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A Study on the Development of Young Children's Problem-Solving Abilities in Outdoor Construction Play and Teacher Support Strategies

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Abstract

Guided by Vygotsky's Zone of Proximal Development theory and employing qualitative case analysis, this study delves into young children's problem-solving behaviors during outdoor constructive play and the underlying cognitive-emotional interaction mechanisms. Findings reveal that children exhibit a "trial-adjustment-continuation" problem-solving pattern, with strategy selection jointly influenced by cognitive level and emotional regulation capacity. Teachers effectively facilitated systematic transfer of experiences and the formation of associative thinking through a three-dimensional support strategy: "cognitive groundwork—delayed analysis—emotional reinforcement." Based on practical reflection, this study proposes three pedagogical principles: "timely nurturing, mutual learning empowerment, and trusting autonomy." These principles aim to construct an educational pathway integrating teacher resilience support with children's autonomous exploration, providing theoretical and practical references for cultivating young children's problem-solving abilities.

Keywords

Outdoor Play
Child Psychology
Constructive Play

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1. Introduction

Outdoor play serves not only as an outlet for energy but also as a setting rich in cognitive, social, and emotional demands. It guides children in setting goals, testing ideas, and negotiating with peers. Within this space, construction play using low-cost materials—such as pipes, building blocks, and cardboard—is particularly creative: open-ended materials offer multiple solutions, stimulating iterative design. However, little is known about the precise strategies young children employ to overcome obstacles in such settings, or how specific teacher interventions sustain or guide these efforts. Drawing on social constructivist learning theory [1] and classical scaffolding theory [2], this study examines problem-solving processes during outdoor construction play in a kindergarten classroom. The research poses the following questions:

(1) Can teacher support strategies resonate with

children's developmental levels?

(2) Can teacher guidance and children's experience transfer be mutually empowering?

(3) How do material cognition and problem-solving thinking develop?

Employing naturalistic video observation and a micro-genetic perspective[3], this study seeks to link the enabling characteristics of outdoor building material environments with the developmental process of problem solving. It also explores the tension between adult guidance and children's autonomy, as well as how safety regulations and material accessibility influence participation [4]. This study employs the term "outdoor building play" rather than "building play." In play research, play typically denotes fixed rule sets and externally defined goals, whereas game emphasizes children's autonomy, openness, and flexible objectives [5].

Outdoor construction play refers to children's self-initiated activities in outdoor settings, where they arrange, combine, balance, and transform low-structured materials to realize individual or collective design concepts or functionalities [6]. Typical materials include so-called loose parts—such as cardboard, pipes, wooden planks, crates, fabric, and logs—whose ambiguous properties yield multiple solutions. The outdoor environment, with its uneven surfaces, variable weather, and expansive activity space, creates rich opportunities for problem discovery and resolution[7].

Outdoor construction zones integrate physical space, variable surfaces, and low-structured materials to form what we term "multidimensional problem fields"—where objectives, constraints, and resources flow and intermingle. Unlike fixed equipment, loose-part materials can be reconfigured and reused, amplifying opportunities for planning, testing, and refinement [6]. Existing research indicates that such play is closely linked to spatial reasoning abilities and subsequent STEM-related competencies [8]. In this study setting, recycled materials (paper rolls, wood scraps, corrugated cardboard) prompted children to transition from two-dimensional layouts to three-dimensional constructions. This shift introduced core themes such as stability, balance, and collaborative design. These inherent challenges—allocating scarce materials, coordinating actions, and incorporating others' ideas—transform the construction zone into an effective setting for observing authentic problem-solving processes, rather than artificially designed task scenarios[7].

This study posits that problem-solving ability manifests in children's observable use and coordination of strategies (e.g., trial-and-error, forward planning, analogy reuse, social negotiation) while pursuing play goals, alongside their perseverance and flexible self-evaluation skills [9]. In outdoor construction activities, irregular materials and dynamically shifting social demands continuously trigger cognitive conflicts, guiding children through a cycle of problem identification → strategy exploration → practical testing → evaluation and refinement [6]. Teacher guidance plays a critical role here: timely prompts, discourse restructuring, or implicit tool provision can expand children's "zone of proximal development" [1,2]. Thus, we regard construction play as a natural laboratory for examining how strategy application emerges, stabilizes, and transforms through interactions involving adult scaffolding and peer collaboration[5].

