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Nature-Based Learning and the Development of Naturalistic Intelligence in Early Childhood

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Abstract
This study investigates the effectiveness of nature-based learning through mini garden activities in stimulating naturalistic intelligence in early childhood. Naturalistic intelligence—the ability to recognize, categorize, and interact with elements of the natural environment—is essential to develop during early years. Using a quantitative pre-experimental design with a one-group pretest-posttest model, the study involved 15 children aged 5–6 at a rural early childhood education institution. Data were collected through observations, structured tests, and interviews. Results showed a significant increase in children's ability to identify plant names and parts, classify natural elements, and demonstrate curiosity toward nature. A paired-sample t-test confirmed this improvement ($p < 0.001$), with a large effect size (Cohen's $d = 2.57$). Expert validation and reliability testing (Cronbach's $\alpha = 0.84$) confirmed the instrument's quality. Findings suggest that nature-based learning is a practical, contextually adaptable approach for enhancing children's cognitive and socio-emotional development through direct environmental interaction.

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INTRODUCTION

Early childhood education is crucial in laying the foundation for children's cognitive, emotional, social, and motor development. At this formative stage, it is essential to implement holistic learning approaches that align with the developmental needs of young learners (Kiviranta et al., 2024; Rasri et al., 2024). One such approach is nature-based learning, which directly engages with the natural environment. This model is considered effective in stimulating children's naturalistic intelligence (Jr. et al., 2014; Sari et al., 2022)—the capacity to recognize, categorize, and interact meaningfully with elements of the natural world.

Through his theory of multiple intelligences, Gardner identifies naturalistic intelligence as one of the core domains that should be nurtured early (Cavas & Cavas, 2020; Gardner, 2011; Morgan, 2021). This type of intelligence encompasses a child's ability to understand flora, fauna, and natural phenomena and appreciate ecological order and beauty. During early childhood, when curiosity and the desire to explore are at their peak, nature-based learning offers an ideal means to develop this intelligence by integrating environmental elements into the learning process.

Despite its potential, implementing nature-based learning in early childhood education (ECE) institutions in Indonesia still faces considerable challenges (Waluyo & Kardoyo, 2020). Predominantly, classroom-based learning with limited media prevails, and using natural surroundings as an educational resource is underutilized (Hunter et al., 2020). Johnstone et al. found that Nature-based early childhood education may improve children's social, emotional, and cognitive development, including observation, classification, and curiosity (Johnstone et al., 2022). That highlights the need for a shift in pedagogical practices to optimize children's developmental outcomes through immersive experiences.

Several studies have emphasized the relevance of nature-based learning in developing naturalistic intelligence. Liani et al. (2020) stated that nature-based learning in early childhood education can develop students' naturalist intelligence. However, schools face some challenges in implementation (Liani et al., 2020), while Hughes (2023) analyzed outdoor learning's impact in a rural kindergarten setting (Hughes, 2023). Afandi (2020) explored the link between children's interest in nature and their levels of naturalistic intelligence (Afandi, 2020). Although informative, these studies do not comprehensively examine structured nature-based interventions such as mini gardens, nor do they explore supporting and inhibiting factors in detail—particularly in rural institutions.

The institution observed in this study has notable potential to implement nature-based learning due to its rural location and access to diverse natural resources, including rice fields, gardens, and rivers. However, interviews with school administrators revealed limited teacher knowledge and a lack of structured learning models as significant barriers. Teachers were willing to integrate natural elements into their pedagogy but lacked practical guidance on designing systematic learning experiences.

Compounding this issue is the growing concern over reduced naturalistic intelligence in today's digital generation. Many Alpha generation children are

more exposed to gadgets than to natural environments (Myung et al., 2025; Susanti, 2023), resulting in diminished ecological understanding. Some parents also prioritize academic achievement over environmental literacy, limiting opportunities for nature-based exploration. However, in a world facing environmental degradation, fostering ecological empathy and environmental problem-solving skills is crucial. As a study suggests, developing naturalistic intelligence can shape responsible individuals who are both environmentally aware and action-oriented (Setyaningsih et al., 2024).

Given these challenges and opportunities, this study addresses the pressing need to identify effective strategies for integrating nature-based learning into early childhood education. Focusing specifically on naturalistic intelligence, the research aims to generate practical insights for educators and parents on balancing technological proficiency with ecological awareness in children's development.

