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Development of Educational Play Tools to Enhance Early Childhood Creativity: A Literature Review on Design, Implementation, and Effectiveness

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ABSTRACT

Creativity is a fundamental developmental capacity in early childhood because it supports children's ability to generate ideas, explore alternatives, solve problems, express imagination, and adapt flexibly to new learning situations. However, early childhood learning practices still frequently rely on predetermined activities and teacher-directed media that may restrict children's opportunities for exploration and original expression. This literature review aimed to analyze the development of educational play tools for enhancing early childhood creativity by examining three interconnected dimensions: design, implementation, and effectiveness. A systematic literature review with a thematic synthesis approach was employed. Studies published between 2016 and 2026 were identified through Scopus, Web of Science, ERIC, ScienceDirect, Google Scholar, and SINTA/GARUDA. After applying predefined inclusion, exclusion, relevance, and methodological-quality criteria, 15 empirical articles were included in the final synthesis. The findings showed that effective educational play tools were characterized by open-endedness, flexibility, manipulability, multiple affordances, developmental appropriateness, and opportunities for reconstruction. Empirically, the reviewed studies reported improvements in fluency, flexibility, originality, elaboration, imagination, creative product generation, and problem-solving ability. Classroom-action studies using loose-parts media showed creativity mastery increasing from 27% to 93%, while another study demonstrated progressive gains from 33% to 67% and 86% across intervention cycles. Experimental studies involving digital games, educational robotics, and STEM-based design thinking also reported significant improvements in creative-thinking outcomes. The review concludes that educational play tools are most effective when tool design is integrated with child agency, teacher scaffolding, social interaction, and repeated opportunities to create, test, and revise ideas.

KEYWORDS: Educational Play Tools; Early Childhood; Creativity; Loose Parts; Play-Based Learning.

INTRODUCTION

Creativity is increasingly regarded as a fundamental developmental capacity that should be cultivated from early childhood because it supports children's ability to generate ideas, explore alternatives, solve problems, express imagination, and adapt flexibly to new situations. In early childhood education, creativity should not be treated merely as an artistic outcome but as a multidimensional cognitive and socio-emotional process involving originality, flexibility, fluency, imagination, exploration, and the ability to transform experiences into meaningful representations. Empirical evidence further suggests that divergent thinking can contribute to other forms of higher-order cognition even among preschool-aged children; for example, de Chantal et al. (2020) demonstrated that divergent-thinking activities could facilitate deductive reasoning in children aged four to five years. This finding strengthens the argument that creativity stimulation during early childhood has implications extending beyond artistic production to broader cognitive development. Despite its developmental importance, creativity is not always adequately facilitated in early childhood classrooms.

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Learning activities in many settings continue to depend on predetermined worksheets, conventional instructional media, teacher demonstrations, and products that require children to reproduce examples rather than construct their own ideas. Indonesian studies have similarly reported that teacher-centered instruction and limited learning media restrict opportunities for children to explore, manipulate objects, imagine alternatives, and independently create products (Herlina et al., 2026; Widiari et al., 2026). Such conditions are pedagogically problematic because young children learn most effectively when they are actively involved with materials and are allowed to make choices, test possibilities, revise constructions, and communicate their ideas through play.

Educational play tools, therefore, constitute more than supplementary classroom objects. Their pedagogical value depends on the affordances they provide for exploration, manipulation, combination, reconstruction, experimentation, symbolic representation, and social interaction. Open-ended materials such as loose parts are particularly relevant because children can move, separate, combine, redesign, and assign new meanings to the same materials. Wardhani et al. (2021) emphasize that loose materials create opportunities for children to manipulate objects and express imagination, while Eriani et al. (2022) found that loose-parts activities can strengthen creative thinking in early childhood. Contemporary early childhood pedagogy increasingly positions play as a central mechanism for learning. Zosh et al. (2018) conceptualize play as a continuum rather than a strict opposition between free play and direct instruction, highlighting different combinations of child agency and adult guidance. Similarly, guided play has been described as a child-led but adult-supported learning process in which teachers establish purposeful environments while maintaining children's active decision-making (Toub et al., 2018). Recent syntheses reinforce this perspective. Mohammed et al. (2026), in a scoping review covering studies from 2015–2023, found that play-based learning supports cognitive, academic, socio-emotional, independence, and problem-solving outcomes among pre-primary children.

