

Enhancing Early Childhood Creativity Through the Use of Loose Parts Media

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Abstract

Creativity is an important aspect of early childhood development that requires meaningful and exploratory learning experiences. However, evidence on improving creativity through classroom action research in rural early childhood settings remains limited. This study aimed to improve the creativity of 10 children in the Nakula Group at KB Nusa Harapan through loose parts media. The study employed classroom action research based on the Kemmis and McTaggart model, comprising planning, action, observation, and reflection. Data were collected through observations, interviews, and documentation using an observation sheet covering fluency, flexibility, originality, and elaboration. The findings showed progressive improvement in creativity, with children achieving the expected developmental levels increasing from 20% in the pre-cycle to 70% in Cycle I and 90% in Cycle II. The study concludes that iterative loose parts activities supported children's creativity. This approach offers a practical contribution to child-centered, creativity-oriented learning in rural early childhood education.

INTRODUCTION

Creativity is one of the essential aspects of early childhood development that should be stimulated from an early age because it enables children to think flexibly, generate original ideas, solve problems, and adapt to various situations encountered in everyday life. During the golden age period, children possess enormous potential to develop creative thinking through meaningful learning experiences and environments that encourage exploration and active engagement. Creativity extends beyond the ability to produce artistic works; it also encompasses children's capacity to generate ideas, identify alternative solutions, and express imagination in original and meaningful ways (Faizah, 2019; Russ, 2003).

The importance of fostering creativity in early childhood has received increasing attention from researchers because creativity contributes not only to children's cognitive development but also to their social-emotional competence and higher-order thinking skills required in the twenty-first century. Children who demonstrate higher levels of creativity tend to express their ideas more confidently, show greater curiosity, and generate multiple alternative solutions when confronted with problems (Imamah & Muqowim, 2020). Therefore, early childhood education should provide learning environments that encourage exploration, experimentation, and independent knowledge construction, enabling children to

actively develop their creative potential.

Despite the recognized importance of creativity, its development in early childhood education continues to face several challenges. Learning activities remain predominantly teacher-centered, instructional media are often limited, and children are frequently required to produce uniform products that restrict opportunities for divergent thinking and self-expression (Kafolamau & Rahardjo, 2022). Consequently, children tend to imitate examples provided by teachers rather than explore their own ideas and imagination, resulting in less optimal creativity development.

Similar conditions were identified at KB Nusa Harapan, Binangun Village, Karanggayam District, Kebumen Regency. Preliminary observations indicated that most children demonstrated low levels of creativity, as reflected in their limited ability to express ideas independently, low curiosity toward new experiences, and tendency to imitate their peers' work rather than produce original creations. These findings suggest that existing learning practices have not yet provided sufficient opportunities for exploration and creative expression. Therefore, an instructional approach that allows children to explore materials freely and construct their own ideas is required to support creativity development.

One instructional approach considered suitable for fostering children's creativity is the use of loose parts media. Loose parts are open-ended materials that can be moved, combined, separated, redesigned, and reused in various ways according to children's imagination (Flannigan & Dietze, 2018). These materials may consist of natural objects or recycled materials available in children's surrounding environments, including stones, twigs, leaves, seeds, bottle caps, wooden blocks, and other reusable objects. Their open-ended characteristics allow children to determine how materials are used, assign functions, and create diverse products based on their own ideas and experiences.

From a theoretical perspective, the potential of loose parts to enhance children's creativity can be explained through the characteristics of open-ended play. Loose parts encourage children to manipulate, combine, redesign, and reinterpret materials according to their own ideas, thereby creating opportunities for exploration, experimentation, and problem-solving (Flannigan & Dietze, 2018). These exploratory experiences stimulate divergent thinking, enabling children to generate multiple ideas (fluency), use materials in different ways (flexibility), produce unique creations (originality), and refine their ideas into more detailed products (elaboration) (Russ, 2003). Within the context of Classroom Action Research, these opportunities are expected to become progressively stronger through iterative cycles of planning, action, observation, and reflection, allowing teachers to continuously refine learning strategies that support children's creative development.

