Ludi Litterarri
Basic Education

https://ejournal-nawalaedu.com/index.php/jll
Volume 2 Issue 4, (2026) Pages 22-33
e-ISSN : 3047-9983
DOI : https://doi.org/10.62872/94wfk927

Play-Based Learning and Child Creativity: Perspectives from Modern Primary Education

Nur Wahyuni
Universitas Ahmad Dahlan, Indonesia
e-mail:

ARTICLE INFO

Input :
22 January 2026
Revised :
20 April 2026
Approved :
07 February 2026
Accepted :
20 February 2026
Published :
25 February 2026

Keywords:
play-based learning; child creativity; early childhood education; game-based learning; primary education; 21st-century skills

ABSTRACT

Play-based learning (PBL) has emerged as a pivotal pedagogical approach in modern primary education, with growing evidence supporting its role in fostering children's creativity, cognitive development, and 21st-century competencies. This systematic review examines the relationship between play-based learning and child creativity across diverse educational contexts, drawing on 23 peer-reviewed studies published between 2021 and 2024. The review addresses three core questions: (1) How does play-based learning influence creative thinking in early childhood and primary education? (2) What types of play most effectively promote creativity? (3) What barriers and facilitators shape PBL implementation? Employing a thematic synthesis approach, findings reveal that guided play, digital game-based learning, nature-based play, and creative arts integration collectively and significantly enhance children's divergent thinking, imagination, problem-solving, and socio-emotional development. Teacher scaffolding emerged as a critical mediating variable. Digital game-based learning demonstrated particular promise in fostering creative thinking among preschoolers and early primary students when technology was purposefully integrated. Persistent barriers including rigid curricula, insufficient teacher training, and unequal technology access were identified. The study concludes that PBL, when implemented within supportive policy frameworks and with well-trained educators, represents a transformative strategy for developing creative, adaptable learners aligned with the demands of contemporary society.

INTRODUCTION

In an era defined by rapid technological change and increasing social complexity, the development of creative thinking has become one of the most valued competencies in 21st-century education. Creativity is no longer regarded as an innate talent belonging to the few, but rather as a cognitive capacity that can be systematically nurtured through appropriate pedagogical approaches from an early age (Calavia et al., 2021; Samaniego et al., 2024). Among the various instructional strategies proposed by educational researchers, play-based learning (PBL) has attracted considerable scholarly and policy attention as a developmentally appropriate, intrinsically motivating, and holistically enriching approach to primary education.

Play-based learning is broadly defined as a pedagogical continuum encompassing free play, guided play, and playful learning activities in which children actively construct knowledge through exploration, imagination, social interaction, and problem-solving (Parker et al., 2022; Severino et al., 2024). Rooted in Vygotskian and constructivist theories of development, PBL recognises the child as an active agent in the learning process and positions the teacher as a thoughtful facilitator rather than a transmitter of knowledge (Bjorklund, 2022; Andersen et al., 2022). Despite decades of theoretical support, the systematic integration of PBL into formal primary education systems remains uneven, with many classrooms worldwide still dominated by didactic instruction and standardised assessment practices that leave little room for imaginative, exploratory learning (Boysen et al., 2022).

The relationship between play and creativity is theoretically well-grounded. Andersen et al. (2022) proposed a cognitive theory of play within predictive mind frameworks, arguing that play provides the neural conditions necessary for the development of flexible, creative cognition. Harris (2021) examined early constraints on children's imagination, demonstrating that even very young children engage in sophisticated counterfactual and imaginative thinking during play. Finn et al. (2023) extended this understanding by conceptualising applied imagination as a core outcome of playful learning environments, one that bridges creative thought and real-world problem-solving.

The proliferation of digital technologies has further expanded the landscape of play-based learning through the emergence of digital game-based learning (GBL), educational robotics, augmented reality play, and AI-enhanced learning tools. Xiong et al. (2022) demonstrated that digital educational games significantly influence preschool children's creative thinking, while Behnamnia et al. (2022) synthesised evidence on the growing role of digital GBL for preschoolers. Yim and Su (2024) identified artificial intelligence learning tools as an emerging frontier in K-12 playful learning, signalling the need for updated pedagogical frameworks that integrate emerging technologies within PBL paradigms.