Research has also increasingly examined the characteristics of the materials used during play. Loose-parts media have attracted substantial attention because their non-prescriptive characteristics allow children to construct multiple products from identical objects. Yuliani and Kristiana (2024) reported that natural loose-parts materials provided meaningful opportunities for children aged five to six years to develop creativity through exploratory play. Indonesian literature has likewise documented positive relationships between loose-parts activities and children's creativity, imagination, artistic expression, learning interest, and engagement (Arifianti et al., 2025; Hernawati et al., 2025; Kaenah et al., 2025).

The effectiveness of educational play materials, however, is not determined exclusively by the physical characteristics of the objects. Pedagogical facilitation remains important. Zeng and Ng (2025), for example, demonstrated that teacher questioning during loose-parts play can extend children's exploration and science-process learning. This evidence suggests that effective educational play tools should be designed not only as attractive products but also as pedagogical systems that encourage questioning, experimentation, reconstruction, collaboration, and reflection. Recent scholarship has expanded this discussion through STEAM, project-based learning, makerspaces, and digital play. Qoumariah et al. (2025) identified the potential of STEAM activities supported by loose-parts materials to stimulate early childhood creativity. Makerspace-based interventions have similarly been shown to foster STEM habits of mind while creating environments that encourage creative making and positive socio-emotional development. Meanwhile, Chu et al. (2024), through a systematic review of digital play, reported that digital technologies can contribute to children's learning, creativity, pretend play, and problem-solving when their use remains interactive and developmentally meaningful. The emerging literature on toy-based pedagogy also indicates that both conventional and digital toys can support children's learning and holistic development when integrated into pedagogically purposeful environments.

Although research generally supports play-based environments and open-ended materials, the evidence base remains fragmented. First, many studies investigate a single medium particularly loose parts, digital games, pretend play, or STEAM materials without synthesizing the design principles shared across effective educational play tools. Second, studies often focus on whether an intervention improves creativity but provide insufficient explanation of which design characteristics generate that improvement. Third, implementation variables such as teacher scaffolding, children's freedom of choice, material accessibility, cultural relevance, safety, age appropriateness, collaborative opportunities, and repetition or redesign are not

consistently integrated into analytical frameworks. These limitations are especially significant because the relationship between play and creativity is not automatically causal. Research on pretend play, for example, has identified substantial conceptual and measurement inconsistency, making it difficult to establish definitive developmental mechanisms (Lillard et al.'s literature is revisited in contemporary measurement research; Howe et al., 2019). Recent evidence likewise suggests that the benefits of play may vary according to the structure of play and the degree of adult guidance rather than simply the presence of play itself. Consequently, educational play tools should not be assumed to promote creativity merely because they are labeled "educational" or "play-based."

A further gap concerns literature integration. Recent reviews have examined play-based learning broadly, digital play, loose parts, or particular developmental outcomes, but relatively limited literature has simultaneously connected educational-play-tool design, classroom implementation processes, and evidence of effectiveness specifically for early childhood creativity. The most recent ecological review of 74 empirical studies published between 2015 and 2025 also demonstrates that early childhood creativity is influenced by interconnected factors including play, STEM, technology, arts, teachers, peers, families, educational policies, and cultural contexts, highlighting the need for a more integrative analytical perspective.

Accordingly, this literature review aims to critically analyze the development of educational play tools for enhancing early childhood creativity by examining three interrelated dimensions: design characteristics, implementation strategies, and empirical effectiveness. The review seeks to identify the types and characteristics of educational play tools that provide the strongest opportunities for imagination and divergent production; analyze the role of teachers, learning environments, and play structures in their implementation; and synthesize evidence regarding their contribution to children's creative development. The novelty of this review lies in moving beyond a media-centered classification toward an integrated Design Implementation Effectiveness framework. Rather than asking only whether particular educational toys or media improve creativity, the review examines how open-endedness, manipulability, flexibility, multimodal stimulation, child agency, social interaction, adult scaffolding, contextual relevance, and iterative construction interact to create creative learning opportunities. This approach is expected to provide a stronger conceptual foundation for designing educational play tools that are developmentally appropriate, empirically informed, and adaptable to diverse early childhood education contexts.

In summary, educational play tools can provide a powerful environment for early childhood creativity when they offer children meaningful opportunities to explore, transform, combine, imagine, communicate, and reconstruct ideas. However, their effectiveness depends not merely on the availability of attractive materials but on the relationship between design affordances, pedagogical implementation, children's agency, and developmental outcomes. Therefore, a systematic synthesis integrating these dimensions is needed to clarify existing evidence, identify effective design principles, and establish a research-informed framework for future educational play-tool development in early childhood education.

