

Cognitive development of preschool children through outdoor activity programs

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Abstract

This experimental research presented in the article investigates the effectiveness of an innovative outdoor learning intervention program designed to enhance cognitive abilities in middle-group preschool children (ages 4-5). The study addresses the insufficient utilization of natural environments in current early childhood education curricula and the concerning "nature deficit" phenomenon affecting contemporary children. The intervention program, grounded in experiential learning principles and Kolb's theory, was implemented to develop four key cognitive dimensions: logical thinking, problem-solving, understanding causal relationships, and observation and comparison skills. The research employed a comparative design with experimental and control groups to evaluate the program's effectiveness and reflects a transdisciplinary approach.

Keywords:

outdoor learning, cognitive development, preschool education, experiential learning

1. Introduction

This experimental research focuses on integrating an innovative intervention program into preschool education, specifically designed for middle-group children (ages 4-5), aimed at developing cognitive abilities through outdoor activities. The educational program ensures comprehensive coverage of all three activity categories outlined in the Early Childhood Education Curriculum (2019) while creating optimal contexts for cognitive enhancement through nature-based learning experiences.

The research foundation rests on substantial scientific evidence demonstrating that experiential learning in natural environments facilitates both autonomous discovery and multisensory learning engagement. Studies indicate that varied and complex sensory experiences in outdoor settings stimulate the development of neuronal structures involved in cognitive processes, supporting fundamental skills such as sustained attention, working memory, executive functions, logical thinking, and language development.

At ages 4-5, children experience optimal periods for cognitive development, characterized by high neuronal plasticity and intense natural curiosity for environmental exploration. However, current curricular documents insufficiently exploit the educational potential of outdoor environments, despite acknowledging natural settings as learning sources.

This methodological gap limits the full utilization of natural contexts in developing preschoolers' cognitive abilities.

The intervention program addresses contemporary challenges in preschool education, including the alarming decrease in children's time spent in nature (the "nature deficit" phenomenon) and excessive orientation toward academic activities at increasingly younger ages. By implementing structured outdoor activities based on experiential learning principles, the program offers a balanced approach that values play and natural exploration as optimal methods for age-appropriate cognitive stimulation.

This research contributes to developing scientifically validated indigenous methodology that integrates outdoor learning systematically into Romanian preschool education, providing concrete methodological solutions for optimizing cognitive development through nature-based educational contexts.

2. Theoretical foundation

This experimental research focuses on integrating an innovative intervention program into preschool education, specifically designed for middle-group children (ages 4-5), aimed at developing cognitive abilities through outdoor activities. The educational program ensures comprehensive coverage of all three



activity categories (ALA, ADE, ADP) outlined in the Early Childhood Education Curriculum (2019) while creating optimal contexts for cognitive enhancement through nature-based learning experiences.

The research foundation rests on substantial scientific evidence demonstrating that experiential learning in natural environments facilitates both autonomous discovery and multisensory learning engagement. According to Kellert (2005), varied and complex sensory experiences in outdoor settings stimulate the development of neuronal structures involved in cognitive processes, supporting fundamental skills such as sustained attention, working memory, executive functions, logical thinking, and language development. The anticipated favorable impact of the intervention program on cognitive development is grounded in experiential learning principles, following Kolb's (1984) theory which identifies four essential stages: concrete experience, reflective observation, abstract conceptualization, and active experimentation, all facilitated by outdoor environments.

The decision to focus on middle-group children was deliberate and theoretically justified. At ages 4-5, children traverse an optimal period for developing fundamental cognitive abilities including sustained attention, working memory, executive functions, logical thinking, and language skills. During this developmental stage, neuronal plasticity remains exceptionally high, and educational interventions can have significant impact on cognitive development (Diamond & Lee, 2011). Additionally, preschoolers at this age manifest intense natural curiosity and intrinsic motivation for environmental exploration, elements that can be optimally utilized in outdoor educational contexts.

