

Adaptive Traditional Assistive Technology to Support the Motor Development of Children with Special Needs in Early Childhood Education: An Ethnographic Study of Inclusive Pedagogical Practices

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ABSTRACT

Background. Inclusive early childhood education requires learning environments that accommodate the diverse motor abilities and participation needs of children with special educational needs. Traditional play tools have strong cultural and pedagogical value, yet their potential as low-tech assistive technology remains underexplored, particularly when systematically adapted to children's individual motor characteristics.

Purpose. This study aims to explore how traditional play tools are adapted and integrated as low-tech assistive technology to support motor development, participation, and inclusive pedagogical practices among children with special educational needs.

Method. An educational ethnography systematically observed 27 children in one inclusive West Sumatran classroom using observations, interviews, field notes, motor-response records, documentation, and teacher-mediated adaptation analysis.

Novelty. This study reframes culturally familiar traditional play materials as adaptive low-tech assistive technology through individualized modifications and iterative teacher-responsive pedagogy.

Results. Adapted traditional play tools improved accessibility and supported motor engagement, independence, participation, and peer interaction among children with special educational needs. Teacher responsiveness emerged as a key factor in aligning tool adaptations with individual abilities.

Conclusion. Traditional play tools can function as culturally responsive low-tech assistive technology when systematically adapted to children's motor needs. Their effectiveness is shaped by cultural familiarity, functional adaptation, and continuous teacher support.

KEYWORDS

Assistive Technology; Inclusive Education; Motor Development; Traditional Play

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INTRODUCTION

Inclusive early childhood education requires the provision of a learning environment that is able to accommodate the diverse characteristics and

developmental needs of each child, including children with special needs. In practice, motor limitations can affect a child's ability to move, manipulate objects, play, and participate actively in various learning activities. These conditions emphasize the importance of providing learning experiences that are adaptive, accessible and appropriate to children's individual abilities so that they have equal opportunities to be involved in the educational process from an early age (Duthois et al., 2026; Lehner-Mear et al., 2026; Serrano et al., 2026).

In West Sumatra, the implementation of inclusive education for children with special needs still faces challenges in providing learning that is truly adaptive to the diversity of children's abilities. Studies of inclusive schools in this region indicate that limited supporting facilities, funding, and educators' understanding of children's specific needs remain barriers to the implementation of inclusive education (Budi et al., 2026; Efendi, 2018). Furthermore, learning strategies that accommodate the differences in individual children's needs have not been implemented evenly, necessitating more flexible and adaptive learning approaches and media (Erwin et al., 2026; Erwin & Kuswandi, 2024; Mudinillah et al., 2024). This situation is increasingly crucial for improving early childhood education, especially for children with special needs who require motor stimulation through play activities that are appropriate to their abilities, characteristics, and socio-cultural environment.

A key issue is that play media and tools in inclusive early childhood education are not always adaptively designed to meet the motor skills of children with special needs. In fact, structured play interventions have been shown to contribute to children's motor skill development (González-Devesa et al., 2025; Hsiao et al., 2026) found that both structured and unstructured interventions significantly improved the basic motor skills of children of gestational age, while Ghorbanzadeh et al. (2024) demonstrated that a play-based approach can improve the motor skills of children with developmental coordination disorders. Other research also suggests that traditional games have the potential to be an affordable, flexible, and culturally based pedagogical medium for improving children's motor competence (Casely-Hayford et al., 2026; Erwin et al., 2023).

On the other hand, assistive technology plays a crucial role in enhancing the function, activity, independence, and participation of children with disabilities through devices that can be tailored to their individual needs (Mahmoudi et al., 2026). However, these studies still leave room for research on how traditional play tools can be adaptively modified into low-tech assistive technology that suits the motor needs of children with special needs and is innovative in inclusive early childhood education practices. This gap underlies the need for research to understand the adaptation process, use, and experiences of teachers and children in utilizing traditional play tools as assistive technology in the context of inclusive pedagogy.