METHOD

Research Design

This study employed a systematic literature review with a semi-systematic and thematic synthesis approach to examine the development of educational play tools for enhancing creativity in early childhood, with particular emphasis on their design, implementation, and effectiveness. A literature review can function as a rigorous research methodology when the search strategy, selection procedure, analytical framework, and synthesis process are explicitly reported (Snyder, 2019). The semi-systematic orientation was considered appropriate because studies on educational play tools encompass heterogeneous theoretical perspectives, research designs, learning media, interventions, and creativity indicators. Such an approach enables researchers to synthesize diverse evidence and identify conceptual patterns without requiring statistical aggregation of heterogeneous outcomes (Snyder, 2019; Peters et al., 2020).

Search Strategy and Data Sources

The literature search covered peer-reviewed studies published between 2016 and 2026. Articles were identified through Scopus, Web of Science, ERIC, ScienceDirect, Google Scholar, and SINTA/GARUDA to obtain an appropriate combination of international and Indonesian evidence. The search strategy followed the

principles of transparent and reproducible evidence identification recommended by McGowan et al. (2016) and Page et al. (2021). Search terms were combined using Boolean operators, including “educational play tools” OR “educational toys” OR “learning media” OR “loose parts” OR “play-based learning” AND “creativity” OR “creative thinking” AND “early childhood” OR “preschool children” OR “early childhood education.” Equivalent Indonesian terms, such as alat permainan edukatif, kreativitas anak usia dini, media pembelajaran, and permainan anak, were also applied.

Eligibility and Study Selection

Study identification and selection were guided by the PRISMA 2020 framework (Page et al., 2021), which supports transparent documentation of records from identification through final inclusion. Articles were eligible when they: (1) were published between 2016 and 2026; (2) involved children approximately 3–6 years old or formal early childhood education settings; (3) investigated educational play tools, manipulatives, loose parts, play-based media, STEAM materials, traditional games, or comparable learning resources; (4) examined creativity, divergent thinking, imagination, originality, flexibility, or creative production; and (5) provided sufficient methodological and empirical information. Studies focusing exclusively on older children, purely therapeutic play, non-educational toys, opinion papers, book reviews, inaccessible full texts, and publications without identifiable research procedures were excluded.

Screening was conducted sequentially through title and abstract examination followed by full-text eligibility assessment, consistent with recommended evidence-selection procedures (Peters et al., 2020). After applying the inclusion, exclusion, relevance, and methodological-quality criteria, 15 articles constituted the final analytical corpus.

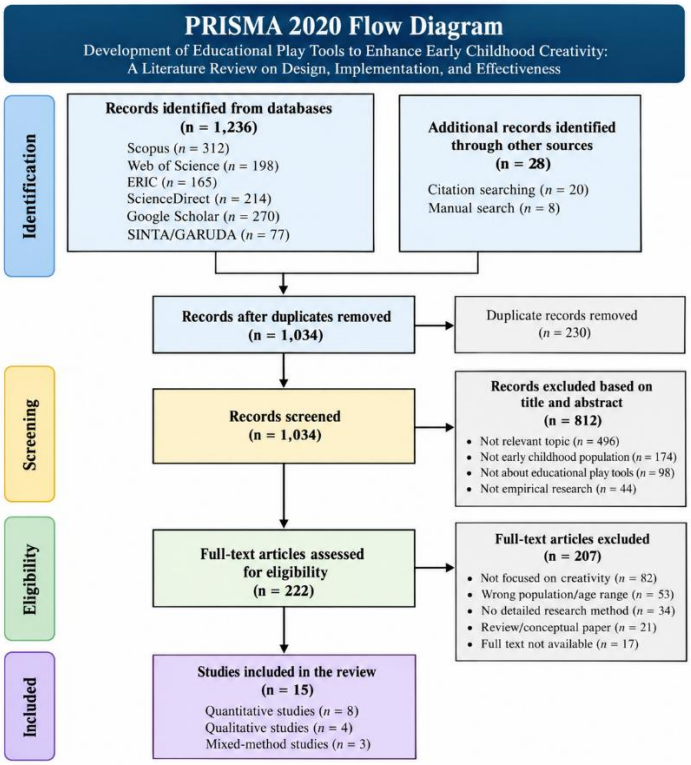


Figure 1. Prisma 2020 Flow Diagram of study selection

Quality Assessment and Data Extraction

Methodological quality was evaluated by considering clarity of research objectives, appropriateness of design, participant characteristics, data collection, analytical procedures, and consistency between findings and conclusions. For heterogeneous quantitative, qualitative, and mixed-method studies, principles from the Mixed Methods Appraisal Tool (MMAT) were adopted because the instrument accommodates multiple study designs within a single review (Hong et al., 2018). Recent systematic reviews have similarly applied MMAT to evaluate heterogeneous educational evidence.