2. Methodology

This study employs a case study approach within a qualitative research paradigm to deeply explore the specific manifestations of young children's problem-solving abilities in a particular context (outdoor construction play) and the interactive mechanisms between these abilities and teacher support strategies[10]. The research design adheres to the principle of "systematic observation in natural settings," emphasizing the capture of children's behavioral details and teacher-child interaction processes within authentic educational practices[11].

3. Research Sample

This study was conducted in a preschool class at XX Kindergarten in XX City. The class comprised 18 children aged 3–4 years (M = 3.5 years). Employing purposive sampling[12], one child—a 3-year-8-month-old boy identified as "Mingming"—was selected as the core observation subject. The selection criteria were: high engagement in play activities, cognitive and social abilities at the class average level, and behavioral patterns

exhibiting good typicality and representativeness. The research setting was the kindergarten's outdoor construction area, equipped with low-structure materials such as paper rolls, wooden blocks, cardboard, and aluminum cans, creating a rich and open problem-solving environment for children.

4. Data Collection and Analysis

Data collection primarily employed two methods to ensure richness and dual verification, with comprehensive analysis conducted using case study methodology.

Non-participatory observation: The researcher conducted outdoor play observations twice weekly for 90 minutes per session between April and June 2025. Employing a combination of time sampling and event sampling methods, continuous and detailed records were made of Mingming and his peers' problem-solving behaviors (e.g., attempts, seeking help, strategy adjustments, success/failure) and teachers' supportive behaviors (e.g., questioning, modeling, emotional encouragement, material provision), supplemented by field notes[13].

Teacher Interview: Following the observation period, a semi-structured interview was conducted with the primary classroom teacher. The interview focused on the teacher's intentions in supporting children's problem-solving, the rationale behind strategy selection, and reflections on intervention effectiveness. This aimed to understand the educational philosophy underlying the teacher's behaviors from their perspective[14].

5. Data Analysis

5.1. RQ1: Can teacher support strategies resonate with children's developmental levels?

In outdoor construction play, young children's problem-solving processes reflect dual trajectories of emotional regulation and cognitive development. On one hand, preschoolers in the younger age group demonstrate nascent resilience when encountering construction challenges. Their "attempt-adjust-persist" behavioral pattern reveals emotional stability and play persistence. On the other hand, their problem-solving efficacy is constrained by cognitive development. When confronted with abstract challenges like material properties, they tend to pursue "indirect development" by shifting the game's direction.

Recording:

Mingming erected two long toilet paper rolls as columns and placed a rectangular block horizontally as a ceiling. After completing the first floor, he attempted to build the second floor using the same method. However, as soon as he placed two cans on top, the first floor collapsed. Undeterred by this first failure, he rebuilt the fallen section. Yet every time he attempted the second level, the long paper roll cores on the first level collapsed. After several failures, Mingming came to me for help: "Teacher, why does my house always fall down?" I replied, "Since your first level keeps collapsing, there must be an issue with it. Can you identify any unsuitable materials in your first level?" Following my advice, he returned to continue building. A short while later, when I checked on him, I found he had stopped building a house and was instead constructing a bridge.

During outdoor construction play, children demonstrate emotional regulation and problem-solving skills when facing failures. In this case, Mingming didn't give up after his initial failure. He kept trying, sought help from the teacher after multiple setbacks, and when his request didn't solve the problem, he calmly adjusted his building plan instead of crying or throwing a tantrum. This shows that children can remain relatively emotionally stable and respond positively when facing challenges. Simultaneously, children's problem-solving abilities are influenced by cognitive development and life experience. Due to limited cognitive levels, preschoolers struggle to comprehend issues like the length, thinness, and material properties of toilet paper rolls affecting structural stability. Mingming, for instance, couldn't grasp the teacher's guidance regarding material limitations. However, they do not halt play due to unresolved problems but instead flexibly adjust their play direction.