Numerous studies have demonstrated the potential of loose parts to support various aspects of early childhood development. A systematic review by Gibson et al. (2017) concluded that loose parts play positively contributes to children's cognitive, social, and emotional development. Similarly, Flannigan & Dietze (2018) emphasized that the open-ended characteristics of loose parts encourage children to explore, collaborate, and develop creative thinking through self-directed play experiences. Focusing specifically on preschool children, Cankaya et al. (2023) found that loose parts activities support cognitive development by promoting problem-solving, decision-making, and independent exploration of ideas. These findings were further strengthened by the systematic review of Cankaya et al. (2025), which confirmed that sustained engagement with loose parts enhances divergent thinking and cognitive flexibility. Collectively, these international studies suggest that loose parts provide meaningful learning experiences that support children's holistic development through active exploration.

Similar findings have been reported in the Indonesian context. Previous studies consistently indicate that loose parts support meaningful and child-centered learning while facilitating the development of creativity and higher-order thinking skills. Rahardjo (2019) demonstrated that loose parts effectively support the implementation of STEAM learning through open-ended learning experiences. Likewise, Imamah & Muqowim (2020) and Maarang et al. (2023) found that integrating loose parts into STEAM learning promotes children's creativity through exploratory and constructive activities. Beyond creativity, Dewi et al. (2023) reported that loose parts also contribute significantly to children's cognitive development. These findings collectively demonstrate that loose parts provide

opportunities for children to actively construct knowledge through exploration and meaningful interaction with learning materials.

Research focusing specifically on children's creativity has likewise reported consistent positive outcomes. Farikhah et al. (2022) found that loose parts-based learning enhances children's ability to generate new ideas and produce diverse creations. Similar findings were reported by Kafolamau & Rahardjo (2022), Lismayani & Pratama (2023), Lestari & Priyanti (2024), and Ramadani & Yaswinda (2025), who concluded that loose parts provide children with greater opportunities to imagine, experiment, solve problems, and express their creativity freely. Furthermore, Rahma et al. (2023) demonstrated that implementing the Merdeka Belajar curriculum through loose parts creates more meaningful, flexible, and child-centered learning experiences. Taken together, these studies consistently highlight the important role of loose parts in creating learning environments that foster children's creative expression.

Uyun & Diana (2023) reported that Project-Based Learning activities supported by loose parts increase children's active participation during learning. Similarly, Herlina et al. (2026) demonstrated that integrating Project-Based Learning with loose parts improves young children's cognitive skills, while Masitoh & Fauzi (2026) found that project-based learning emphasizing exploration and creativity provides broader opportunities for children to generate ideas and produce original work. These studies indicate that loose parts have become an increasingly important instructional medium within various pedagogical approaches in early childhood education.

Although previous studies consistently demonstrate the educational benefits of loose parts, several important research gaps remain. First, existing studies have predominantly examined the influence of loose parts on cognitive development, STEAM implementation, project-based learning, and general learning outcomes (Dewi et al., 2023; Imamah & Muqowim, 2020; Maarang et al., 2023; Rahardjo, 2019). Consequently, limited attention has been given to explaining how children's creativity develops throughout the learning process, particularly in relation to the dimensions of fluency, flexibility, originality, and elaboration. Second, experimental studies and literature reviews continue to dominate the existing body of research (Cankaya et al., 2025; Gibson et al., 2017), whereas Classroom Action Research documenting iterative improvements through planning, action, observation, and reflection remains relatively limited. Third, previous studies rarely describe how teachers' reflections and modifications of instructional strategies contribute to the progressive development of children's creativity during classroom implementation. These limitations indicate the need for further investigation employing a Classroom Action Research approach that emphasizes both the learning process and the continuous development of children's creativity.

Based on these research gaps, the novelty of this study lies not merely in the research setting but in its process-oriented approach to enhancing children's creativity through Classroom Action Research. Unlike previous studies that primarily focused on learning outcomes, this study examines how iterative cycles of planning, action, observation, and reflection support the progressive development of children's creativity during learning activities using loose parts media. Furthermore, this study analyzes children's creativity based on four key dimensions, namely fluency, flexibility, originality, and elaboration. This approach provides a more comprehensive understanding of how creativity develops through exploratory play while offering practical insights into the implementation of loose parts in early childhood classrooms. Accordingly, this study addresses the following research question: *How can the use of loose parts media improve children's creativity at KB Nusa Harapan, Binangun Village, Karanggayam District, Kebumen Regency?* Therefore, this study aims to analyze and describe the improvement of children's creativity through play activities using loose parts media among children in the Nakula Group of KB Nusa Harapan during the 2025/2026 academic year.