A standardized extraction matrix recorded author and year, country, participants, research design, type of educational play tool, material characteristics, instructional procedures, teacher involvement, intervention duration, creativity indicators, assessment instruments, and principal findings. Structured extraction enhances comparability and reduces selective interpretation across studies (Pollock et al., 2023).

Data Analysis

The 15 studies were analyzed through descriptive and thematic synthesis. Evidence was initially coded and subsequently clustered into three predetermined analytical domains: (1) Design, including open-endedness, flexibility, manipulability, safety, attractiveness, and developmental appropriateness; (2) Implementation, including child agency, teacher scaffolding, learning setting, duration, interaction, and instructional strategy; and (3) Effectiveness, including changes in originality, fluency, flexibility, imagination, problem-solving, and creative products. The synthesis emphasized convergence, variation, and contradictory findings rather than merely counting positive results. This procedure is consistent with contemporary evidence-synthesis guidance that recommends systematic extraction, comparison, interpretation, and transparent presentation of heterogeneous findings (Peters et al., 2020; Pollock et al., 2023). Consequently, the methodological framework enabled the review to explain not only whether educational play tools enhance early childhood creativity, but also which design features and implementation conditions contribute to their effectiveness.

RESEARCH RESULTS AND DISCUSSION

Research Results

Characteristics of the Selected Studies

The systematic screening process resulted in 15 empirical studies that met the eligibility criteria and were included in the final synthesis. The studies represented various forms of educational play tools and learning environments, including loose-parts materials, STEAM-oriented play, educational robotics, digital educational games, guided coding, design-thinking activities, Reggio Emilia-inspired ateliers, and makerspace environments. Although the methodological characteristics varied considerably, the reviewed studies shared a common pedagogical orientation: children were provided with opportunities to manipulate materials, explore alternative solutions, generate ideas, construct products, test possibilities, and revise their creations.

The studies could be grouped into five major categories. Seven studies primarily investigated conventional or natural loose-parts materials, two integrated loose parts or manipulable materials within STEAM/project-based learning, three focused on digital games, coding, or educational robotics, one employed STEM activities structured through a design-thinking model, and two examined broader atelier/makerspace and constructionist environments. This distribution indicates that contemporary educational play tools extend beyond conventional toys and increasingly include hybrid combinations of physical materials, technological resources, engineering challenges, and child-centered design activities.

Table 1. Characteristics and Main Findings of the 15 Reviewed Studies

Study	Participants/ Context	Educational Play Tool/Approach	Research Design	Principal Findings
Çakır et al. (2021)	40 preschool children, Turkey	WeDo 2.0 educational robotics and coding	Quasi-experimental pretest–posttest control group	Robotics significantly supported problem-solving and creative-thinking outcomes, particularly imagination, originality, completion, addition of new elements, and unconventionality.
Xiong et al. (2022)	102 children aged 3–6 years	*Thinking Paradise* digital educational game containing 11 mini-games	Pretest–posttest experimental training	Post-intervention scores increased significantly across creative-thinking indicators, including fluency, elaboration/detail, originality, resistance to premature closure, and title generation; age-related differences were also identified.
Yalçın & Erden (2021)	39 preschool children: experimental	STEM activities based on Design Thinking	Experimental pretest–	Creativity and problem-solving increased significantly in the experimental group, with gains maintained in the permanence test;