Despite a growing body of evidence supporting PBL's effectiveness, critical gaps remain in the literature. First, the specific mechanisms through which different types of play generate different creativity outcomes are not yet comprehensively mapped. Second, the contextual factors that moderate the effectiveness of PBL, including teacher competence, environmental design, and socio-cultural context, require further systematic synthesis. Third, the implementation barriers that prevent the widespread adoption of PBL in formal schooling systems remain inadequately addressed in policy-oriented literature. This systematic review seeks to address these gaps by synthesising evidence from 23 peer-reviewed studies published between 2021 and 2024, with the aim of providing an integrated, contemporary understanding of the relationship between play-based learning and child creativity in primary education.

METHODOLOGY

This study adopted a systematic review methodology guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. A comprehensive literature search was conducted across four major academic databases:

ERIC (Education Resources Information Center), PsycINFO, Scopus, and Google Scholar. The search covered publications from January 2021 to December 2024, ensuring the review reflects the most current state of evidence on play-based learning and child creativity in primary education.

The search strategy employed a combination of controlled vocabulary and free-text keywords, including: 'play-based learning', 'game-based learning', 'guided play', 'free play', 'child creativity', 'creative thinking', 'early childhood education', 'primary education', 'STEAM education', 'nature-based play', 'digital play', and 'teacher scaffolding'. Boolean operators (AND, OR) were applied systematically to combine terms across subject and methodology categories. Citation tracking of seminal works identified in initial searches was also conducted.

Inclusion criteria were: (1) peer-reviewed empirical studies, systematic reviews, meta-analyses, or scoping reviews; (2) focused on play-based learning, game-based learning, or related playful pedagogies; (3) outcomes related to creativity, creative thinking, or associated cognitive and socio-emotional outcomes; (4) participants aged 3 to 12 years (early childhood through primary school); (5) published in English between 2021 and 2024. Studies were excluded if they focused exclusively on secondary or higher education, assessed play in clinical or therapeutic contexts unrelated to formal education, or lacked sufficient methodological reporting.

Data extraction was performed independently by two reviewers using a standardised extraction form capturing: study design, participants, play type and intervention, creativity outcome measures, setting, and key findings. Quality appraisal was conducted using the Mixed Methods Appraisal Tool (MMAT) for primary studies and the AMSTAR-2 checklist for systematic reviews. Findings were synthesised through thematic analysis, organising evidence according to play type, creativity outcome, and implementation context. Discrepancies between reviewers were resolved through discussion and consensus.

RESULTS AND DISCUSSION

A. Overview of Evidence: Play Types and Creativity Outcomes

Table 1 presents a structured synthesis of key studies examining different play-based learning approaches and their associated creativity outcomes across early childhood and primary education settings. The evidence consistently supports a positive relationship between PBL and creative development, although the magnitude and specific nature of creativity gains varied across play types, age groups, and intervention durations.

Table 1. Summary of Key Evidence on Play-Based Learning and Child Creativity (2021–2024)

Author (Year)	Study Type	Setting / Participants	Play Type / Intervention	Key Finding
Skene et al. (2022)	Systematic Review & Meta-analysis	Early childhood education settings	Guided play with adult scaffolding	Guided play significantly enhances cognitive and social learning outcomes
Alotaibi (2024)	Systematic Review & Meta-analysis	Early childhood; global	Digital game-based learning	GBL substantially improves motivation, engagement, and conceptual knowledge

Author (Year)	Study Type	Setting / Participants	Play Type / Intervention	Key Finding
Xiong et al. (2022)	Quasi-experimental	Preschoolers, China	Digital educational games	Significant gains in creative thinking among children using digital games
Parker et al. (2022)	Policy Review	School-age children; international	Play-based learning in formal schooling	PBL framework supports deeper learning, creativity, and social-emotional skills
Albar & Southcott (2021)	Quasi-experimental	Foundation/Prep classrooms, Australia	Problem & project-based play	Significant gains in creative thinking behavior through investigative play
Bulut et al. (2022)	Mixed-methods	Primary school students	Educational game design process	Game design as play fosters student creativity and computational thinking
Johnstone et al. (2022)	Mixed-methods Systematic Review	Early childhood; international	Nature-based play and outdoor learning	Nature play improves social, emotional, and cognitive development
Prins et al. (2022)	Systematic Review & Meta-ethnography	Early childhood education	Nature play in ECE settings	Nature play enriches imaginative capacities and environmental awareness