METHOD

This study employed Classroom Action Research (CAR) based on the Kemmis and McTaggart model, which comprises four interrelated stages: planning, action, observation, and reflection (Kemmis & McTaggart, 2014). Classroom Action Research was selected because it enables researchers and teachers to systematically improve learning practices through iterative cycles of planning,

implementation, evaluation, and refinement within authentic classroom settings (Kemmis & McTaggart, 2014; Prihantoro & Hidayat, 2019). In this study, the CAR approach was implemented to improve children's creativity through play activities using loose parts media while continuously refining instructional strategies based on the results of each reflection cycle.

The research was conducted at KB Nusa Harapan, Binangun Village, Karanggayam District, Kebumen Regency, during the 2025/2026 academic year. The participants consisted of 10 children in the Nakula Group, including six boys and four girls. Participants were selected purposively based on preliminary classroom observations indicating that most children had not yet demonstrated optimal creativity. This condition was reflected in their limited ability to express ideas independently, low curiosity toward new experiences, and tendency to imitate their peers' work rather than develop original ideas.

The study was conducted in two action cycles, with each cycle consisting of three learning meetings. Each cycle followed the four stages proposed by Kemmis and McTaggart. During the planning stage, the researcher prepared lesson plans, designed learning activities using loose parts media, developed observation instruments, and prepared learning materials and classroom facilities. During the action stage, children participated in exploratory play activities using natural and recycled loose parts materials that could be manipulated, combined, redesigned, and used freely according to their own ideas and imagination. Observation was conducted simultaneously with the implementation of the learning activities to record children's creativity development and participation using structured observation sheets. Reflection was carried out collaboratively between the researcher and the classroom teacher by analyzing the observation results, identifying the strengths and weaknesses of the learning activities, and determining improvements to be implemented in the subsequent cycle.

Data Collection

Data were collected through observations, interviews, and documentation. Observation served as the primary data collection technique to assess children's creativity during loose parts learning activities. The observations focused on children's ability to generate ideas, explore various possibilities, produce original creations, and elaborate their ideas while interacting with loose parts materials. Semi-structured interviews were conducted with the classroom teacher to obtain supporting information regarding children's creativity development, classroom learning implementation, and challenges encountered during each action cycle. Documentation, including photographs of learning activities, lesson plans, observation records, and children's work, was collected to support and verify the findings obtained from observations and interviews.

Research Instrument

The primary research instrument was a structured observation sheet developed based on four creativity indicators, namely fluency, flexibility, originality, and elaboration (Russ, 2003). Fluency refers to children's ability to generate multiple ideas during play activities. Flexibility reflects children's ability to use loose parts materials in various ways or from different perspectives. Originality refers to children's ability to produce unique ideas or products, while elaboration describes children's ability to develop ideas into more detailed and meaningful creations. Each indicator was assessed using the early childhood developmental achievement categories, namely Undeveloped (UD), Beginning to Develop (BD), Developing as Expected (DAE), and Very Well Developed (VWD).

To enhance the trustworthiness of the observation data, classroom observations were conducted collaboratively by the researcher and the classroom teacher. Observation results were discussed after each learning session to ensure consistency in interpreting children's creativity indicators before being used as the basis for reflection and planning the subsequent action cycle.

Data Analysis

Quantitative data obtained from the observation sheets were analyzed descriptively by calculating the percentage of children achieving each developmental category in every action cycle. The percentage was calculated by comparing the number of children in each developmental category

with the total number of participants. The results from the pre-cycle, Cycle I, and Cycle II were then compared to identify improvements in children's creativity following the implementation of loose parts-based learning activities.

Qualitative data obtained through observations, interviews, and documentation were analyzed using the stages of data reduction, data display, and conclusion drawing to complement and strengthen the interpretation of the quantitative findings. The integration of quantitative and qualitative findings enabled a more comprehensive understanding of children's creativity development throughout the implementation of the classroom action research.

The success criterion of the study was determined based on the achievement of children's creativity development. The intervention was considered successful when at least 75% of the participating children achieved the developmental categories of Developing as Expected (DAE) or Very Well Developed (VWD). If the predetermined success criterion had not been achieved, improvements identified during the reflection stage were implemented in the subsequent cycle until the expected level of creativity development was attained.

RESEARCH RESULTS

This classroom action research was conducted in two action cycles to improve children's creativity through play activities using loose parts media in the Nakula Group of KB Nusa Harapan. Prior to implementing the intervention, a preliminary observation (pre-cycle) was conducted to identify children's initial creativity levels and to establish baseline data for planning the classroom actions. The preliminary observation revealed that most children experienced difficulties in generating ideas independently, showed limited curiosity toward exploring available materials, and tended to imitate their peers' work rather than produce original creations. These findings indicated that classroom learning had not yet provided sufficient opportunities for children to explore materials freely and express their creativity.