Interviews with parents further underscore the demand for diverse and engaging learning experiences. One parent shared that although her child enjoyed playing in the garden, she hoped for more structured and educational activities. This sentiment reflects the necessity of embedding nature-based learning systematically into the curriculum. While the institution's setting offers rich opportunities for contextual learning, empirical studies evaluating the effectiveness of such interventions remain scarce. This study seeks to fill that gap by examining the impact of a structured mini-garden program on the naturalistic intelligence of early childhood learners.

According to studies, nature-based learning benefits intellectual development and children's social and emotional growth (Johnstone et al., 2022; Tamblyn et al., 2023). Children who regularly interact with nature tend to be more empathetic and cooperative (Giusti et al., 2014). It is supported by Wetering et al., who noted that Environmental education improves children's environmental knowledge, attitudes, intentions, and behaviors (Wetering et al., 2022). Nature-based activities also contribute to physical development by enhancing fine and gross motor skills (Watts, 2022).

Considering the aforementioned factors, investigating the effectiveness of nature-based learning becomes imperative. This study evaluates the extent to which this pedagogical approach enhances naturalistic intelligence and explores the contextual enablers and barriers to its implementation. The insights gained are intended to assist educators in designing sustainable and impactful nature-based learning practices in early childhood settings. The primary objectives are to describe the implementation of nature-based learning, analyze its effectiveness in stimulating children's naturalistic intelligence through a mini garden program, and identify key factors that facilitate or hinder its success.

METHOD

This research employed a quantitative pre-experimental design using a one-group pretest-posttest model to determine the effectiveness of nature-based learning—specifically the "Mini Garden" activity—in stimulating the development of naturalistic intelligence among early childhood learners. This

design enables the comparison of children's naturalistic intelligence before and after the intervention to assess the instructional impact.

The study was conducted at a preschool institution located in a rural area that is conducive to nature-based activities. The participants were 15 children aged 5–6 years selected through purposive sampling based on teacher recommendations concerning their readiness and participation potential in outdoor learning programs. The sample size, while limited, is typical for exploratory early childhood studies in natural settings.

The nature-based learning intervention spanned four consecutive weeks, with one session per week lasting approximately 60 minutes. Activities included planting, watering, observing plant growth, drawing observations, and discussions on plant functions, which were thematically integrated across science, language, and arts domains.

The primary instrument was a researcher-developed observational and test-based assessment of naturalistic intelligence, encompassing the following indicators:

1. Recognition of plant names;
2. Identification of plant parts (roots, stems, leaves);
3. Classification of plants based on shape/color
4. Expression of curiosity and questions about nature.

Details of the instrument, including item formats and scoring rubrics, are provided in Appendix A.

Three early childhood education specialists and one educational psychologist expertly validated the instrument. The experts evaluated it based on content relevance, clarity, and developmental appropriateness, and they recommended revisions.

To determine internal consistency reliability, a pilot test was conducted with 10 children from a neighboring ECE institution. The resulting Cronbach's alpha coefficient was 0.84, indicating high reliability for the instrument ($\alpha > 0.70$ is considered acceptable).

Children's naturalistic intelligence was assessed before (pretest) and after (post-test) the intervention. Scores were analyzed using the paired-sample t-test to determine the significance of mean score differences. Cohen's d was calculated to assess the effect size.

Table 1

the Descriptive Statistics and Inferential Test Results

Variable	Pretest Mean (SD)	Post-test Mean (SD)	t (df=14)	p-value	Cohen's d
Naturalistic Intelligence Score	57.3 (±8.45)	82.1 (±6.90)	-11.62	< 0.001	2.57

