braille passages aloud, identify Braille symbols together, or solve tactile puzzles."	Improved communication, cooperation, tactile problem-solving, and peer-supported literacy
Head teacher, HTM	"Collaborative learning encourages Braille beginners to work together, promoting social skills and teamwork."	Social competence, shared responsibility, empathy, and classroom inclusion
Head teachers, HTM and HTB	"Relevant and sufficient instructional materials, motivated and competent teachers, a specific curriculum, appropriate teacher-to-learner ratios, and assistive devices are essential."	Equitable access, instructional quality, individualized attention, and effective curriculum implementation
Head teacher, HTF	"There should be a special curriculum for Braille beginners, a flexible duration of schooling and timetable, and in-service training of teachers."	Curriculum responsiveness, mastery-based progression, and continuing teacher development
Teacher, FT2	"Special rooms with relevant assistive technologies allow close supervision and follow-ups one by one."	Accessible learning spaces, individualized monitoring, and effective use of assistive technology
Teacher, FT1	"Two blind learners require one-on-one assistance because of additional cognitive and speech impairments."	Differentiated intervention, inclusion of learners with multiple disabilities, and reduced risk of educational exclusion
Head teacher, HTB	"Parents' involvement in providing information about their learners is crucial to allow teachers to plan for an effective Individualized Education Plan."	Home–school collaboration, accurate assessment, and learner-centred educational planning

Table 4 shows that holistic Braille readiness depends on the interaction between structured collaboration and supportive educational conditions. Peer activities develop communication, empathy, teamwork, orientation, problem-solving, confidence, and increasing independence, while teacher competence, adequate materials, assistive technologies, flexible curricula, manageable class sizes, individualized interventions, and family participation ensure that these benefits are accessible to learners with diverse needs. These elements are interdependent because weaknesses in resources, professional support, institutional flexibility, or parental involvement can reduce the effectiveness of collaboration. Overall, peer interaction functions as the immediate learning process, whereas social, pedagogical, technological, organizational, and family support provides the structure that enables collaborative experiences to develop into independent Braille learning.

Discussion

The first finding shows that Braille readiness develops when instruction is structured, sequential, and adjusted to individual pace. This accords with Stewart, Zebehazy, and Holbrook (2022), who demonstrate that assessment-informed Braille instruction can identify reading needs and guide targeted intervention. It also supports McCarthy, Anderson, and Emerson (2023), whose learning-media framework emphasizes learner characteristics, literacy tools, accommodations, and academic performance. The present study extends this literature by showing how assessment principles are enacted through demonstration, repetition, oral questioning, immediate correction, and additional instructional time in pre-primary classrooms. Unlike studies concentrating on

formal assessment instruments, these findings reveal individualization as an ongoing interaction between teacher judgment and learner response. Theoretically, this supports dynamic scaffolding, where readiness emerges through calibrated assistance rather than maturation alone. Practically, teachers should document progress, vary lesson pace, and provide mastery-based opportunities before introducing complex Braille configurations.

The finding also confirms that teacher competence is central to individualized Braille instruction. Farrand, Koehler, and Vasquez (2022) report variation in personnel-preparation programs and argue for common proficiency standards among Braille professionals. The field evidence indicates that sequencing letters, modelling hand movements, and correcting dot-position errors require specialized knowledge, patience, and sustained attention. Tian et al. (2023) show that tactile Braille reading recruits neural systems shaped jointly by sensory modality, reading hand, and spoken language, supporting combined tactile practice and oral language activities. A distinction emerges. Existing studies often examine proficient readers or professional preparation, whereas this research captures how beginners coordinate touch, movement, listening, memory, and confidence. Its theoretical contribution is to conceptualize readiness as a multimodal developmental system. Its practical impact lies in competency-based teacher training, individualized progress monitoring, and protected supplementary instruction for learners requiring slower consolidation.