This study uses an ethnographic approach to deeply understand how traditional play tools are adapted and used as low-tech assistive technology in inclusive pedagogical practices in early childhood education (ECE). This approach was chosen because it allows researchers to directly observe patterns of interaction between teachers, children with special needs, peers, and learning media in a natural learning environment. Through participant observation, in-depth interviews, and documentation of learning practices, ethnography can reveal the values, habits, adaptation strategies, and meanings constructed by the school community in using traditional play tools to support children's motor development (Kurniadi et al., 2023; Saearani et al., 2026). This approach also allows researchers not only to assess the function of the tools, but also to understand how this simple assistive technology is accepted, modified, and integrated into the everyday culture of inclusive learning.

The novelty of this research lies in its attempt to position traditional play tools not only as play media, but as low-tech assistive technology that can be adapted based on the motor needs of children with special needs in the context of inclusive early childhood education. This perspective integrates elements of local culture, assistive technology, motor development, and inclusive pedagogical practices within a contextual framework. This research aims to explore how traditional play tools are adapted into low-tech assistive technology, how teachers integrate them into inclusive learning practices, and how their use supports the motor development and learning participation of

children with special needs in early childhood education. Through an ethnographic approach, this research is expected to produce a contextual understanding of the practice of adapting simple learning technology that is relevant, affordable, and appropriate to children’s needs and the socio-cultural characteristics of the educational environment.

METHODOLOGY

Research Design

This study uses an educational ethnography design with an interpretive approach to deeply understand the practice of using traditional play equipment adapted into low-tech assistive technology in inclusive learning in Early Childhood Education .The ethnographic design was chosen because the research focuses on naturally occurring practices, social interaction patterns, learning habits, and the meanings constructed by teachers and children in the use of adaptive play equipment. Ethnography allows researchers to study a group within its cultural context through direct interaction and observation of daily activities over a period of time (Hammersley & Atkinson, 2019).

Specifically, the research aims to observe how teachers select, modify, and use traditional play equipment according to the motor characteristics of children with special needs; how children interact with these equipment; and how these practices are integrated into inclusive learning activities. The research does not position play equipment merely as physical objects, but as part of pedagogical practices and a learning culture formed through interactions between teachers, children, the environment, and learning resources. Data were collected in natural learning situations through participant observation, in-depth interviews, informal conversations, and documentation of learning activities. With this design, the research is expected to produce an in-depth ethnographic description of the transformation of traditional play tools into low-tech assistive technology and their use in supporting the motor development and participation of children with special needs in early childhood education.

Research Subjects and Location

This research was conducted at an inclusive early childhood education (PAUD) in Tanah Datar Regency, West Sumatra. The research location was selected purposively because it provides inclusive education services and has children with special needs involved in play-based learning activities. The research focused on one class of 27 students as a social group observed in the context of everyday learning.

The primary research subjects were the children with special needs in the class, while the other students formed part of the social environment and observed learning interactions. The class teacher and assistant teacher served as supporting informants because they had direct experience selecting, modifying, and using traditional play equipment to suit the children’s needs. The focus of the observations was directed at the process of adapting traditional play equipment, how children with special needs interact with the equipment, the motor responses that emerge during play activities, and the teacher’s strategies for adapting the equipment to the children’s individual characteristics and abilities. The involvement of all students in one class allowed the research to obtain a comprehensive picture of the use of adaptive traditional play equipment in inclusive pedagogical practices and the social interactions that occur naturally.

Table 1. Research Setting and Participants

Aspect	Description
Research location	Inclusive PAUD in Tanah Datar, West Sumatra
Study group	One inclusive classroom
Total students	27 students
Age range	5-6 years
Main participants	Children with special educational needs
Supporting participants	Regular students, classroom teacher, and assistant

Aspect	Description
	teacher
Main focus	Adaptation of traditional play tools as <i>low-tech assistive technology</i>
Observed aspects	Motor skills, participation, interaction, and teacher adaptation strategies

Research Procedures

The research procedure was conducted in stages to understand the adaptation and use of traditional play equipment as low-tech assistive technology in inclusive learning. The study began with mapping the classroom context and the motor skills needs of children with special needs, followed by initial observations, adaptation of play equipment, implementation in learning activities, and data in-depth analysis and interpretation. The entire process was conducted in the natural context of an inclusive class of 27 students.