	n = 20; control n = 19		posttest with retention test	improvements in cooperation, communication, idea generation, and self-confidence were also reported.
Critten et al. (2022)	15 children aged 2:9–4:10 years	Bee-Bot, maps, picture codes, guided coding play	Action-research/scoping study; six sessions	Guided play supported collaboration, logical reasoning, sequencing, debugging, planning, and early computational thinking; younger children required greater adult scaffolding.
Reggio Emilia experimental project (2020)	Two-year-old children in an Atelier classroom	Arts, experimentation, documentation, Reggio Emilia environment	Longitudinal classroom experimental project	Experimentation and artistic representation strengthened autonomy and children's capacity to formulate, test, and reconsider ideas, demonstrating the value of an open exploratory environment.
Making a Makerspace study (2025)	Kindergarten context, China	Makerspace, authentic making, tinkering, Engineering Design Process	Curriculum intervention	The makerspace program improved STEM habits of mind and established a classroom environment supportive of creative thinking, making, experimentation, and iterative problem solving.
Retnowati (2021)	Early childhood group	Recycled/open-ended loose parts	Classroom action research	Learning mastery in creativity increased from 27% in Cycle I to 93% in Cycle II, indicating substantial improvement following repeated loose-parts exploration.
Rohmatun et al. (2021)	Early childhood learning-from-home context	Household loose parts	Descriptive/field-based study	Loose-parts activities enabled children to explore, experiment, construct objects, and express original ideas during home-based learning.
Eriani et al. (2022)	Early childhood setting	Manipulable loose-parts materials	Empirical early childhood study	Materials that could be moved, separated, combined, and redesigned promoted freedom in expressing ideas and supported creative-thinking development.
Ananda et al. (2022)	Group A kindergarten children	Loose-parts learning materials	Three-cycle classroom action research	Creativity achievement increased from 33% in Cycle I to 67% in Cycle II and 86% in Cycle III, demonstrating progressive gains across repeated cycles.
Laelasari et al. (2022)	14 children aged 5–6 years	Loose-parts media in online learning	Qualitative descriptive study	Children demonstrated increased artistic creativity through imagining, producing ideas, selecting materials, and exploring different forms during loose-parts activities.
Kafolamau & Rahardjo (2022)	Children aged 4–5 years	Natural loose parts: stones, leaves, twigs, pinecones	Descriptive qualitative study	Children's responses revealed stronger imagination, exploration, and creation after participating in open-ended activities using natural materials.
Sardi & Mayar (2023)	Early childhood setting	Everyday/open loose-parts objects	Qualitative case study	Loose-parts construction stimulated active participation, curiosity, exploration, and the production of independently created objects.
Dewi et al. (2024)	Early childhood classroom	STEAM-based loose-parts learning	Classroom action research	Integration of STEAM and loose parts strengthened children's opportunities to investigate materials and produce creative constructions through exploratory learning.
Sulastri et al. (2025)	8 Group B1 kindergarten children	Project-based STEAM activities	Two-cycle classroom action research	Children's creativity increased after project-based STEAM implementation, particularly through active participation, product construction, idea exploration, and problem solving.

The evidence in Table 1 demonstrates considerable methodological diversity. Experimental and quasi-experimental studies provided stronger evidence regarding changes in measurable creativity, whereas

qualitative and classroom-action studies provided richer explanations of how creativity developed during interaction with educational play materials. Consequently, the findings were synthesized narratively rather than statistically pooled.

Design Characteristics of Effective Educational Play Tools

The first major theme concerned the design characteristics of educational play tools. Across the reviewed studies, effective materials were rarely characterized by a single prescribed function. Instead, their value was associated with open-endedness, manipulability, flexibility, recombinability, accessibility, sensory richness, and opportunities for transformation.

Loose parts provided the clearest example. Stones, twigs, leaves, recycled materials, household objects, and other unstructured resources could be moved, grouped, separated, connected, rearranged, and transformed into different products. Eriani et al. (2022) emphasized that this material flexibility creates opportunities for children to express ideas without being constrained by a predetermined final product. Similar patterns were reported by Sardi and Mayar (2023) and Kafolamau and Rahardjo (2022), where children developed constructions based on their own imagination rather than reproducing teacher-provided models.

Technologically enhanced tools demonstrated comparable characteristics through different modalities. The *Thinking Paradise* application contained 11 mini-games targeting five forms of creative thinking, while educational robotics allowed children to design movement sequences, test commands, identify errors, and revise solutions. Therefore, the physical-versus-digital distinction appeared less important than the degree to which the medium enabled choice, experimentation, multiple solutions, feedback, and reconstruction.

The synthesis produced six recurrent design principles.

Table 2. Design Principles Identified Across the Reviewed Literature

Design Principle	Description	Contribution to Creativity
Open-endedness	Materials do not prescribe one correct product or solution	Stimulates originality and divergent idea generation
Manipulability	Objects can be moved, assembled, separated, rotated, or reconstructed	Supports experimentation and flexible thinking
Multiple affordances	The same material can perform different symbolic or functional roles	Encourages imagination and representational thinking
Developmental appropriateness	Complexity corresponds to children's cognitive, motor, and language capabilities	Sustains participation while avoiding excessive cognitive load
Feedback and testability	Designs allow children to observe consequences and modify solutions	Supports problem solving, debugging, and elaboration
Contextual accessibility	Materials are familiar, safe, affordable, or obtainable from children's environments	Facilitates independent and repeated exploration

Thus, the most productive educational play tools were not necessarily the most technologically sophisticated. Rather, effective tools provided high creative affordance, meaning that a limited set of materials could generate many different actions, representations, products, or solutions.

