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Development of Sensory Board Media in Rhythm Relay Activities to Stimulate Sensorimotor Skills in Early Childhood

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Abstract

Although various theories emphasize the importance of sensorimotor activities in child development, the application of concrete media, such as sensory boards, in Montessori learning remains limited. Therefore, this study aims to develop and explore the use of sensory board media to enhance the sensorimotor skills of children in Montessori kindergartens. This research follows a Research and Development (R&D) approach involving ten stages of Borg & Gall's educational research and development that the results are summarized in three key results, namely need assessment, development stage, model feasibility and product trial. The instruments used in this study included questionnaires and expert validation sheets. The findings of this study indicate the urgency of developing media that support rhythm relay activities. The results uncovered that the developed sensory board media is highly suitable for use in Montessori learning. The media expert provided a score of 89%, and the content expert rated it at 89.6%. Meanwhile, small-group testing yielded a score of 87.5%, and large-group testing resulted in 88.5%. The study suggests that sensory boards can effectively support sensorimotor development in early childhood students, and further dissemination of sensory board media in rhythm relay activities can further stimulate sensorimotor skills in early childhood.

Keywords: Rhythm Relay Activities, Sensory Board Media, Sensorimotor Skills

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Abstrak

Meskipun berbagai teori menekankan pentingnya aktivitas sensorimotor dalam perkembangan anak, namun penerapan media konkret, seperti papan sensorik, dalam pembelajaran Montessori masih terbatas. Oleh karena itu, penelitian ini bertujuan untuk mengembangkan dan mengeksplorasi penggunaan media papan sensori untuk meningkatkan kemampuan sensorimotor anak di taman kanak-kanak Montessori. Penelitian ini mengikuti pendekatan Research and Development (R&D) yang melibatkan sepuluh tahap penelitian dan pengembangan pendidikan Borg & Gall yang hasilnya dirangkum dalam tiga hasil utama, yaitu penilaian kebutuhan, tahap pengembangan, kelayakan model, dan uji coba produk. Instrumen yang digunakan dalam penelitian ini meliputi kuesioner dan lembar validasi ahli. Temuan dari penelitian ini menunjukkan urgensi pengembangan media yang mendukung kegiatan estafet ritmik. Hasil penelitian menunjukkan bahwa media papan sensori yang dikembangkan sangat layak digunakan dalam pembelajaran Montessori. Ahli media memberikan nilai 89%, dan ahli materi memberikan nilai 89,6%. Sementara itu, uji coba kelompok kecil menghasilkan skor 87,5%, dan uji coba kelompok besar menghasilkan 88,5%. Hasil penelitian ini menunjukkan bahwa papan sensorik dapat secara efektif mendukung perkembangan sensorimotorik pada siswa usia dini, dan penyebaran lebih lanjut dari media papan sensorik dalam kegiatan estafet irama dapat lebih menstimulasi kemampuan sensorimotorik pada anak usia dini.

Kata Kunci: Kegiatan Estafet Irama, Media Papan Sensorik, Keterampilan Sensorimotor

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INTRODUCTION

Early childhood development encompasses a broad range of domains, with sensorimotor development being one of the most crucial, as it forms the foundation for numerous other developmental processes. Sensorimotor development refers to the growth and refinement of a child's ability to interact with their environment through sensory input (such as sight, sound, and touch) and motor skills (such as movement and coordination) (McClelland & Lin, 2021; Deding & Minnaert, 2024). Piaget, in his work on cognitive development, described sensorimotor development as the initial stage of learning, where children explore their world primarily through their senses and motor activities. Through actions such as grasping, reaching, and touching, children not only learn about their environment but also develop essential cognitive skills. These sensorimotor activities play a vital role in strengthening the neural connections in the brain, enhancing the overall cognitive abilities that children will later use for more complex thinking processes (Bago et al., 2020; Nora, 2021).

During early childhood, the integration of sensory and motor functions is still in its developmental phase. Full coordination between the nervous system and the various body parts is yet to be established, which is why it is crucial to engage children in sensorimotor activities that promote this coordination (Azkiya, 2021). These activities are important not only for refining physical movement but also a key to developing a child's sensory perception, such as the ability to differentiate tastes, textures, and sounds-which is foundational for later cognitive, language, and social-emotional development (Solicha & Suyadi, 2021). In fact, sensorimotor skills are so foundational that they influence a child's social relationships and emotional development throughout their early years (Anugrah & Lukman, 2020). Hence, activities that support and stimulate the growth of these skills are vital for children in their formative years.