A complementary argument stems from the specificity of early childhood education: the preschool period represents the stage where formal learning prerequisites are consolidated and cognitive abilities necessary for adaptation to future schooling requirements are developed. Simultaneously, there is an increasing trend toward sedentarism and indoor time with excessive screen exposure, which can negatively affect optimal cognitive development. Therefore, instructional-educational activities in kindergarten must harness the potential of natural environments to reduce these tendencies and provide authentic, multisensory, and complex learning contexts.

However, current curricular documents insufficiently exploit the educational potential of outdoor environments, despite acknowledging natural settings as learning sources. A careful analysis of current curricular documents for preschool education reveals insufficient utilization of the educational potential of outdoor environments. Although the Early Childhood Education Curriculum (2019) mentions natural environments as learning sources, there is no systematic and explicit approach to how outdoor activities can be integrated into educational practice for cognitive optimization. This methodological gap limits the full utilization of natural contexts in developing preschoolers' cognitive abilities, constituting additional justification for the necessity of this research.

The methodological letter for the 2021-2022 school year (Ministry of Education, 2021) signaled the need for diversifying learning contexts, mentioning the value of outdoor activities for children's holistic development. However, concrete methodological aspects regarding the design and implementation of systematic outdoor activity programs focused on cognitive stimulation remain insufficiently elaborated. This normative framework, while recognizing the importance of outdoor education, requires scientifically grounded methodological developments, an objective to which this research aims to contribute.

The intervention program addresses contemporary challenges in preschool education, including the alarming decrease in children's time spent in nature (the "nature deficit" phenomenon as described by Louv, 2008) and excessive orientation toward academic activities at increasingly younger ages, which can lead to inadequate cognitive pressure and diminished intrinsic motivation for learning. Systematic research has indicated significant statistical associations between nature activities and attention improvement (Faber Taylor & Kuo, 2009), between outdoor play and executive function development (Burdette & Whitaker, 2005), between direct experiences in natural environments and increased problem-solving capacities (Kellert, 2005), and between natural environment exploration and development of descriptive language and scientific thinking (Fjørtoft, 2001).

International literature highlights the existence of significant educational currents oriented toward utilizing natural environments as learning spaces. Conceptualizations such as "Forest Kindergarten" in Nordic countries, "Nature Preschools" in the United

States and Great Britain, and "Waldkindergarten" in Germany represent institutional models that have demonstrated significant cognitive benefits for preschoolers (Sobel, 2016). However, in the Romanian educational context, these approaches are insufficiently integrated and adapted to national cultural and curricular specificity, representing another argument for developing scientifically validated indigenous methodology.

By implementing structured outdoor activities based on experiential learning principles, the program offers a balanced approach that values play and natural exploration as optimal methods for age-appropriate cognitive stimulation. The program promotes active exploration and direct interaction with natural environments, supporting principles of integrated learning and child-centered approaches, making participation in educational activities a source of satisfaction derived from discovery, autonomy, competence, and connection with nature.

This research contributes to developing scientifically validated indigenous methodology that integrates outdoor learning systematically into Romanian preschool education, providing concrete methodological solutions for optimizing cognitive development through nature-based educational contexts. The insufficient operationalization of outdoor activities in current curricular documents represents an opportunity for developing innovative methodological proposals that optimize the utilization of natural environments in cognitive stimulation of preschoolers.

3. Research methodology

The purpose of this research was to identify the effectiveness of an experimental intervention program focusing on outdoor activities that foster cognitive development, applicable to middle groups preschool children.

Research objectives are as follows:

1. Design and implementation of an intervention program based on outdoor learning activities, complementary to curricular activities, aimed at developing cognitive abilities of middle-group preschoolers.
2. Analysis of changes in cognitive development indicators following the implementation of the intervention program in the experimental group of subjects, through comparison of results from the pre-experimental and post-experimental phases

and comparison of results between the experimental and control groups.