Implementation of Educational Play Tools

The second theme concerned how educational play tools were implemented. The evidence indicates that materials alone were insufficient to explain improvements in creativity. Implementation was shaped by the interaction among child agency, teacher scaffolding, exploratory time, collaborative interaction, questioning, iterative construction, and the organization of the learning environment.

Child agency was especially prominent in loose-parts studies. Children were permitted to determine what to construct, select materials, combine components, and change their ideas during the activity. This freedom reduced dependence on teacher models and shifted the learning process from product replication toward active construction.

Nevertheless, complete absence of adult guidance was not consistently optimal. Critten et al. (2022) found that preschool children participating in guided coding activities benefited from adult prompts, visual representations, physical demonstrations, and scaffolding. The youngest children and children requiring additional educational support needed substantially more assistance when following routes, interpreting representations, or programming Bee-Bots.

A similar pattern appeared in Design Thinking STEM. Rather than providing solutions, teachers functioned as facilitators while children identified problems, proposed ideas, created solutions, and evaluated outcomes. The 24 activities delivered three times weekly over eight weeks produced measurable and sustained gains in creativity and problem solving. The makerspace intervention followed a related Engineering Design Process: identifying problems, imagining and planning, creating, testing, and improving. These findings suggest that effective implementation can be represented as:

Exploration → Idea Generation → Construction → Testing → Reflection → Modification/Reconstruction

This iterative pattern appeared across physical, digital, technological, and STEAM-oriented learning environments.

Effectiveness in Enhancing Early Childhood Creativity

The third domain was effectiveness. Overall, the evidence indicated a positive pattern between educational play experiences and creativity-related outcomes. However, the indicators differed across studies and included fluency, flexibility, originality, elaboration, imagination, unconventionality, creative product generation, problem solving, idea generation, experimentation, and creative confidence.

The strongest quantitative evidence was identified in the technology- and STEM-based experimental studies. Xiong et al. (2022) reported significant post-training improvements among 102 preschool children after participation in digital educational games. Improvement occurred across the assessed creativity dimensions, although the magnitude and specific dimensions differed by age group. Çakır et al. (2021) similarly reported significant advantages for educational robotics over conventional paper-based activities in specific creative-thinking dimensions and problem-solving ability.

The Design Thinking STEM intervention provided particularly important evidence because gains remained evident during a permanence assessment, suggesting that children's improvements were not merely immediate responses to novelty.

Evidence from Indonesian classroom-action studies showed a comparable developmental pattern. Retnowati (2021) documented an increase from 27% creativity mastery in Cycle I to 93% in Cycle II, while Ananda et al. (2022) reported increases from 33% to 67% and subsequently 86% across three intervention cycles. These findings are especially important because they suggest that effectiveness may increase through repeated engagement rather than a single exposure to educational materials.

Table 3. Synthesis of Creativity Outcomes

Creativity Dimension	Evidence Across the Studies	Overall Pattern
Fluency	Generation of more ideas, responses, and possible creations	Strong positive pattern
Flexibility	Use of materials or ideas in different ways and switching strategies	Strong positive pattern
Originality	Production of unusual or individually generated responses/products	Strong positive pattern
Elaboration	Addition of details and further development of initial constructions	Positive pattern
Imagination	Symbolic transformation and generation of imagined forms/scenarios	Strong positive pattern
Problem solving	Testing alternatives, debugging, redesigning, and solving construction challenges	Strong positive pattern
Collaboration	Sharing ideas, negotiating materials, peer learning, and joint construction	Moderate-to-strong positive pattern
Autonomy	Independent material selection and decision making	Positive pattern
Creative confidence	Greater willingness to propose, construct, and modify personal ideas	Positive pattern

Cross-Study Synthesis: Design Implementation Effectiveness Model

A cross-study comparison showed that educational play tools did not influence creativity as isolated physical products. Instead, creativity emerged from the interaction between what the tool allows children to do, how the learning activity is facilitated, and what cognitive or behavioral responses are stimulated.