Effective training activities, particularly those involving both children and teachers, are crucial in early childhood education. These activities give both educators and researchers an opportunity to observe how engaged the children are and how effectively they are developing key skills (Susanti et al., 2020). In early childhood, learning is not a passive experience; it is inherently connected to physical activity and practice. Through hands-on experiences, children learn to focus, concentrate, and engage their motor skills while also developing their intellectual abilities. Therefore, any training activity designed for children must be supported by suitable props or media. The presence of the right tools ensures that the activities are meaningful and target the correct developmental objectives.

In line with that, research of Putri et al. (2018) suggests that children's sensorimotor skills can be enhanced through various play activities, many of which provide opportunities for children to interact with their environment and peers. Building upon this, the current study proposes the integration of rhythm relay as a structured and playful sensorimotor activity. Rhythm relay combines rhythmic elements, such as music and movement, into group activities that are specifically designed to engage children in the development of motor skills. For example, a rhythm relay activity centered around a vehicle theme may involve children pretending to be part of a train, using movement and rhythm as they follow the music. The primary objective is to enhance children's sensorimotor skills while promoting cooperation and socialization among peers.

Specifically, the Montessori Kindergarten in Botubarani serves as one of the primary research sites for this study. Observations conducted at this institution revealed that the children's sensorimotor development was not optimal. While the institution offered some sensory-based activities, such as playdough or playing with textured materials, these activities were generally passive and did not engage the children in meaningful ways (Dapp et al., 2021; Treewong, 2022). Children were often left to engage with these materials individually, with little opportunity for coordinated motor activity or multisensory stimulation. As a result, the activities failed to spark a wide range of sensory responses or foster motor coordination (Blanchet &

Assaiante, 2022). This observation highlighted the urgent need for new educational strategies that could create more dynamic, interactive, and meaningful learning experiences for children, one that effectively integrates movement and sensory input (De Bruyn et al., 2020; Balanev et al., 2022).

The main issue identified was the lack of variety in the media and activities provided for the children. The available activities were repetitive and did not cater to the diverse developmental needs of young children, who require stimulation that engages multiple senses simultaneously. In fact, early childhood is a crucial period for sensorimotor development, as it lays the foundation for cognitive, language, and social-emotional growth. Without proper stimulation, children may miss out on valuable learning opportunities (Adams et al., 2018). This lack of variety in activities also restricted children's ability to explore and develop their physical and sensory abilities fully.

To address these issues, the current study proposes a new approach by introducing rhythm relay as a core activity for sensorimotor development. Rhythm relay is a form of activity that integrates music, movement, and coordination into a structured group setting. In these activities, children respond to rhythmic cues or musical signals with specific movements, such as clapping, stomping, or mimicking the movements of animals, all done in coordination with their peers. This type of activity not only stimulates both fine and gross motor skills but also promotes visual-auditory-motor coordination. Rhythm relay activities are also designed to be both fun and educational, encouraging children to work together, follow instructions, and engage with the rhythm and pace of the music.

Rhythm Relay offers a holistic learning experience that enhances both physical and cognitive development. Through these activities, children can learn to recognize rhythm, synchronize their movements, and practice social skills such as sharing and cooperating with their peers. In addition to promoting motor skills, rhythm relay activities encourage creativity, boost self-confidence, and support emotional regulation—all crucial aspects of early childhood development. By providing children with engaging, multisensory learning experiences, rhythm relay activities can help foster well-rounded growth and development.

In this case, the Montessori Kindergarten in Botubarani offers a unique setting for this study, as the Montessori method of education emphasizes hands-on learning, individualized instruction, and child-led activities. However, despite its focus on active learning, the institution's existing sensorimotor activities were found to be inadequate in meeting the developmental needs of young children. This highlights the importance of integrating new, innovative approaches, such as rhythm relay, into the Montessori curriculum to enhance the effectiveness of the learning process. The incorporation of rhythm relay into the Montessori method offers an exciting opportunity to combine the strengths of both approaches, creating an environment that is engaging, structured, and responsive to the developmental needs of children.