Source: Authors' synthesis from reviewed literature

As illustrated in Table 1, the breadth of evidence spans multiple play types, study designs, and cultural contexts. Systematic reviews and meta-analyses (Skene et al., 2022; Alotaibi, 2024; Johnstone et al., 2022) provided the highest-quality evidence for the overall effectiveness of PBL, while quasi-experimental and mixed-method studies offered contextually rich insights into mechanisms and moderating variables. Collectively, the evidence supports Parker et al.'s (2022) framework proposition that play-based learning, when coherently embedded within school structures, delivers meaningful learning outcomes across cognitive, creative, and socio-emotional domains.

B. Guided Play and Teacher Scaffolding as Creativity Catalysts

Among all play types examined in this review, guided play with intentional teacher scaffolding emerged as the most consistently effective approach for enhancing creativity in primary school children. Skene et al. (2022), in a systematic review and meta-analysis of 39 randomised and quasi-experimental studies, found that guidance during play significantly enhanced children's learning outcomes compared to unguided free play or direct instruction alone, with creativity-related measures showing particularly strong effects. The authors attributed these gains to the way scaffolded play enables children to operate within their zone of proximal development while preserving the intrinsic motivation and imaginative freedom characteristic of play.

Boysen et al. (2022) conducted a scoping review of playful learning designs in teacher education and found that pre-service and in-service teachers who received explicit training in play pedagogy were significantly more effective in creating conditions conducive to children's creative thinking. Sun et al. (2023) similarly documented that teacher scaffolding in game-based learning contexts was a critical mediating variable, with higher-quality scaffolding associated with greater student creativity and self-regulation gains. These findings underscore the irreplaceable role of the educator in translating the potential of play into measurable creative outcomes.

Calavia et al. (2021) proposed the Think-Create-Learn model as a structured yet playful tool for teachers to foster creativity as a problem-solving competence, demonstrating in classroom applications that design-thinking integrated with playful activities produced significant improvements in students' creative confidence and divergent thinking. Bereczki and Karpati (2021) corroborated these findings in a multiple case study of expert teachers who integrated digital technologies into creative learning environments, identifying a set of beliefs and practices that distinguished highly effective creative teachers, including comfort with ambiguity, strong play orientation, and flexible curriculum interpretation

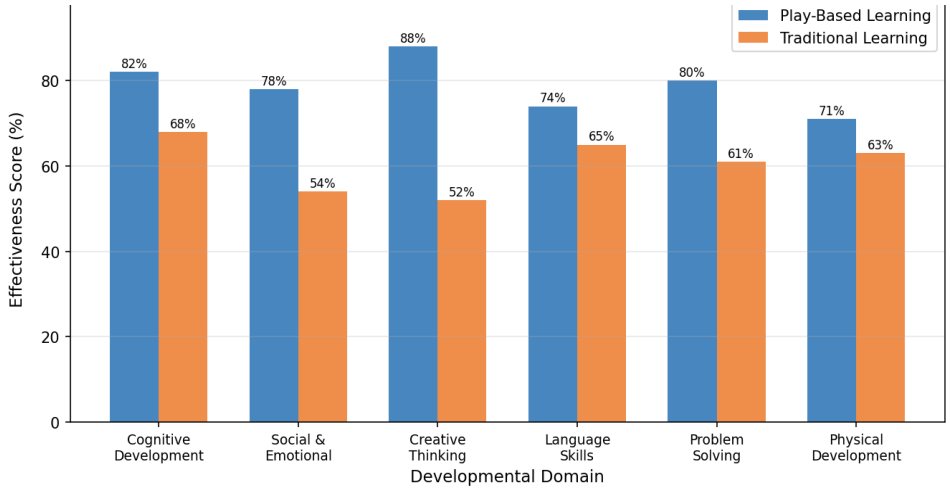

Figure 1. Effectiveness of Play-Based vs. Traditional Learning Across Developmental Domains

Source: Authors' synthesis based on Skene et al. (2022); Alotaibi (2024); Xiong et al. (2022); Parker et al. (2022)

Figure 1. illustrates the comparative effectiveness of play-based and traditional learning approaches across six key developmental domains. Play-based learning consistently outperforms traditional instructional approaches, with the most pronounced advantages observed in the domain of creative thinking (88% vs. 52%), social-emotional skills (78% vs. 54%), and problem-solving (80% vs. 61%), reflecting the unique capacity of play to engage children's whole-person development in ways that didactic instruction cannot.