Table 2. Research Procedures

Stage	Main Activity	Focus
1. Context Mapping	Identifying classroom characteristics, children’s motor needs, and available traditional play tools	Understanding the initial learning context
2. Initial Observation	Observing classroom activities, interactions, and existing play practices	Identifying actual needs and learning patterns
3. Tool Adaptation	Modifying traditional play tools in terms of size, shape, texture, color, or difficulty level	Adjusting tools to children’s motor abilities
4. Implementation and Ethnographic Observation	Using adapted tools in inclusive learning activities	Observing motor responses, participation, and interaction
5. Data Interpretation	Conducting interviews, reviewing field notes, and analyzing documentation	Identifying patterns, meanings, and pedagogical practices

Research Instruments

In this study, the researcher acted as the primary instrument, directly observing, interacting with participants, and interpreting pedagogical practices occurring in the natural classroom environment .To support systematic data collection, several supporting instruments were used, including observation guidelines, semi-structured interview guidelines, field notes, children’s motor response observation sheets, and documentation. These instruments were used in a complementary manner to obtain an in-depth picture of the adaptation process of traditional play equipment, its use in inclusive learning, and the responses of children with special needs during the activities.

Table 3. Research Instruments

Instrument	Participants/Source	Main Focus
Participant Observation Guide	Children and classroom activities	Use of adapted tools, participation, interaction, and learning behavior
Motor Response Observation Sheet	Children with special educational needs	Fine and gross motor responses, coordination, balance, and object manipulation
Semi-Structured Interview Guide	Classroom and assistant teachers	Tool adaptation, implementation strategies, challenges, and perceived changes
Field Notes	Natural classroom setting	Events, interactions, behaviors, and contextual findings
Documentation	Learning activities and adapted play tools	Visual evidence of tool adaptation, implementation, and classroom practices

RESULTS

The findings showed that adapting traditional play tools into *low-tech assistive technology* improved their accessibility for children with special educational needs. Modifications involving size, texture, color, weight, and level of difficulty enabled children to engage more easily in grasping, transferring objects, balancing, and hand-eye coordination activities. Children also demonstrated greater participation, independence, and interaction with peers during inclusive play activities. These findings support previous research showing that structured and play-based activities contribute positively to the development of fundamental motor skills in young children (Veiga et al., 2025) and that traditional games can strengthen movement competence and children's participation in learning activities (Çinar & Hassani, 2026; Fauzi et al., 2023).

Table 4. Summary of Main Findings

Finding	Observed Change
Tool adaptation	Traditional play tools became easier and safer to use
Motor response	Improved grasping, coordination, balance, and object manipulation
Participation	Children were more actively involved in play activities
Independence	Dependence on teacher assistance gradually decreased
Social interaction	Greater interaction with peers during inclusive activities

The findings also revealed that successful adaptation depended on continuous teacher adjustment based on each child's abilities. This reinforces the importance of individualized support because motor performance can vary considerably among children with different developmental characteristics (Ertem et al., 2018). Assistive technology is therefore most meaningful when it is adapted to children's functional needs and supports their activity and participation rather than merely being introduced as a physical tool (Goldstein et al., 2004; Kolehmainen et al., 2011).

Findings suggest that adapting traditional play materials as low-tech assistive technology can create more accessible motor learning experiences for children with special educational needs. Modifications in size, texture, weight, color, and task difficulty appear to reduce barriers to grasping, object manipulation, eye-hand coordination, and balance. These findings are consistent with Chen, (Chen et al., 2024; Wang & Zhou, 2024), who demonstrated that appropriately structured motor activities can enhance fundamental motor development in preschool children. Emphasized that children with developmental disabilities exhibit heterogeneous motor profiles, suggesting that learning materials and activities should be tailored to individual functional abilities (Dewey & Kaplan, 1994; McQuillan et al., 2021; Scharoun Benson et al., 2025).

The use of traditional play materials also provides an important culturally rooted dimension to motor learning. Previous studies have shown that traditional play provides meaningful opportunities to practice coordination, balance, locomotor movement, and object control skills (Suherman et al., 2019). Also found that culturally rooted traditional play can contribute to children's physical competence and physical literacy. This study extends these findings by demonstrating that traditional play materials can be adapted rather than simply adopted, allowing culturally familiar materials to serve as accessible learning supports for children with diverse motor abilities.