Numerous studies conducted internationally from 2015 to 2025 have provided strong evidence for the effectiveness of rhythm and movement-based activities in enhancing sensorimotor development. For example, as Cason et al. (2015) and Hu et al., 2020) found, Novel Rhythmic Physical Activities (NRPA) were more effective than traditional rhythmic activities in improving locomotor, manipulative, and balance skills in children aged 3-5. Similarly, as Khalil et al., (2013) and Yin et al. (2023) showed, rhythmic training improved general motor coordination and specific skills, such as swimming, in children aged 8-12. Furthermore, it is concluded by Cason et al. (2015) and Drăgoi et al. (2024) that rhythmic physical activities are highly effective in enhancing executive functions, particularly inhibitory control and working memory, in preschool-aged children. Such studies demonstrate the importance of integrating rhythm into early childhood education to support both cognitive and motor development.

Despite these positive findings, many early childhood settings still rely on repetitive, passive activities such as playdough sessions, which do not provide the level of engagement needed for optimal sensorimotor development

(Kaida et al., 2022; Drăgoi et al., 2024). This highlights the importance of creating dynamic, varied, and contextually relevant learning experiences for young children. Recent research calls for the integration of rhythmic activities in early childhood education to foster both motor and cognitive growth and suggests the use of new technologies and culturally relevant methods to make these activities even more effective (Ahmed et al., 2020).

In conclusion, this study aims to contribute by developing a structured, engaging rhythm relay-based sensorimotor activity model that aligns with the developmental needs of young children in Indonesia. By incorporating rhythm and movement into educational practices, the study seeks to enhance the sensorimotor skills of children in early childhood settings, supporting their holistic development and providing a practical solution to the challenges identified in the Montessori Kindergarten at Botubarani.

METHODS

This research adopted a research and development (R&D) approach. The development model utilized was that of Borg & Gall (Gustiani, 2019).

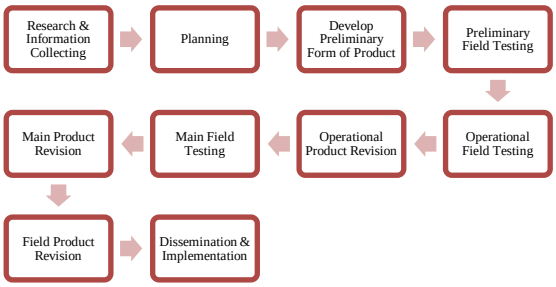

Figure 1. Borg & Gall Research and Development (R&D) Methods

Data collection in this study was conducted in stages, following the development process outlined by Borg and Gall, with specific data collection at each stage as follows (Gustiani, 2019):

The first step is *Research and Information Collecting*, which was conducted through classroom observations, interviews with Montessori kindergarten teachers, and questionnaires distributed to teachers and parents to identify the needs related to sensorimotor learning media. The second step, *Planning*, involved formulating learning objectives, identifying target sensorimotor competencies for early childhood, and organizing material sequences based on curriculum analysis and relevant literature.

The third step was the *Development of the Preliminary Product Draft*, including the visual design of the sensory board media, a list of sensorimotor activities, and a structured rhythm relay activity, which were reviewed through Focus Group Discussions (FGD) with teachers. The fourth step, *Preliminary Field Testing*, was conducted with a small group of children to observe engagement, ease of use, and developmental appropriateness of the activities.

The fifth step, the *Main Product Revision*, was based on user feedback regarding difficulties encountered by children, clarity of instructions, and the attractiveness of the media. The sixth step, *Main Field Testing*, involved testing the revised media with a larger group of children to assess engagement, activity completion rates, and teacher feedback on its effectiveness in larger settings. The seventh step was *Operational Product Revision*, where the media were further improved based on the results of the larger field test, including adjustments to the design, activity sequence, and usage instructions.

The eighth step, *Final Product Development*, resulted in a ready-to-use sensorimotor learning media package complete with a user manual for teachers and parents. However, the ninth step, *Field Product Revision* and the tenth step, *Dissemination and Implementation* as the final evaluation were not conducted in this study. Therefore, this research was limited to the product development phase only.