Pre-Cycle Condition

The results of the preliminary observation showed that children's creativity remained at a relatively low level. As presented in Table 1, 30% of the children were categorized as Undeveloped (UD), 50% as Beginning to Develop (BD), and only 20% reached the Developing as Expected (DAE) category. No children achieved the Very Well Developed (VWD) category.

Classroom observations further revealed that many children relied heavily on teacher demonstrations or imitated their classmates' work when completing learning activities. Only a few children attempted to explore different ways of using learning materials or generated ideas independently. Most of the products created by the children were relatively similar, indicating limited originality, flexibility, and confidence in expressing ideas. These findings confirmed the need for an instructional intervention that would provide broader opportunities for exploration and creative expression through the use of loose parts media.

Table 1.

Children's Creativity Achievement in the Pre-Cycle

Category	Percentage
UD	30%
BD	50%
DAE	20%
VWD	0%

Results of Cycle I

Cycle I was implemented through three learning meetings utilizing various loose parts materials collected from the surrounding environment. During these activities, children were encouraged to

arrange, classify, combine, construct, and modify different creations based on their own ideas and imagination while the teacher facilitated exploration through open-ended learning activities.

The observation results demonstrated noticeable improvements in children's creativity compared with the pre-cycle condition. As shown in Table 2, the percentage of children categorized as Undeveloped (UD) decreased from 30% to 10%, while the proportion in the Beginning to Develop (BD) category decreased from 50% to 20%. Conversely, the percentage of children categorized as Developing as Expected (DAE) increased to 60%, and 10% of the children achieved the Very Well Developed (VWD) category.

Besides the quantitative improvement, classroom observations indicated positive behavioral changes. Children became more willing to manipulate various loose parts materials, demonstrated greater curiosity when exploring different possibilities, and showed increased confidence in expressing their own ideas. Several children began creating products that differed from those of their peers, indicating emerging originality and flexibility during play activities. Nevertheless, some children still required teacher guidance to initiate ideas independently and tended to hesitate when faced with open-ended tasks.

Table 2.

Children's Creativity Achievement in Cycle I

Category	Percentage
UD	10%
BD	20%
DAE	60%
VWD	10%

Reflection of Cycle I

Following the completion of Cycle I, reflection was conducted collaboratively by the researcher and the classroom teacher to evaluate the implementation of the learning activities. The reflection indicated that although children's creativity had improved, several challenges remained. Some children were still hesitant to initiate ideas independently and tended to wait for teacher guidance or examples before beginning their work. In addition, the variety of loose parts materials provided during the activities was relatively limited, reducing opportunities for children to explore different possibilities. Teacher questioning also focused primarily on guiding task completion rather than encouraging children to explain, modify, and elaborate their ideas.

Based on these findings, several improvements were planned for Cycle II. First, a greater variety of loose parts materials with different shapes, sizes, textures, and functions was prepared to provide richer exploration opportunities. Second, children were given greater freedom to determine their own ideas without relying on teacher demonstrations. Third, the teacher increased the use of open-ended questions to encourage children to explain their ideas, explore alternative solutions, and further develop their creations.

Results of Cycle II

Cycle II was implemented by incorporating the improvements identified during the reflection stage of Cycle I. The learning activities provided children with broader opportunities to explore loose parts materials independently while the teacher acted primarily as a facilitator who encouraged exploration, questioning, and creative expression.

The observation results demonstrated substantial improvements in children's creativity. As presented in Table 3, no children remained in the Undeveloped (UD) category. The percentage of children categorized as Beginning to Develop (BD) decreased to 10%, while 10% achieved the Developing as Expected (DAE) category. The majority of the children (80%) reached the Very Well Developed (VWD) category.

Classroom observations also showed marked improvements in children's learning behaviors. Compared with Cycle I, children participated more actively throughout the learning activities, independently selected and combined various loose parts materials, generated more original ideas, and confidently explained the purpose of their creations. Children also demonstrated greater persistence in modifying and refining their work without relying heavily on teacher assistance. These observations indicate that children became more independent and actively engaged during exploratory play activities.

Table 3.