During the children's play, the teacher attempted to provide cognitive support by posing questions to help them discover the material issue—that using a long paper roll core was unsuitable for constructing a single layer of pillars. However, due to the preschoolers' limited cognitive development and life experience, they were

unable to effectively understand the teacher's guidance. Consequently, the support provided by the teacher did not effectively resolve the problem the children faced. Subsequently, the children chose to abandon the issue and continue playing. This demonstrates that not every problem encountered in children's play requires immediate resolution. Support strategies that do not align with children's cognitive development and experiential background are unlikely to effectively assist them in solving problems. Teachers can assess whether a particular issue will disrupt the normal flow of play. If children can continue playing using their own methods, there is no need to rush to resolve the problem.

5.2. RQ2: Can teacher guidance and children's experience transfer be mutually empowering?

When solving problems encountered during outdoor play, young children need to draw upon their existing experiences. These experiences stem from all aspects of their daily lives. On one hand, preschoolers in the current small class can already spontaneously draw upon fragmented experiences to achieve cross-contextual strategy transfer, demonstrating the cognitive leap of "assimilation-accommodation." On the other hand, the three-dimensional support system constructed by teachers—through prior cognitive groundwork, delayed experience connections, and positive emotional reinforcement—not only provides scaffolding for children's independent exploration but also subtly advances their experience integration capabilities from "fragmented responses" to "systematic thinking."

Recording:

Mingming was building a house using wooden and plastic blocks. Progress was smooth initially as he selected materials based on his construction pace. When reaching the roof stage, he realized the large triangular blocks he needed were depleted. He searched through various bins, rummaging through boxes only to find small triangular blocks. He took several small triangles and fiddled with them on his house. Soon, he combined two small triangles to form a large one. After assembling it, he excitedly told me, "Teacher, look! I made a big triangle with two small ones!" I praised him: "You're amazing! You applied the skills you learned yesterday with the brain-teaser toys here!" During the game-sharing session, I shared Mingming's successful experience with the other children.

In outdoor construction play, children's problem-solving behaviors fully demonstrate the development of their ability to transfer and integrate experiences. In this case, Mingming encountered an obstacle while building a roof due to a shortage of materials. However, he quickly drew upon the shape-combining skills he had acquired during individualized learning activities. By combining two small triangular blocks into a large triangle to replace the missing material, he successfully overcame the challenge. This process indicates that preschoolers possess the awareness to transfer concrete experiences gained in activity areas to construction scenarios. Especially when play materials share similarities in shape, function, or other attributes with their original experiential carriers, they can proactively establish connections and attempt cross-contextual problem-solving strategies, demonstrating the "assimilation-accommodation" process. Mingming's actions not only reflect a deepened understanding of shape-matching principles but also demonstrate an emerging ability to integrate fragmented experiences into a universal problem-solving approach. This capacity enables him to apply consistent logic to similar challenges across different scenarios.

Teachers effectively fostered children's experiential transfer abilities through multidimensional support strategies. Cognitively, early individualized learning involving shape combination activities helped children accumulate foundational experience with triangle assembly, laying the cognitive groundwork for flexible application in subsequent construction play. During extended support sessions, teachers leveraged post-game sharing opportunities to transform Mingming's successful case into a collective learning resource. This approach reinforced his personal sense of accomplishment while guiding all children to recognize the transferability of experiences across different activity areas, gradually building metacognitive awareness that "learning experiences can be transferred." On the emotional front, timely encouragement and affirmation from teachers not only bolstered children's confidence in facing challenges but also reinforced the positive experience cycle of "attempt-solve-succeed" through positive feedback. This phased, multidimensional support model respects the

learning characteristics of preschoolers—who primarily rely on direct experiences—while subtly advancing their ability to integrate experiences to higher levels.

5.3. RQ3: How do material cognition and problem-solving thinking develop?

In the practical setting of outdoor construction play, young children's understanding of material properties and problem-solving abilities develop dynamically through embodied manipulation. Through emotional encouragement and cognitive guidance, teachers both strengthen children's confidence in exploration and help them transform fragmented experiences into transferable cognitive structures. This "experience-reflection" support model safeguards children's autonomy while cultivating their associative thinking between "material properties and problem-solving," revealing the mechanisms of deep learning within play contexts.