The evaluation was carried out on a limited scale using a model assessment instrument to assess content feasibility, visual design, activity integration, appropriateness for early childhood characteristics, and the media's potential effectiveness in stimulating sensorimotor development. The result analysis is summarized into three key findings related

to the need analysis, product development, model feasibility, and product testing or trial.

RESULTS AND DISCUSSION

Need Assessment Results

This research was conducted by following the steps of development research outlined by Borg and Gall. To find out the extent of the need for sensorimotor activities in children, the researchers conducted a needs assessment. This analysis was conducted by distributing questionnaires to ten respondents who were children in Montessori Kindergarten. The questionnaire was designed to ask for responses that provide clarity.

Table 1. Need Assessment Results

Item	Response	F	%
Have you ever implemented sensorimotor activities?	Not yet	4	40
	Yes	6	60
	Always	0	0
How do you perceive the sensorimotor activities that have been done?	Pleasant	6	60
	Just normal	4	40
	Boring	0	0
What kind of sensorimotor activities are expected at school?	Pleasant	10	100
	Serious	0	0
	Others	0	0
Learning resources used for sensorimotor activities (multiple choice)	LKS (Student Worksheets)	10	100
	Package book	0	0
	Internet	0	0
	E-books	0	0
	Tutorial videos	0	0
	Learning comics	0	0
	Others	0	0
Do you have a specific handbook for sensorimotor activities?	Yes	5	50
	No	5	50
Have you ever conducted sensorimotor activities using LCD and projector?	Yes	0	0
	No	0	0
	Sometimes	10	100
Do current sensorimotor activity books help develop sensorimotor skills?	Yes	5	50
	No	5	50
Have you ever conducted evaluations of sensorimotor, religious, and moral development?	Yes	0	0
	No	10	100
If new media were created to support sensorimotor development, would you agree?	Agree	10	100
	Disagree	0	0

The needs analysis results, summarized in Table 1, indicate that 60% of the 10 surveyed teachers have implemented sensorimotor activities. Regarding the implementation process of sensorimotor activities, 60% of these teachers described it as enjoyable, while 40% considered it to be average. When asked about the types of sensorimotor activities they expected to have at school, all of the teachers (100%) responded positively. Concerning the learning resources used for sensorimotor activities, all of the teachers (100%) reported using worksheets. Additionally, all respondents confirmed that their school possessed a specialized book for sensorimotor activities. In the context of using LCDs and projectors for these activities, 100% of the teachers indicated that they do so occasionally.

On whether the book illustrations help children understand sensorimotor-related activities, the teachers were split, with 50% answering in the affirmative and the remaining 50% in the negative. When asked if there had been an evaluation of sensorimotor learning activities, all teachers (100%) responded that there had not been any. Finally, when questioned if there was interest in creating media to develop sensory-motor activity in children, all teachers (100%) responded positively. These questionnaire results led to the conclusion that there is a strong desire among teachers to develop sensorimotor activities for children further.

Development Stage Results

At this phase, the researchers initiated the development of a sensory board media. This media consisted of banners, each with specific activities for the children. The banners measured 40 inches and were sequentially numbered. Banner number 1 featured a 'circle play' activity. Banner number 2 was designed

for children to practice jumping on two feet. Banner number 3 displayed an arrangement of blocks for the children to organize. Banner number 4 illustrated children playing with a hula hoop. Banner number 5 engaged children in putting together puzzles. On banner number 6, children had the opportunity to color. Banner number 7 was set up for montage activities. Banner number 8 presented children with geometric shapes to cut out, and banner number 9 was also for montage activities.

This sensory board media set was accompanied by a die labeled with numbers 1-9 to guide the sequence of activities. The sensory board media is illustrated as follows.

Figure 2. Sensory Board Media

Here are the steps for using the sensory board media in early childhood learning activities. Children are asked to line up and wait for their turn in an orderly manner while listening to a song being played. The song serves as a signal to start the activity and helps create a fun and engaging atmosphere. When the music stops, the child whose turn it is steps forward and rolls a die. The die is numbered from 1 to 9, with each number corresponding to a specific banner on the sensory board.

After rolling the die and revealing a number—such as 1 or 5—the child proceeds to the banner on the sensory board that matches the number rolled. The child then engages in the activity shown on that banner, such as circle play, jumping, block-stacking, hula hooping, puzzle assembly, coloring, creating montages, or cutting geometric shapes.