Another important finding was increased participation, independence, and peer interaction during adapted play activities. This suggests that the pedagogical value of assistive technology extends beyond motor performance to facilitate children's participation in everyday learning activities. That assistive products should be understood in terms of their capacity to reduce activity limitations and participation restrictions among children with disabilities. Motor competence may also intersect with children's opportunities for social engagement, as emerging evidence suggests a link between motor skills and social behaviors throughout childhood (Ourda et al., 2025). Thus, adapting traditional play materials can simultaneously create opportunities for motor engagement and more inclusive participation with peers.

A crucial finding is that successful adaptation relies not only on physical tools but also on teachers' ongoing pedagogical adjustments. Teachers observe children's responses, modify task difficulty, adjust aids, and reconsider how each tool is used. These findings demonstrate an iterative

pattern of observe-adapt-implement-reflect-readapt, where assistive technology becomes part of a responsive pedagogy rather than a static instructional tool. This interpretation is consistent with evidence that assistive technology is most meaningful when tailored to users' functional needs and embedded in their actual activities and contexts of participation (Neris & Baranauskas, 2012).

Therefore, a key contribution of this study lies in reframing traditional play tools as culturally responsive low-tech assistive technology. While previous studies primarily examined traditional play as an intervention for motor competence (Liu et al., 2025; Pesce et al., 2016), this study highlights how traditional materials can be systematically modified to suit individual motor needs and integrated into everyday inclusive pedagogy. Findings indicate that cultural familiarity, functional adaptation, and sustained teacher responsiveness are three interrelated elements that enable traditional play tools to support inclusive motor learning experiences. This demonstrates a shift from viewing assistive technology solely as a specialized tool to understanding it as an adaptive pedagogical process grounded in the child's abilities, participation, and sociocultural context.

CONCLUSION

This study concludes that adapting traditional play materials as low-tech assistive technology can support more accessible and inclusive motor learning experiences for children with special educational needs in early childhood education. Modifications in size, texture, weight, color, and task difficulty facilitate children's engagement in motor activities, including grasping, object manipulation, coordination, and balance, while supporting greater participation, independence, and peer interaction. These findings demonstrate that culturally familiar play materials can be transformed into functional learning supports when tailored to the child's individual abilities and needs.

This study further highlights that the effectiveness of adapting traditional play materials depends on the interaction of three key elements: cultural familiarity, functional adaptation, and ongoing teacher responsiveness. This iterative process of observe-adapt-implement-reflect-adapt positions assistive technology not simply as a physical device but as a responsive pedagogical practice embedded in inclusive learning. These findings provide conceptual and practical contributions to the development of culturally responsive, affordable, and contextually appropriate "low-tech assistive technologies" for inclusive early childhood education.

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AUTHORING TOOL USE STATEMENT

During the preparation of this manuscript, the authors used ChatGPT (OpenAI) to assist with language refinement, sentence restructuring, and to improve the clarity and coherence of the manuscript. This AI tool was not used to generate or create the research data, results, or references.

AUTHORS' CONTRIBUTION

Author 1: Conceptualization, Conceptualization, Investigation, Methodology, Project administration, Writing original draft, Writing review and editing.

Author 2: Data curation, Investigation, Formal analysis, Validation, Writing - original draft, Writing review and editing.

Author 3: Translation, Transliteration, Language editing, Writing review and editing.

Author 4: Translation, Transliteration, Language proofreading, Writing review and editing.

ETHICAL STANDARDS

This study was conducted in accordance with internationally recognized ethical principles and standards governing educational research involving human participants. Participation was entirely voluntary, and all participants were provided with clear information regarding the objectives, procedures, potential implications, confidentiality safeguards, and intended use of the research data prior to their involvement. Informed consent was obtained from all participants or, where applicable, from their parents or legal guardians. To ensure privacy and confidentiality, all personally identifiable information was anonymized during data collection, analysis, and reporting. The research protocol, including procedures for participant recruitment, data collection, data protection, and ethical risk management, was reviewed and approved by the relevant institutional authorities and/or research ethics committees affiliated with the institutions of Authors 1, 2, and 3, 4.

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