Recording:

Mingming selected wooden blocks and cardboard for construction today. He first used cylindrical wooden blocks as first-floor columns, placing large rectangular cardboard pieces atop them. He then selected various blocks to build a second level on the cardboard, seemingly without a clear pattern. During the sharing session, I asked Mingming to describe his creation while other children could ask questions. Mingming said, "This is the little park I built." Chenchen asked, "What's this tallest roof part?" Mingming pointed and explained, "This is the office. There's a little opening here—it's the park's gate. You go in through here." I pointed to two long cardboard pieces and asked, "What are these long cardboard pieces?" Mingming replied, "These are the roof. You can place blocks on top so the roof won't blow away." I said, "Mingming knows blocks are heavy, while cardboard is light and easily blown away by wind. So he placed blocks on top of the cardboard to weigh it down. This is a very useful method. Next time, we can learn from his clever idea."

During outdoor construction play, children's understanding and application of material properties naturally emerge through specific contexts. In this case, Mingming demonstrated a clear grasp of materials' physical characteristics during building: he observed that thin cardboard is easily affected by wind, while building blocks provide stability due to their weight. He then proactively combined the two materials—using blocks to weigh down the cardboard edges against wind interference. This behavior indicates that preschoolers can accumulate material experience through direct perception and have begun to develop a basic physical understanding of "light versus heavy." When natural factors (like wind) disrupt the building process, children can mobilize diverse materials from their environment (such as construction units of different textures and weights) as problem-solving tools. This demonstrates how the open-ended nature of play materials supports children in responding to challenges.

Teachers deepen children's play experiences and learning abilities through dual emotional and cognitive support. During the sharing session, teachers employed peer-to-peer interactions and teacher-student questioning to guide children's focus on Mingming's material combination strategy. This approach reinforced his sense of accomplishment through peer affirmation while analyzing the principle of "securing lighter objects with heavier ones" through concrete examples, transforming fragmented experiences into transferable cognitive structures. This support strategy safeguards children's enthusiasm for independent exploration while expanding individual experience boundaries through collective wisdom—teachers guided children to observe material weight differences through questioning, making abstract concepts tangible. Timely emotional encouragement combined with cognitive refinement of experiences synergistically propelled children to construct "material properties-problem solving" associative thinking within authentic problem-solving contexts.

6. Conclusions

This study systematically examined preschoolers' problem-solving behaviors during outdoor construction play and their interactive mechanisms with teacher support through qualitative case analysis. Key findings can be summarized in three aspects: First, the problem situations encountered by children in outdoor construction play primarily encompass three categories: structural challenges with materials, scarcity challenges with resources, and environmental

interference challenges. Second, when confronting these challenges, children exhibited a foundational "attempt-adjust-persist" behavioral pattern. They flexibly applied multi-tiered resolution strategies—persistence, experience transfer, and strategic avoidance—based on situational complexity. Most critically, the study revealed that the effectiveness of teacher support is highly contingent upon its alignment with children's cognitive developmental levels. By establishing a three-dimensional support system encompassing "cognitive groundwork, emotional empowerment, and socialized sharing," teachers can effectively facilitate children's transformation of fragmented experiences into systematic cognitive structures. This support helps children establish associative thinking between material properties and solution strategies, provided the intervention timing is accurately calibrated. Based on empirical findings, this study distills three educational principles: "timely nurturing," "mutual learning empowerment," and "trustful letting go." These principles provide theoretical foundations and practical guidance for constructing an educational pathway of collaborative development between teachers and children.

7. Limitations

This study has several limitations that warrant reflection. First, the single-case study design, while enabling in-depth description, limits the generalizability and extrapolation of findings. The subject, Mingming, possesses average abilities; although his behavioral patterns exhibit some typicality, they fail to encompass the diverse problem-solving approaches of children at different cognitive developmental levels and temperament types. Second, data collection primarily relied on observation and teacher interviews, lacking in-depth materials from the children's perspective (such as brief interviews or pictorial representations). Interpretations of children's internal cognitive motivations and emotional experiences thus depended heavily on adult external interpretations, carrying a certain risk of subjective inference. Furthermore, this study focused mainly on the immediate effects of teacher support, failing to track the long-term impact of these strategies on the development of children's problem-solving abilities. Future research should employ more diverse data sources and longer-term designs to reveal the developmental mechanisms of children's problem-solving abilities in a more comprehensive and profound manner.

Disclosure statement

The author declares no conflict of interest.

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