Once the activity is completed, the child returns to the line, and the next child takes a turn. This process continues until all children have had a chance to roll the die and participate in the activity. This method not only stimulates children's sensorimotor development but also fosters discipline, patience, and cooperation in a joyful and energetic learning environment.

Model Feasibility Review

The feasibility of the model was assessed through the design of sensorimotor activities for early childhood using a sensory board as the media. The design of these sensorimotor activities served as an evaluation of the model's feasibility, offering a variety of play activity options. This model was developed with the involvement of experts through expert judgment to determine its level of feasibility. The feasibility test was carried out by distributing questionnaires to experts, including media and material specialists. Each expert provided assessments and suggestions for improving the media and materials related to sensorimotor activities. The goal was to produce a high-quality design or model that could be accepted by users or target audiences, particularly schools. The final results of the expert evaluation have been obtained and are described in the following section.

Media Expert Validation

The validation of media experts was conducted by administering a questionnaire consisting of 18 items to experts who were highly qualified in their respective fields. This validation process refers to the standards of instructional media development as outlined by experts, who emphasize the importance of expert judgment in ensuring media quality and effectiveness. The purpose of this validation was to assess the feasibility, clarity, and appropriateness of the designed sensory board media before it was implemented. The feedback provided by the media experts served to improve the design and ensure that the media supports sensorimotor development in a meaningful and engaging way. The results of the media expert validation are presented in the following section.

Table 2. Media Expert Validation

No	Assessment Aspects	%
1	Suitability of media models with instruments	90
2	Suitability of media to children's characteristics	90
3	The accuracy of the use and benefits of the media	90
4	Accuracy in the use of basic media materials	90
5	The feasibility of sensory board media in introducing sensory motors	85
Average (∑)		89
Criteria		Very feasible

Table 2 shows the results of media expert validation indicating that the suitability of the media model with the instrument received a score of 90%. Additionally, the media's compatibility with children's characteristics and the accuracy of the media's use and benefits also score of 90%. Moreover, the accuracy of using basic media materials obtained a score of 90%. However, the feasibility of the sensory board media model in introducing sensorimotor skills to children was rated at 85%. Consequently, the average score obtained from all aspects is 89%, which falls into the category of "very feasible."

Material Expert Validation

The result of material expert test evaluated the materials and the value of activities related to moral and religious education in children, using an assessment scale ranging from 1 to 5 are as follows.

Table 3. Material Expert Validation

No	Assessment Aspects	%
1	Suitability of material to student needs	90
2	Suitability of sensory board materials and media	90
3	Clarity of letters and words contained in sensory board media	90
4	Ease of understanding the indications on the sensory board media	90
5	Correct use of language	88
Average (∑)		89.6
Criteria		Very feasible

The validation results from material experts regarding the aspects of sensorimotor learning design indicate a high level of suitability. The total scores reflect that the material met student needs with a score of 90%. Additionally, the suitability of the material and media used in the sensory board also achieved a score of 90%. The clarity of letters and words in the sensory board media received a score of 90%, as did the ease of understanding the instructions provided. Furthermore, language accuracy was rated with a score of 90% as well. The overall score derived from all dimensions was 89.6%, indicating a classification of "very feasible".

Product Trial Results

The researchers conducted product trials following Borg and Gall's development stages. The first stage trial, or small field trial, involved five Montessori kindergarten teachers. Materials were created using Canva and printed on a banner measuring 40 inches. Subsequently, the researcher explained the steps for using the printed sensory board media. The contents of the media trials included block games, small circles, hula hoops, puzzles, coloring, stringing, cutting, and montage.

Following revisions, the trial entered the second stage, or the main field trial, which involved ten teachers from the Montessori Kindergarten. The second phase of testing served as a revision of the first phase, with improvements made to media design and material, guided by expert feedback. The product trial applied interactive learning media created through expert testing/expert validity regarding media, materials, and learning. This was achieved by providing an instrument grid in the form of a questionnaire. The following presents the results of the product trials.