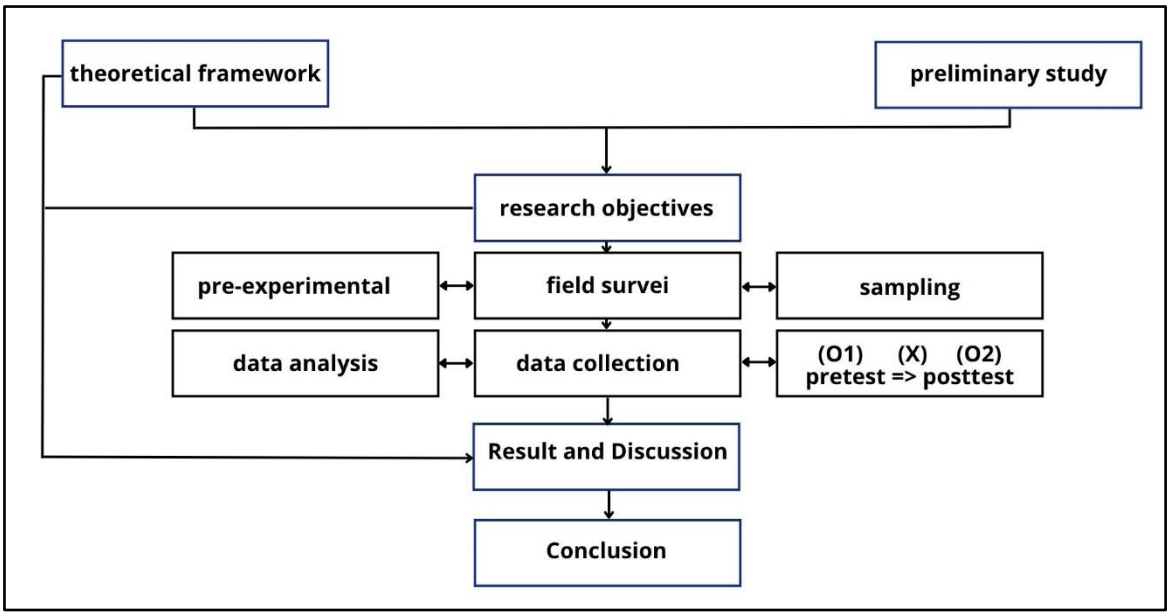
The t-test results revealed a statistically significant increase in post-test scores ($p < 0.001$), with an enormous effect size (Cohen's $d = 2.57$), suggesting

that nature-based learning had a substantial positive impact on children's naturalistic intelligence.

The flowchart of this research is as follows:

Picture 1

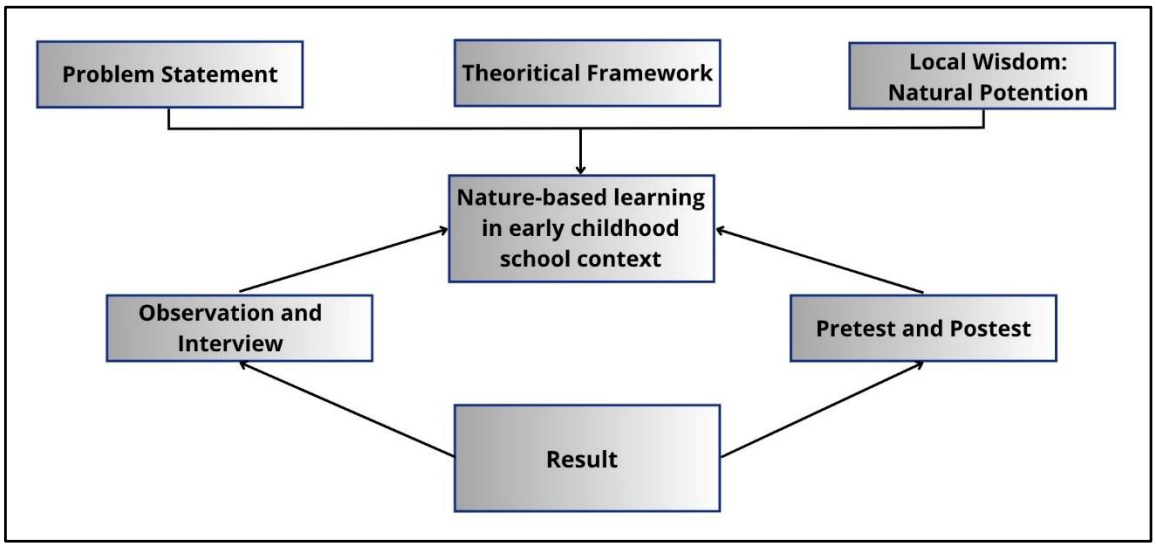
Research Flow Chart



For further clarity regarding the framework of thought that has been described, it can be explained through the following diagram:

Picture 2

Research framework



RESULT

1. Implementation of Nature-Based Learning

The Nature-based learning was implemented through a "Mini Garden" activity designed to integrate the local natural environment into the educational process. Over four weeks, children participated in weekly sessions of approximately 60 minutes each.

Observational and documentation analysis showed that teachers effectively facilitated exploratory learning experiences targeting multiple aspects of child development. Activities included planting, watering, observing plant growth, illustrating observations, and conducting simple discussions on the functions of plants in daily life. These findings reveal that teachers moved beyond conventional instruction, offering direct, meaningful interactions between children and their environment.

Teachers assumed roles as active and reflective facilitators, designing contextual outdoor activities. This setting fostered a joyful learning atmosphere and encouraged children's natural exploration and understanding. This approach resonates with early childhood education principles, emphasizing child-centered learning grounded in real-world experience.