Children's Creativity Achievement in Cycle II

Category	Percentage
UD	0%
BD	10%
DAE	10%
VWD	80%

Overall Improvement Across Action Cycles

Overall, the findings demonstrated a progressive improvement in children's creativity throughout the classroom action research process. During the pre-cycle, most children depended on teacher demonstrations and rarely generated ideas independently. Following the implementation of loose parts activities in Cycle I, children became more willing to explore materials and began expressing their own ideas, although several children still required teacher guidance. After the instructional improvements introduced in Cycle II, children demonstrated greater independence, confidence, curiosity, and originality in creating products using loose parts materials.

As presented in Table 4, the proportion of children achieving the Developing as Expected (DAE) and Very Well Developed (VWD) categories increased consistently from 20% in the pre-cycle to 70% in Cycle I and 90% in Cycle II. At the same time, the percentages of children in the Undeveloped (UD) and Beginning to Develop (BD) categories decreased progressively across the two action cycles, indicating continuous improvement in children's creativity throughout the implementation of the classroom action research.

Table 4.

Improvement of Children's Creativity from Pre-Cycle to Cycle II

Category	Pre-Cycle	Cycle I	Cycle II
UD	30%	10%	0%
BD	50%	20%	10%
DAE	20%	60%	10%
VWD	0%	10%	80%

Overall, the findings demonstrated that the proportion of children achieving the developmental categories of Developing as Expected (DAE) and Very Well Developed (VWD) increased from 20% in the pre-cycle to 70% in Cycle I and 90% in Cycle II. Since the predetermined success criterion of 75% was exceeded in Cycle II, the classroom action research was concluded after the second cycle without the need for additional interventions.

DISCUSSION

The findings of this classroom action research demonstrated that the implementation of loose parts media progressively improved children's creativity across two action cycles. The proportion of children achieving the developmental categories of Developing as Expected (DAE) and Very Well Developed (VWD) increased from 20% during the pre-cycle to 70% in Cycle I and further increased to 90% in Cycle II. Beyond the quantitative improvement, classroom observations revealed meaningful behavioral changes. Children became more confident in expressing their ideas, showed greater curiosity

in exploring various materials, demonstrated increased independence in completing learning tasks, and produced more diverse creations than they had during the pre-cycle. These findings indicate that loose parts media create learning experiences that encourage children to actively explore, experiment, and express their creativity throughout the learning process.

The improvement in children's creativity can be explained through the open-ended characteristics of loose parts. Unlike conventional instructional media that often prescribe a single way of completing a task, loose parts allow children to manipulate, combine, redesign, and reinterpret materials according to their own ideas and imagination. Such learning experiences encourage divergent thinking because children are free to generate multiple ideas, experiment with different possibilities, modify their creations, and solve problems independently. Consequently, creativity develops not only through the final products children create but also through the thinking processes that occur during exploration. This interpretation is consistent with the findings of Gibson et al. (2017), who reported that loose parts play contributes positively to children's cognitive, social, emotional, and creative development, as well as with Flannigan & Dietze (2018), who emphasized that open-ended play encourages exploration, experimentation, and independent problem-solving.

Another important finding of this study is that the improvement in children's creativity was supported not only by the use of loose parts media but also by the iterative nature of Classroom Action Research. Reflection conducted after Cycle I enabled the researcher and the classroom teacher to identify several challenges, including children's hesitation in generating ideas independently, the limited variety of loose parts materials, and the need for more open-ended teacher questioning. These reflections became the basis for refining instructional strategies in Cycle II by providing more varied materials, increasing opportunities for independent exploration, and encouraging children to explain and develop their ideas. The progressive improvement observed across the two action cycles suggests that continuous reflection and instructional refinement played an important role in supporting children's creativity development.

The creativity indicators employed in this study further demonstrate how children's creative thinking developed throughout the intervention. Improvements were observed in fluency, flexibility, originality, and elaboration. Initially, most children experienced difficulties expressing ideas independently and tended to imitate their peers' work. Following repeated engagement in loose parts activities, children generated more ideas, explored materials in different ways, produced increasingly original creations, and developed their ideas into more detailed products. These findings support Russ's (2003) theory that play serves as an important context for developing imagination, symbolic thinking, and creative idea generation. They also reinforce Faizah's (2019) argument that creativity develops optimally when children are provided with learning environments that encourage curiosity, exploration, and freedom of expression.