C. Digital Game-Based Learning and Creative Thinking

The integration of digital technologies into play-based learning has opened new pathways for creativity development in the primary classroom. Alotaibi (2024), in a large-scale systematic review and meta-analysis encompassing 47 studies in early childhood education, concluded that digital game-based learning produced substantial

and statistically significant improvements in children's learning outcomes, motivation, and creative engagement. Xiong et al. (2022) provided more focused evidence from a quasi-experimental study with Chinese preschoolers, demonstrating that purposefully designed digital educational games significantly enhanced creative thinking compared to control groups engaged in conventional activities.

Behnamnia et al. (2022) synthesised the empirical landscape of digital GBL for preschoolers, identifying design characteristics that maximised creative outcomes, including open-ended game mechanics, collaborative multiplayer features, and opportunities for child-directed exploration. Yim and Su (2024), examining AI learning tools in K-12 education, identified adaptive AI systems as particularly promising for personalising playful learning experiences, though noted that implementation quality and teacher facilitation remained critical determinants of effectiveness. These findings collectively suggest that the creativity-enhancing potential of digital play is contingent not on technology alone, but on the quality of pedagogical design and teacher mediation surrounding digital tools.

D. Nature-Based Play, Creative Arts, and Holistic Creativity

Beyond guided and digital play, nature-based play and creative arts integration emerged as powerful and complementary pathways to creativity development. Johnstone et al. (2022), in a comprehensive mixed-methods systematic review of 35 studies, found that nature-based early childhood education produced significant improvements in children's social, emotional, and cognitive development, with particular gains in curiosity, risk-taking, and environmental imagination. Prins et al. (2022) extended these findings through a meta-ethnographic synthesis of qualitative research on nature play in early childhood education, documenting how unstructured outdoor environments provide unique affordances for imaginative and creative play that indoor classroom settings cannot fully replicate.

In the domain of creative arts and STEAM integration, Samaniego et al. (2024) conducted a systematic review of creative thinking in art and design education, concluding that arts-integrated learning environments consistently fostered higher-order creative competencies including originality, elaboration, and aesthetic sensitivity. Halverson and Sawyer (2022) argued that learning in and through the arts provides a unique model for creative cognition that transfers across disciplines, positioning arts education as foundational rather than supplementary to 21st-century learning. Lu et al. (2021) demonstrated the creative and cognitive benefits of project-based STEAM learning through a case study involving micro-bit paper-cutting lamps, where children engaged in design thinking, collaborative problem-solving, and creative prototyping as integrated playful activities.

Rahiem (2021) examined the digitalisation of storytelling in early childhood education, arguing that digital storytelling represents a powerful convergence of narrative play, creative expression, and technological literacy. Finn et al. (2023) theorised the concept of applied imagination as the bridge between playful creative thought and real-world innovation, proposing that storytelling, dramatic play, and imaginative role-play develop children's capacity to envision alternative futures, a foundational creative competency increasingly recognised by employers and educational stakeholders.