Children demonstrated enthusiastic responses to outdoor learning. Observations revealed high levels of engagement, curiosity, and spontaneous participation. Children frequently asked questions, shared ideas about their observations, and exhibited excitement when illustrating what they saw, indicating increased intrinsic motivation.

The learning process was also implemented thematically and integratively, bridging multiple developmental domains. Scientific understanding was promoted through observations and discussions of plant structures and functions. Language development occurs via interactive communication between teachers and children. Meanwhile, artistic expression was nurtured through drawing activities based on direct experiences. This multidisciplinary integration effectively enriched children's comprehensive development.

Overall, these findings confirm that nature-based learning, as applied, promotes children's motivation, engagement, and multidimensional growth. The thematic-integrative strategy is well-aligned with Indonesia's Merdeka Curriculum, which encourages contextualized, flexible, and creative learning approaches.

Table 2

The Observation Results on the Nature-Based Learning Implementation

No	Observed Aspects	Findings
1	Teacher Facilitation	Exploratory activities such as planting, watering, observing, drawing, and discussion
2	Children's Responses to Outdoor Activities	High interest, active engagement, and spontaneous inquiry
3	Learning Approach	Thematic and integrative, covering science, language, and art

Nonetheless, the absence of a formal nature-based learning module or detailed lesson plans meant that instructional design relied heavily on contextual understanding and teacher improvisation, limiting systematic innovation.

2. The Effectiveness of Nature-Based Learning in Stimulating Children's Naturalistic Intelligence

The impact of nature-based learning was assessed using pretest and post-test measures of naturalistic intelligence. The results across specific indicators are presented below:

Table 3

The Results of the Pretest and Post-test

Indicator	Before (Pretest)	After (Post-test)	Improvement
Recognizing plant names	3 out of 15 children	12 out of 15 children	300% increase
Identifying plant parts (roots, stems, leaves)	2 children	10 children	400% increase
Classifying plants by shape/color	1 child	8 children	Significant improvement
Curiosity about nature	5 active children	13 active children	Increased exploratory engagement

Statistical analysis showed a substantial increase in average scores, rising from 57.3 (pretest) to 82.1 (post-test)—a gain of 24.8 points. This improvement supports the conclusion that nature-based interventions significantly enhance naturalistic intelligence.

Several contributing factors were identified:

a. Concrete, hands-on experiences: Direct interaction with nature—planting, touching soil, observing growth—helped children internalize concepts more effectively than visual instruction alone.
b. Physical and emotional engagement: Outdoor settings stimulated cognitive and affective domains, offering freedom and enjoyment that enriched learning outcomes.
c. Activation of naturalistic skills: The activities allowed children to practice observing, classifying, and reflecting—key components of naturalistic intelligence. Environmental stimuli sharpened their ability to detect natural patterns and ecological relationships.

3. Supporting and Inhibiting Factors

The implementation of nature-based learning was influenced by both facilitating and constraining factors. Understanding these dynamics is essential for improving program sustainability.

a. Supporting Factors

1) Supportive Physical Environment

The school is surrounded by natural features such as gardens, rice fields, and trees, offering rich contextual and experiential learning resources.

2) Developmental Characteristics of Children

Group B children (aged 5–6 years) are at a developmental peak in curiosity and sensory engagement, making them naturally responsive to environmental stimuli.

3) Teacher Initiative and Informal Support

Despite limited formal training, many teachers showed strong initiative and creativity in developing nature-based activities. Their commitment has been a key driver of implementation success.

b. Inhibiting Factors

1) Limited Teacher Knowledge

A lack of formal understanding of nature-based pedagogy resulted in inconsistent planning, suboptimal media use, and inadequate assessment strategies. Most teachers relied on intuition and conventional practices.

2) Conservative Parental Mindsets

Many parents prioritized academic skills (e.g., literacy and numeracy) over environmental learning. This skepticism led to passive resistance toward outdoor educational innovations.

3) Technical and Infrastructure Constraints

Unparalleled weather, lack of outdoor instructional tools, and the absence of Standard Operating Procedures (SOPs) hindered smooth implementation. Activities were often conducted informally without structured planning, safety guidelines, or defined success indicators.

Recognizing both enabling and inhibiting factors offers valuable direction for future program improvement. Recommendations include targeted professional development for teachers, broader parent education about the value of nature-based learning, and the development of clear operational guidelines. With these strategies, the institution can sustain and scale nature-based learning as a transformative, context-driven educational model for early childhood development.