4. Results

The analysis of results demonstrates the effectiveness of the experiential intervention program in the natural environment for developing all four cognitive dimensions investigated. For an overall picture of the intervention effects, we present below a synthesis of comparative results between the experimental group and the control group.

Table 1.

Comparison of Cognitive Dimensions: Experimental vs Control Groups

Cognitive Dimension	Group	Pretest		Posttest		Difference	F(1; 129)	p	η^2
		M	SD	M	SD				
Logical thinking	Experimental	85.2	7.5	97.3	6.4	12.1	26.87	0.001	0.17
	Control	84.8	7.3	86.2	7.1	1.4			
Problem solving	Experimental	84.5	7.2	96.8	6.7	12.3	29.84	0.001	0.19
	Control	85.1	7.0	87.3	6.9	2.2			
Understanding causal relationships	Experimental	82.3	7.8	95.7	6.5	13.4	31.77	0.001	0.20
	Control	81.9	7.5	84.2	7.8	2.3			
Observation and comparison	Experimental	76.8	8.2	92.4	7.6	15.6	33.86	0.001	0.21
	Control	77.1	7.9	80.7	8.1	3.6			

As can be observed from Table 1, for all four cognitive dimensions investigated, the experimental group recorded significantly greater improvement in performance between the pretest and posttest phases, compared to the control group. The statistical analysis reveals robust and consistent patterns of enhancement across all measured cognitive abilities, demonstrating the substantial effectiveness of the experiential intervention program implemented in the natural environment.

The magnitude of improvements achieved by the experimental group substantially exceeds those of the control group across all dimensions. These findings provide compelling evidence for the efficacy of the intervention, with effect sizes ranging from moderate to large ($\eta^2 = 0.17$ to 0.21), indicating that the intervention accounts for 17% to 21% of the variance

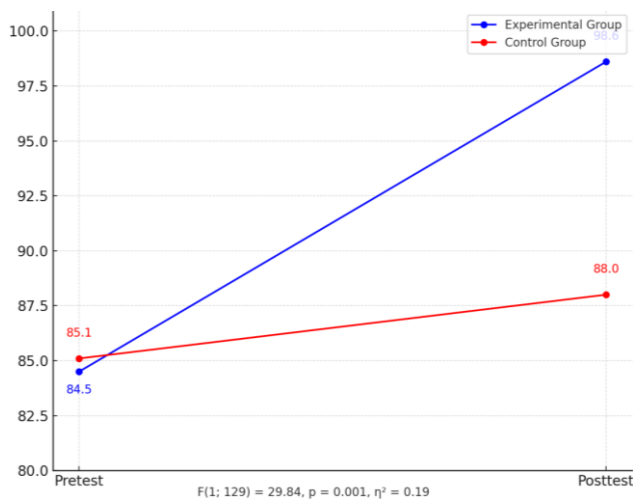
in cognitive performance improvements. All F-statistics demonstrate high significance levels ($p < 0.001$), confirming that the observed differences are statistically robust and unlikely to have occurred by chance.

The consistency of results across all four cognitive dimensions suggests that the experiential intervention program addresses fundamental cognitive processes that underlie multiple aspects of intellectual development. This comprehensive improvement pattern indicates that the intervention effectively targets core cognitive mechanisms rather than isolated skills, leading to broad-spectrum enhancement in cognitive functioning among middle-aged preschoolers.

Furthermore, the substantial numerical differences between groups highlight the practical significance of the intervention beyond mere statistical significance. The experimental group's gains represent meaningful developmental advances that are likely to have lasting impact on children's cognitive development and academic readiness.

Figure 1.