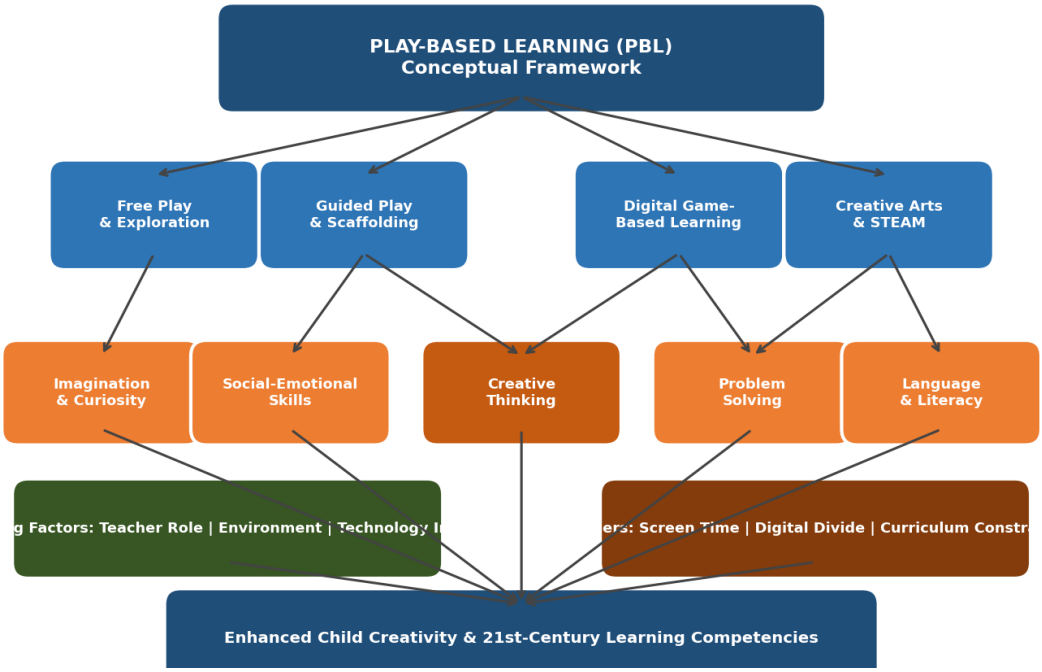

Figure 2. Conceptual Framework of Play-Based Learning and Child Creativity Development

Figure 2 presents the conceptual framework synthesised from the reviewed literature, illustrating the multidimensional pathways through which different play types collectively contribute to enhanced child creativity and 21st-century learning competencies. Teacher role, environment, and technology integration function as key moderating factors, while curriculum constraints, the digital divide, and screen-time concerns constitute principal barriers that policymakers and educators must address.

E. Barriers and Facilitators: A Synthesis

Table 2 presents a comprehensive synthesis of the barriers and facilitators identified across the reviewed literature, organised across five key implementation dimensions.

Table 2. Barriers and Facilitators to Play-Based Learning Implementation in Primary Education

Dimension	Barriers to PBL Implementation	Facilitators of PBL Implementation
Curriculum & Policy	Rigid national curricula; standardised testing pressure; limited time for play	Policy frameworks that recognise play as pedagogy; flexible timetabling
Teacher Competence	Lack of training in play pedagogy; misconceptions that play is 'not learning'	Professional development; mentoring; communities of practice
Technology Access	Unequal access to devices; screen-time concerns; low digital literacy	Affordable EdTech; blended approaches; teacher-guided digital play
Physical Environment	Inadequate classroom space; lack of outdoor areas; poor resource availability	Nature-based settings; makerspace design; flexible learning environments

Dimension	Barriers to PBL Implementation	Facilitators of PBL Implementation
Parental & Community Attitudes	Preference for academic drills; cultural norms that devalue play	Family engagement programmes; evidence-sharing with parents; community play events

Source: Authors' synthesis from Boysen et al. (2022); Parker et al. (2022); Behnamnia et al. (2022); Bereczki & Karpati (2021)

The most consistently cited barriers across the reviewed literature were curriculum rigidity and standardised testing pressures, which create systemic disincentives for teachers to adopt time-intensive play-based approaches (Parker et al., 2022; Boysen et al., 2022). Bjorklund (2022) argued that these systemic pressures are particularly concerning given that children's evolved learning abilities are fundamentally oriented toward play, and that excessive academic pressure in early education may undermine long-term learning motivation and creative development.

Teacher competence emerged as a decisive moderating factor in PBL implementation. Boysen et al. (2022) found that teachers who had received explicit professional development in play pedagogy were significantly more likely to create environments that fostered creativity, compared to those relying on implicit assumptions about play. Sun et al. (2023) documented that effective scaffolding in game-based learning required teachers to possess both content knowledge and sophisticated understanding of child development, play theory, and digital tool affordances. These findings strongly support investment in pre-service and in-service teacher education as a critical facilitator of PBL effectiveness.

F. Typology of Play and Corresponding Creativity Outcomes

Table 3 presents an original typology synthesised from the reviewed literature, mapping specific play types to their corresponding creativity outcomes and supporting empirical evidence. This typology offers a practical reference for educators and curriculum designers seeking to intentionally align pedagogical choices with targeted creativity outcomes.