DISCUSSION

This study demonstrated that nature-based learning, implemented through structured mini-garden activities, significantly improved the naturalistic intelligence of early childhood learners. Quantitative results revealed a 24.8-point increase in average scores, supported by a large effect size (Cohen's d = 2.57). This outcome was further reflected in observable changes across all four measured indicators—plant recognition, part identification, classification, and curiosity—where increases ranged from 160% to 400%. These findings suggest that when learning is rooted in direct, tangible experiences, it becomes more meaningful and developmentally impactful for young children.

The results align closely with Howard Gardner's theory of multiple intelligences, emphasizing real-world experiences' role in developing naturalistic intelligence (Gardner, 2011). Children's ability to recognize patterns in nature, ask exploratory questions, and classify natural elements

confirms Gardner's assertion that this intelligence can and should be fostered from an early age. Furthermore, the engagement observed aligns with constructivist learning principles, which advocate for hands-on, contextualized experiences to deepen understanding (Sardar, 2023; Sharma, 2020).

The present findings support earlier research highlighting the benefits of outdoor or nature-based education. For instance, Johnstone et al. (2022) found that nature-based early education promotes children's cognitive and emotional development (Johnstone et al., 2022). However, this study contributes further by quantifying the effect and implementing a structured model over a short, replicable timeframe. Compared to Afandi, who explored children's interest in nature, our findings indicate heightened interest and measurable cognitive gains (Afandi, 2020). Additionally, the thematic integration of science, language, and arts reinforces findings from Sari et al. on the value of multidisciplinary learning in outdoor contexts (Sari et al., 2022).

These results underscore the potential of nature-based learning as a low-cost, high-impact pedagogical model, particularly in rural or semi-natural environments. In Indonesia's Merdeka Curriculum, which emphasizes flexibility, contextual learning, and holistic development, structured nature-based modules can enrich early childhood education. Various studies have mentioned ways to implement nature-based learning. Among them are Smedsrud et al., who states that teachers can support children's play in nature-based outdoor spaces by facilitating free/unstructured play and teacher-led/guided interactions (Smedsrud et al., 2024).

Children's increased motivation, cooperation, and empathy support arguments for incorporating environmental education into the core curriculum (Mann et al., 2022; Wetering et al., 2022). Moreover, this study shows how nature can be used as a context for play and an intentional learning medium (Prins et al., 2022; Sobel, 2014).

Another key finding relates to the role of the teacher. Despite limited formal training, teachers effectively facilitated exploratory activities by drawing on contextual understanding and initiative. That affirms the position of Davis and Davis, who advocate for strengthening teacher capacity through environmental pedagogy (Davis & Davis, 2020). However, parental perceptions remained challenging; many still viewed academic instruction as superior to exploratory or outdoor learning. Therefore, effective communication strategies and parental involvement programs are essential for the long-term adoption of nature-based approaches.

While the results are promising, several limitations should be acknowledged. First, the small sample size (n = 15) limits generalizability. Second, the short intervention duration (4 weeks) may not capture long-term developmental impacts. Third, the lack of a control group makes it difficult to isolate the effect of the intervention from other potential variables. Additionally, the teacher's dual role as facilitator and observer may introduce subjectivity.

Future research should involve larger, more diverse samples, experimental or quasi-experimental designs, and longitudinal studies to assess sustained outcomes. Investigating blended models that combine digital media with

outdoor learning could also address digital-native children's challenges while maintaining ecological awareness.

CONCLUSION

This study confirms that nature-based learning, implemented through structured mini-garden activities, is highly effective in stimulating naturalistic intelligence in early childhood. The intervention significantly improved children's ability to recognize, classify, and reflect on elements of nature, as evidenced by a substantial increase in post-test scores and a large effect size (Cohen's d = 2.57). These results validate the importance of real, sensory-rich experiences in supporting cognitive and emotional development, consistent with Gardner's theory of multiple intelligences.

In addition to cognitive gains, nature-based learning fostered children's curiosity, engagement, and social-emotional skills such as collaboration and empathy. The thematic and integrative approach supported holistic development across scientific, linguistic, and artistic domains. These findings reinforce the relevance of context-based learning models, particularly in rural early childhood education settings with abundant natural resources.

However, challenges persist. Limited teacher training, parental misconceptions favoring academic instruction, and logistical constraints must be addressed to ensure sustainable implementation. To maximize impact, nature-based learning should be embedded within the national early childhood curriculum, supported by teacher capacity-building programs, improved outdoor infrastructure, and active parent-school collaboration. With appropriate support, this approach holds strong potential for broader application across early childhood institutions in Indonesia and beyond.

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