The second finding, concerning multisensory and experiential learning, is consistent with evidence that children with visual impairment encounter motor-development challenges. Ebrahimi et al. (2024) found disparities in locomotor performance and emphasized the need to assess motor abilities. The present findings explain how schools may address those vulnerabilities through tactile sorting, object manipulation, movement songs, puzzles, nature exploration, and role-play. They also align with Gori et al. (2025), who argue that multisensory, body-based intervention can strengthen spatial and sensorimotor development from early childhood. However, this study moves beyond technology-oriented rehabilitation by demonstrating that locally available materials, including seeds, stones, fabrics, utensils, and environmental sounds, can produce meaningful learning. Theoretically, the result supports embodied cognition because concepts are constructed through coordinated perception, action, and language. Practically, schools can establish low-cost routines that strengthen tactile discrimination, bilateral coordination, spatial understanding, vocabulary, attention, and Braille-symbol recognition.

Evidence concerning tangible play and symbolic activity reinforces the second finding. Cardenas Castaneda et al. (2025) found that audio guidance combined with tactile objects increased interest and conceptual understanding when concepts were introduced and repeated. Similarly, Federici et al. (2025) identified relationships among pretend play, storytelling, creativity, and emotional regulation, while noting symbolic-play performance among children with congenital visual impairment. The present research agrees that role-play and songs cultivate communication, imagination, memory, and social participation, but adds a literacy-specific pathway. Sensory encounters generate concepts, which are verbalized, organized, and later associated with Braille symbols. This mechanism contributes theoretically by linking experiential learning to symbol formation rather than treating play as enrichment. Its practical contribution is an integrated design combining tactile exploration, oral description, movement, music, and

simulated routines. The expected impact includes engagement, functional vocabulary, independence, and transferable pre-literacy competence.

The third finding demonstrates that readiness is socially and institutionally produced, not merely acquired through individual practice. Anđić et al. (2024) found that cooperative activities supported verbal and nonverbal interaction, durable knowledge, and perceptions in inclusive classrooms using tangible materials. This corresponds with peer assistance in tactile discrimination, mobility, line tracking, and problem-solving. Parker et al. (2024) identified parental participation, tailored instruction, and accommodations as supports for learners with visual impairment, while reporting reduced social richness in distance-learning contexts. The present study confirms both positions but highlights a contextual tension: peer collaboration can foster confidence and responsibility, yet scarce materials and high teacher–learner ratios may convert collaboration into compensation for shortages. Theoretically, this supports an ecological account of readiness involving relationships, resources, and organizational structures. Practically, schools must design peer roles while ensuring materials, supervision, family communication, and individualized support.

Across the three findings, the study's novelty lies in integrating instructional, embodied, relational, and structural conditions within one model of Braille readiness. Fernández-Batanero et al. (2022) conclude that assistive technology can improve accessibility and inclusion, although training and institutional access constrain implementation. Mercuriali et al. (2025) advocate interdisciplinary, family-centred evaluation that combines perspectives and caregiver participation. This study advances those arguments by demonstrating that technology and collaboration become effective when anchored in sequenced teaching, tactile experience, pacing, and social interaction. The contribution is not an inventory of strategies, but an explanation of how strategies operate together: structure stabilizes learning, multisensory experience builds competencies, and supportive relationships enable transfer toward independence. The impact includes a framework for curriculum design, teacher development, resource allocation, individualized planning, and engagement. Theoretically, readiness is reframed as an emergent ecological capability rather than a fixed learner prerequisite.

CONCLUSION

This study concludes that Braille readiness is an emergent capability shaped by structured instruction, multisensory experience, and supportive social and institutional conditions. Learners progress more effectively when teachers sequence tasks, adapt instruction to individual pace, provide repeated tactile and oral practice, and connect Braille symbols with meaningful objects, language, movement, and peer interaction. The study proposes an ecological model that integrates instructional, sensory-motor, communicative, relational, and structural dimensions, offering practical implications for curriculum design, teacher preparation, individualized planning, resource allocation, and inclusive Braille programmes. However, the findings are limited by the qualitative design, small and geographically concentrated sample, and context-specific data. Future research should examine the model across broader populations using longitudinal and mixed-method approaches and assess how teaching strategies, technology, teacher competence, family involvement, and learner characteristics influence Braille fluency, independence, communication, and academic participation.

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