Table 4. Product Trials

Trial Category	Score	Criteria
Small Group Trials	87.5%	Very Feasible
Large Group Trials	88.5%	Very Feasible

The results of product trials with Montessori Kindergarten Teachers, as shown in Table 4, categorize the outcomes as 'very

feasible.' In the small field trial involving five teachers, the average feasibility score from the learning media assessment questionnaire was 87.5%, placing it in the 'very feasible' category. Similarly, in the large field trial with ten teachers, the average feasibility score was 88.5%, also categorized as 'very feasible.' The assessment included two teachers who provided decent ratings, while the remaining eight teachers gave very decent ratings. Consequently, the sensory board learning media for introducing children's sensorimotor skills was very feasible for use as a learning medium.

Discussion

The development of rhythm-relay-based sensorimotor activities in early childhood is based on the hypothesis that rhythm-based activities can significantly improve children's cognitive, motor, and emotional development. The close relationship between sensory input and motor skills suggests that optimal sensorimotor experiences can strengthen various domains of child development (McClelland & Lin, 2021; Herth & Jayathissa, 2024). This study examines how the integration of rhythm in learning activities can enrich multisensory experiences that are essential in the early developmental phase.

Based on comparisons with previously published data, the use of media such as sensory boards and rhythm relays has been shown to support children's fine and gross motor development (Bago et al., 2020; Nora, 2021). Recent research highlights that the combination of music, movement, and social engagement in rhythm-based activities can improve concentration, social skills, and motor coordination activities (De Bruyn et al., 2020; Sergeeva, 2021), accelerate the formation of new neural pathways, strengthen brain plasticity, and improve executive functions such as inhibitory control and working memory (Bonacina et al., 2021; Widjayatri et al., 2022; Balıkçı et al., 2023;). These activities also contribute to the development of social-emotional skills, such as emotion regulation and cooperation, which are important for future academic and social success (Cristini et al., 2023; Salim et al., 2023; Williams et al., 2023).

As for further research prospects, there is a need to examine the long-term effectiveness of rhythm relay-based interventions on early childhood development. Longitudinal research is required to assess the extent to which the improvements in motor and cognitive skills obtained are maintained into the next developmental stage (Ruffino et al., 2021; Mahayati et al., 2023). In addition, the adaptation of rhythm relay for children with special needs, such as children with autism spectrum or motor development disorders, is a promising area for further exploration (Ahmed et al., 2020; Fu et al., 2022).

The application of these sensorimotor-based innovations is also expected to be expanded in the context of technology-based education, such as the use of rhythm-based interactive applications to support learning (Rosati, 2024; Treewong, 2022). The implementation of these technologies allows sensorimotor activities to be more widely accessible and adaptive to children's individual needs, reinforcing previous findings that multisensory environments accelerate motor and cognitive development (Gasco-Txabarri & Zuazagoitia, 2022; Utama & Mawardi, 2023). Taking these findings into account, it can be concluded that the development of rhythm relay-based sensorimotor activities is not only innovative but also essential to support optimal early childhood development. This model provides a strong basis for further research and development in the field of early childhood education, especially in creating sensory and motor-rich, adaptive, and inclusive learning environments (Gerker, 2023; Sezgin & Şener, 2024). Future research recommendations include conducting longitudinal studies to evaluate the long-term impact of rhythm relay activities, adapting the model for children with special needs, exploring the use of rhythm-based technologies in learning, and neurophysiological studies to understand neural changes due to sensorimotor engagement. These efforts are important to extend the effectiveness of the approach and enrich future early childhood education strategies.

CONCLUSION

This study demonstrates that the development of sensorimotor activities based on rhythm relays is effective in improving early childhood sensorimotor skills. Using a

Research and Development (R&D) approach based on the Borg and Gall model, this study successfully identified needs, designed, tested, and revised sensory board media that supports rhythm-based activities. The results of validation by media and material experts showed a very high level of feasibility, supported by the results of small and large group trials that achieved scores above 87%. The integration of rhythm, movement, and coordination in the rhythm relay was exhibited to significantly improve children's fine motor, gross motor, and social skills. In addition, it could overcome the limitations of passive sensorimotor activities in previous Montessori institutions. This research confirms the importance of a dynamic multisensory approach to support early childhood cognitive, motor, emotional, and social development. Therefore, this rhythm-based media innovation is highly relevant to be integrated into the curriculum of children's education, especially the Montessori method. In the future, longitudinal research and the development of adaptations for children with special needs, as well as the integration of rhythm-based technology, are recommended to expand the applicability and effectiveness of this model.

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