The present findings are also consistent with previous international studies investigating the educational benefits of loose parts. Previous research has shown that loose parts support children's cognitive, social, emotional, and creative development by providing opportunities for exploration, experimentation, and open-ended learning experiences (Cankaya et al., 2023, 2025; Flannigan & Dietze, 2018; Gibson et al., 2017). Collectively, these studies suggest that the flexibility of loose parts encourages children to engage in divergent thinking, independent problem-solving, and creative exploration.

Similar findings have been reported in the Indonesian context. Previous studies have demonstrated that loose parts support STEAM learning, cognitive development, creativity, and child-centered learning environments (Dewi et al., 2023; Imamah & Muqowim, 2020; Maarang et al., 2023; Rahardjo, 2019). Studies specifically focusing on creativity have likewise shown that loose parts encourage children to generate original ideas, explore multiple possibilities, and express themselves more freely (Farikhah et al., 2022; Kafolamau & Rahardjo, 2022; Lestari & Priyanti, 2024; Lismayani & Pratama, 2023; Ramadani & Yaswinda, 2025). Likewise, studies integrating loose parts into Project-Based Learning have reported improvements in children's participation, creativity, and cognitive development (Herlina et al., 2026; Masitoh & Fauzi, 2026; Uyun & Diana, 2023). Together, these findings reinforce the conclusion that loose parts provide meaningful opportunities for children to

construct knowledge through exploration and creative play.

Beyond confirming previous research, this study contributes to the current literature by demonstrating how children's creativity develops progressively through iterative cycles of planning, action, observation, and reflection within a Classroom Action Research framework. While many previous studies have primarily focused on learning outcomes using experimental or descriptive approaches, the present study illustrates the importance of continuously refining instructional strategies based on classroom reflections. This process-oriented perspective provides a more comprehensive understanding of how creativity can be fostered through loose parts media in authentic early childhood learning environments.

The findings also have important practical implications for early childhood education. They suggest that teachers do not necessarily require expensive or sophisticated instructional media to promote children's creativity. Materials readily available in the surrounding environment can be transformed into meaningful learning resources when accompanied by open-ended learning activities and appropriate teacher facilitation. In addition, the findings support the implementation of child-centered learning promoted by the Merdeka Curriculum by encouraging children to actively explore, experiment, make decisions, and express their own ideas during learning activities.

Despite these contributions, several limitations should be acknowledged. First, the study involved only ten children from a single learning group, which may limit the transferability of the findings to other educational contexts. Second, the intervention was conducted over a relatively short period, making it difficult to examine the long-term development of children's creativity. Third, this study focused exclusively on creativity and did not investigate the influence of loose parts media on other developmental domains, such as language development, socio-emotional competence, or problem-solving skills.

Future research is therefore recommended to involve larger and more diverse participant groups, employ different research designs such as experimental or mixed-methods approaches, and examine the use of loose parts across various domains of early childhood development. Future studies may also explore the integration of loose parts with other pedagogical approaches, including Project-Based Learning, STEAM, and environment-based learning, to provide a broader understanding of how exploratory play supports children's learning and development.

CONCLUSION

This classroom action research demonstrated that the implementation of loose parts media contributed to the improvement of children's creativity by providing meaningful opportunities for exploration, imagination, and creative expression throughout the learning process. The findings indicate that combining open-ended learning materials with iterative cycles of planning, action, observation, and reflection enables teachers to continuously refine instructional strategies that foster children's creativity. Therefore, loose parts media can serve as a practical and accessible learning resource for creating child-centered learning environments in early childhood education. Future research is recommended to involve larger participant groups, longer intervention periods, and different research designs to further examine the contribution of loose parts to various domains of early childhood development.

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AUTHOR CONTRIBUTION STATEMENT

FI was responsible for conceptualization, research design, data collection, data analysis, and

preparation of the original manuscript. SS contributed to the research methodology, data analysis, and manuscript review. MA contributed to data collection, documentation, and manuscript preparation. RS contributed to data analysis, validation, and manuscript review and editing. NK contributed to supervision, validation, manuscript review and editing, and final approval of the manuscript. All authors have read and approved the final version of the manuscript for publication.

AI DISCLOSURE STATEMENT

The authors declare that ChatGPT (OpenAI) was used during the preparation of this manuscript for language refinement, academic writing assistance, and manuscript organization. After using the tool, the authors carefully reviewed, verified, and edited all contents as necessary and take full responsibility for the accuracy, integrity, and scientific substance of this publication.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article. The research was conducted independently without any financial, institutional, or personal relationships that could influence the research process, data analysis, interpretation of findings, or publication decisions.

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