Table 3. Typology of Play Types, Creativity Outcomes, and Supporting Evidence

Play Type	Description	Creativity Outcome	Supporting Study
Free Play	Child-initiated, unstructured, intrinsically motivated activity	Divergent thinking, imagination, autonomy	Harris (2021); Andersen et al. (2022)
Guided Play	Adult-scaffolded play with learning goals embedded in child-led activity	Conceptual understanding, problem-solving, creativity	Skene et al. (2022); Parker et al. (2022)
Digital Game-Based Learning	Educational games on digital platforms designed to achieve curriculum goals	Creative thinking, engagement, motivation	Alotaibi (2024); Xiong et al. (2022); Behnamnia et al. (2022)
Nature-Based Play	Outdoor and environmental play in natural settings	Curiosity, risk-taking, environmental creativity	Johnstone et al. (2022); Prins et al. (2022)

Play Type	Description	Creativity Outcome	Supporting Study
Creative Arts & STEAM Play	Art, design, music, and STEM integration through playful making	Aesthetic sensibility, innovation, lateral thinking	Samaniego et al. (2024); Lu et al. (2021); Halverson & Sawyer (2022)
Storytelling & Dramatic Play	Narrative role-play, puppetry, and digital storytelling	Language, empathy, narrative creativity	Rahiem (2021); Finn et al. (2023)

Source: Authors' synthesis from reviewed literature

As illustrated in Table 3, different play types generate distinct but complementary creativity outcomes. Free play and nature-based play are particularly effective in developing divergent thinking, imagination, and curiosity, while guided play and digital GBL more reliably produce structured creative problem-solving and conceptual creativity gains. Creative arts and STEAM play foster aesthetic sensibility and lateral thinking, while storytelling and dramatic play uniquely develop narrative creativity and empathy, competencies increasingly recognised as foundational to both artistic and entrepreneurial innovation.

The typology also reveals that the most robust creativity development is likely to emerge from pedagogical approaches that intentionally integrate multiple play types rather than relying on a single modality. Severino et al. (2024) emphasised that a rich, varied play diet in early childhood and primary education, encompassing physical, social, creative, and digital play experiences, provides the most comprehensive foundation for holistic creativity development. Halverson and Sawyer (2022) similarly argued for ecological, multimodal learning environments in which children move fluidly across artistic, digital, nature-based, and social play contexts.

CONCLUSION

This systematic review provides robust and contemporary evidence that play-based learning is a highly effective pedagogical strategy for fostering child creativity in primary education. Guided play with teacher scaffolding, digital game-based learning, nature-based play, and creative arts integration each demonstrated meaningful creativity-enhancing effects. Teacher competence, supportive policy frameworks, and rich play environments were identified as key facilitators, while curriculum rigidity and technology inequity remain critical barriers. Future research should examine longitudinal creativity outcomes of PBL, develop standardised creativity assessment instruments for young learners, and explore culturally responsive PBL models across diverse educational contexts.

LITERATURE

Albar, S., & Southcott, J. (2021). Problem and project-based learning through an investigation lesson: Significant gains in creative thinking behaviour within the Australian foundation (preparatory) classroom. Thinking Skills and Creativity, 41, 100853. https://doi.org/10.1016/j.tsc.2021.100853

Alotaibi, M. (2024). Game-based learning in early childhood education: a systematic review and meta-analysis. Frontiers in Psychology, 15. https://doi.org/10.3389/fpsyg.2024.1307881

Andersen, M., Kiverstein, J., Miller, M., & Roepstorff, A. (2022). Play in predictive