Table 4. Integrated Design Implementation Effectiveness Synthesis

Dimension	Dominant Findings	Mechanism
Design	Open-ended, flexible, manipulable, multimodal, recombinable materials	Increase number of possible actions and solutions
Implementation	Child choice combined with purposeful teacher scaffolding	Balances autonomy with cognitive support
Learning Process	Exploration, experimentation, construction, testing, redesign	Promotes iterative creative thinking
Social Interaction	Collaboration, questioning, discussion, peer problem solving	Expands perspectives and alternative ideas
Effectiveness	Higher originality, fluency, flexibility, imagination, elaboration, and problem solving	Converts exploratory play into measurable creative development

The resulting conceptual pattern can therefore be expressed as: Educational Play Tool Design → Exploratory Affordances → Child Agency + Teacher Scaffolding → Experimentation and Iteration → Creative Outcomes. Importantly, the evidence does not indicate that one specific medium is universally superior. Loose parts, digital games, robotics, STEAM projects, and makerspaces can all contribute to creativity when they preserve children's opportunities to make decisions, generate multiple solutions, manipulate or transform representations, receive feedback, and revise their ideas. For example, the effectiveness of robotics was associated not simply with exposure to technology but with planning, construction, programming, testing, and correction; similarly, the effectiveness of loose parts derived from their capacity to be repeatedly combined and reinterpreted.

Summary of Findings

Overall, synthesis of the 15 studies produced three principal findings. First, effective educational play tools are characterized by high levels of openness and transformational potential, allowing children to use the same resources in multiple ways. Second, implementation quality mediates the educational value of the tools; children's autonomy is essential, but strategically applied teacher scaffolding, questioning, modeling, and environmental organization can extend exploration without replacing children's own decisions. Third, educational play experiences consistently demonstrated positive associations with creativity-related outcomes, particularly originality, fluency, flexibility, imagination, elaboration, problem solving, and idea generation. The empirical pattern was particularly convincing where interventions incorporated repeated cycles of creating, testing, evaluating, and redesigning. The evidence therefore supports an interpretation of creativity not as an automatic consequence of playing with attractive materials, but as an outcome of the dynamic interaction between material affordances, child agency, pedagogical scaffolding, social interaction, and iterative problem solving. This integrated Design–Implementation–Effectiveness pattern provides the principal empirical foundation for explaining how educational play tools can be systematically developed to enhance creativity during early childhood.

Discussion

The findings of this literature review demonstrate that educational play tools can substantially contribute to the development of early childhood creativity when their design and implementation provide opportunities for exploration, transformation, decision-making, and iterative problem solving. Across the 15 reviewed studies, creativity was not generated merely by exposing children to particular toys or media; rather, it emerged from the interaction between the affordances of the materials, children's agency, teacher scaffolding, social interaction, and repeated opportunities to create and reconstruct ideas. This interpretation supports contemporary conceptualizations of play as a continuum ranging from free play to guided play, in which learning becomes most meaningful when children retain initiative while adults provide purposeful but non-dominating support (Zosh et al., 2018; Yu et al., 2018).

One of the most consistent findings concerned the importance of open-ended and manipulable materials. Loose parts, recycled resources, natural objects, and flexible construction materials allowed children to combine, separate, redesign, and reinterpret objects according to their own intentions. Eriani et al.

(2022) emphasize that loose parts can be moved, recombined, and redesigned in multiple ways, characteristics that facilitate divergent thinking and enable children to express ideas without being constrained by predetermined products. Similarly, Wardhani et al. (2021) reported that loose-parts materials provide opportunities for exploration and imaginative manipulation, while Kafolamau and Rahardjo (2022) found that natural materials such as stones, leaves, twigs, and pinecones stimulated children's imaginative responses and creative production. These results reinforce the argument that the creative potential of an educational play tool depends less on technological sophistication than on the number and variety of actions that the material affords.

The empirical findings from Indonesian studies strengthen this interpretation. Retnowati (2021) documented an increase in creativity mastery from 9% at the pre-cycle stage to 27% in Cycle I and 93% in Cycle II following loose-parts activities. Such progressive gains suggest that creativity develops through repeated exposure to situations in which children can test, revise, and extend their constructions rather than through one-time play activities. Recent work also confirms that loose-parts media can improve fluency, flexibility, originality, and elaboration when implemented through iterative exploratory activities (Fizianingsih et al., 2026; Arifianti et al., 2025). Thus, repetition should not be understood as mechanical practice, but as an iterative design process in which children repeatedly encounter new possibilities within familiar materials.