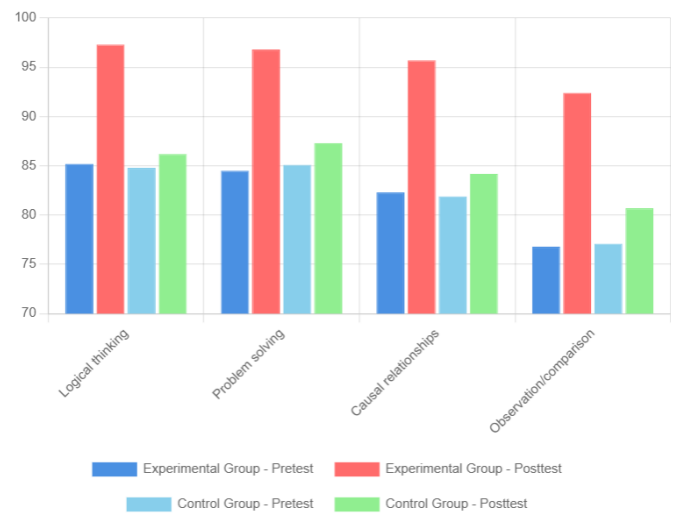
Comparison of the level of problem-solving skill development between the experimental group and the control group



This analysis compares the development of problem-solving skills between the experimental group and the control group. The results indicate that the experimental group showed a significant improvement from the pretest to the posttest, suggesting that the intervention had a strong positive effect. In contrast, the control group displayed only a slight increase, implying that without the intervention, problem-solving skills remained relatively stable. This supports the effectiveness of the applied program in enhancing cognitive abilities related to problem resolution.

Figure 2.

Synthesis of the evolution of cognitive abilities in middle-aged preschool children: A comparative analysis of pretest and posttest results between the experimental and control groups



5. Discussions

The findings of this study highlight the positive impact of outdoor education on the development of cognitive skills in preschool children. The statistically significant improvements observed in the experimental group—particularly in areas such as logical thinking, problem solving, causal reasoning, and observational comparison—demonstrate the effectiveness of the outdoor learning intervention. In contrast, the control group showed only marginal progress, reinforcing the assumption that traditional indoor instruction alone may not suffice in stimulating complex cognitive development during early childhood.

These results align with prior research (e.g., Dillon et al., 2006; Maynard & Waters, 2007), which emphasizes the role of outdoor environments in fostering active engagement, intrinsic motivation, and deeper conceptual understanding. The present study also supports constructivist learning theories, suggesting that meaningful knowledge construction occurs most effectively through direct exploration, hands-on experiences, and situated learning in real-life contexts.

From an educational perspective, the data advocates for the systematic inclusion of outdoor learning experiences within the early childhood curriculum. Rather than serving as supplementary or recreational activities, outdoor pedagogies should be recognized as legitimate, evidence-based methodologies capable of achieving curricular goals through inquiry, experimentation, and reflective practice.

However, this study is not without limitations. The relatively short duration of the intervention and the limited sample size may affect the generalizability of the findings. Additionally, contextual variables- such as the educators' level of training, the quality of outdoor resources, or environmental conditions- might have influenced the outcomes to some extent.

Future research should consider longitudinal designs, larger and more diverse participant groups, and multi-dimensional assessments that explore not only cognitive gains but also social, emotional, and motor development. Such investigations would further elucidate the scope and sustainability of outdoor education's benefits across multiple domains of early childhood growth.

6. Conclusions

A key finding of this research highlights the potential of outdoor education to organically integrate content from various domains of experience, providing authentic opportunities for contextualized learning. The proposed activities are not mere supplements to the existing curriculum, but rather effective methodological alternatives for achieving curricular objectives through exploration, discovery, and active reflection. This transdisciplinary approach aligns with contemporary trends in early childhood education, which advocate for moving beyond rigid boundaries between domains of knowledge and promoting meaningful learning in real-life contexts. As Dillon et al. (2006) emphasize, outdoor education offers integrated learning opportunities that cannot be replicated within the conventional classroom environment, thereby reinforcing the role of nature as a complex educational space that fosters holistic cognitive development.

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