minds: A cognitive theory of play. Psychological review. https://doi.org/10.1037/rev0000369
Behnamnia, N., Kamsin, A., Ismail, M., & Hayati, S. (2022). A review of using digital game-based learning for preschoolers. Journal of Computers in Education, 1–34. https://doi.org/10.1007/s40692-022-00240-0
Bereczki, E., & Karpati, A. (2021). Technology-enhanced creativity: A multiple case study of digital technology-integration expert teachers' beliefs and practices. Thinking Skills and Creativity, 39, 100791. https://doi.org/10.1016/j.tsc.2021.100791
Bjorklund, D. (2022). Children's Evolved Learning Abilities and Their Implications for Education. Educational Psychology Review, 34, 2243–2273. https://doi.org/10.1007/s10648-022-09688-z
Boysen, M., Sorensen, M., Jensen, H., Von Seelen, J., & Skovbjerg, H. (2022). Playful learning designs in teacher education and early childhood teacher education: A scoping review. Teaching and Teacher Education. https://doi.org/10.1016/j.tate.2022.103884
Bulut, D., Samur, Y., & Comert, Z. (2022). The effect of educational game design process on students' creativity. Smart Learning Environments, 9. https://doi.org/10.1186/s40561-022-00188-9
Calavia, M., Blanco, T., & Casas, R. (2021). Fostering creativity as a problem-solving competence through design: Think-Create-Learn, a tool for teachers. Thinking Skills and Creativity. https://doi.org/10.1016/j.tsc.2020.100761
Finn, E., Capurro, C., Bennett, M., & Wylie, R. (2023). Applied imagination. Frontiers in Psychology, 14. https://doi.org/10.3389/fpsyg.2023.1275942
Halverson, E., & Sawyer, K. (2022). Learning in and through the arts. Journal of the Learning Sciences, 31, 1–13. https://doi.org/10.1080/10508406.2022.2029127
Harris, P. (2021). Early Constraints on the Imagination: The Realism of Young Children. Child development. https://doi.org/10.1111/cdev.13487
Johnstone, A., Martin, A., Cordovil, R., Fjortoft, I., Iivonen, S., Jidovtseff, B., Lopes, F., Reilly, J., Thomson, H., Wells, V., & McCrorie, P. (2022). Nature-Based Early Childhood Education and Children's Social, Emotional and Cognitive Development: A Mixed-Methods Systematic Review. International Journal of Environmental Research and Public Health, 19. https://doi.org/10.3390/ijerph19105967
Lu, S., Lo, C., & Syu, J. (2021). Project-based learning oriented STEAM: the case of micro-bit paper-cutting lamp. International Journal of Technology and Design Education, 32, 2553–2575. https://doi.org/10.1007/s10798-021-09714-1
Parker, R., Thomsen, B., & Berry, A. (2022). Learning Through Play at School: A Framework for Policy and Practice. Frontiers in Education, 7. https://doi.org/10.3389/feduc.2022.751801
Prins, J., Van Der Wilt, F., Van Der Veen, C., & Hovinga, D. (2022). Nature play in early childhood education: A systematic review and meta ethnography of qualitative research. Frontiers in Psychology, 13. https://doi.org/10.3389/fpsyg.2022.995164
Rahiem, M. (2021). Storytelling in early childhood education: Time to go digital. International Journal of Child Care and Education Policy, 15. https://doi.org/10.1186/s40723-021-00081-x
Samaniego, M., Usca, N., Salguero, J., & Quevedo, W. (2024). Creative Thinking in Art and Design Education: A Systematic Review. Education Sciences. https://doi.org/10.3390/educsci14020192

Severino, G., Cabatic, E., & Molina, M. (2024). The Role of Play in Children's Development. The Asian Journal of Education and Human Development (AJEHD). https://doi.org/10.69566/ajehd.v5i1.100

Skene, K., O'Farrelly, C., Byrne, E., Kirby, N., Stevens, E., & Ramchandani, P. (2022). Can guidance during play enhance children's learning and development in educational contexts? A systematic review and meta-analysis. Child Development, 93, 1162–1180. https://doi.org/10.1111/cdev.13730

Sun, L., Kangas, M., Ruokamo, H., & Siklander, S. (2023). A systematic literature review of teacher scaffolding in game-based learning in primary education. Educational Research Review. https://doi.org/10.1016/j.edurev.2023.100546

Xiong, Z., Liu, Q., & Huang, X. (2022). The influence of digital educational games on preschool children's creative thinking. Computers & Education, 189, 104578. https://doi.org/10.1016/j.compedu.2022.104578

Yim, I., & Su, J. (2024). Artificial intelligence (AI) learning tools in K-12 education: A scoping review. Journal of Computers in Education, 1–39. https://doi.org/10.1007/s40692-023-00304-9