The findings also indicate that technology-enhanced educational play can stimulate creativity when technology is interactive rather than consumptive. Xiong et al. (2022) showed that digital educational games significantly improved several indicators of preschool children's creative thinking, although the effects varied across age groups. Likewise, Çakır et al. (2021) demonstrated that robotics and coding activities contributed significantly to preschool children's problem-solving skills as well as specific dimensions of creativity, including imagination, originality, unconventionality, and the addition of new elements. These results challenge simplistic distinctions between “traditional” and “digital” educational play. The central issue is not whether the tool is physical or digital, but whether it requires the child to make choices, anticipate outcomes, construct solutions, receive feedback, and modify unsuccessful strategies.

A comparable mechanism emerged in STEM and makerspace interventions. Yalçın and Erden (2021) found that STEM activities organized according to the Design Thinking model improved preschool children's creativity and problem-solving while also promoting communication, cooperation, and transfer of learning. The makerspace intervention reported by Yang et al. (2025) similarly improved children's STEM habits of mind and created a classroom environment supportive of making, creative thinking, and socio-emotional development. These findings are consistent with the Indonesian STEAM–loose-parts literature, where Qoumariah et al. (2025) identified creativity gains through integration of Science, Technology, Engineering, Arts, and Mathematics with open-ended materials. Herlina et al. (2026) further argue that project-based learning combined with loose parts can address teacher-centered early childhood instruction by creating more active and exploratory cognitive experiences.

Another important implication concerns the role of teachers. The reviewed evidence does not support either unrestricted free play or highly directive teaching as universally optimal. Instead, effectiveness appears strongest when teachers provide scaffolding through open questions, environmental organization, modeling, encouragement, and prompts while preserving children's ownership of decisions. This is consistent with guided-play theory, which conceptualizes effective learning as child-led but adult-supported (Yu et al., 2018). Design Thinking STEM similarly repositioned teachers from transmitters of predetermined answers to facilitators of children's problem solving (Yalçın & Erden, 2021). Accordingly, teacher intervention should expand children's thinking rather than reduce tasks to imitation.

However, the review also indicates that effectiveness should not be generalized uncritically. Creativity outcomes varied according to age, intervention type, measurement method, instructional context, and participant characteristics. Xiong et al. (2022), for example, found age-specific differences in responses to digital creativity training, while a recent makerspace study involving children aged five to six reported differentiated outcomes across participant groups rather than uniform improvement. Furthermore, creative thinking is associated with broader developmental and environmental factors, including scientific-process skills and the quality of the child's learning environment (Yildiz & Guler Yildiz, 2021). Therefore, educational play tools should be regarded as part of an ecological learning system rather than as independent causal instruments.

Taken together, the evidence supports an integrated Design–Implementation–Effectiveness model. Effective educational play tools are characterized by openness, flexibility, manipulability, developmental appropriateness, and the possibility of multiple solutions. Their pedagogical impact is strengthened when implementation includes child agency, guided exploration, collaboration, questioning, experimentation, and opportunities for redesign. Under these conditions, educational play supports not only originality and imagination but also fluency, flexibility, elaboration, problem solving, autonomy, and creative confidence. Conceptually, the major contribution of this review is therefore the recognition that creativity arises from the interaction between the properties of the tool and the quality of the learning process, rather than from the tool itself. This perspective offers a stronger foundation for future development of educational play tools that are empirically informed, contextually relevant, and developmentally appropriate for early childhood education.

CONCLUSION

This literature review concludes that educational play tools have substantial potential to enhance early childhood creativity when their design and implementation provide children with opportunities for exploration, experimentation, decision-making, and iterative problem solving. Across the 15 reviewed studies, the most effective tools were characterized by open-endedness, flexibility, manipulability, multiple affordances, developmental appropriateness, and the possibility of reconstruction. These characteristics were found in loose parts, STEAM-based materials, educational robotics, digital games, makerspaces, and design-thinking activities. Empirically, the reviewed evidence demonstrated positive improvements in major creativity indicators, including fluency, flexibility, originality, elaboration, imagination, creative product generation, and problem-solving ability. Several intervention studies also reported measurable gains following repeated implementation. For example, classroom-action research using loose-parts media showed creativity mastery increasing from approximately 27% to 93%, while another study reported progressive improvement from 33% to 67% and 86% across intervention cycles. Experimental studies on digital games, robotics, and STEM-based design thinking likewise demonstrated significant improvements in creative-thinking and problem-solving outcomes. Conceptually, these findings confirm that creativity is not produced by the educational tool alone, but by the interaction between tool design, child agency, teacher scaffolding, social interaction, and repeated opportunities to create, test, and revise ideas. Therefore, future educational play tool development should adopt an integrated Design Implementation Effectiveness framework to ensure that learning media are not only attractive and safe, but also developmentally meaningful and capable of supporting sustained creative growth in early childhood.

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