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BRIDGING DIGITAL AND NATURAL WORLDS: NATURE-BASED LEARNING FOR ENHANCING CREATIVITY, SOCIO-EMOTIONAL DEVELOPMENT, AND ENVIRONMENTAL STEWARDSHIP IN MALAYSIAN PRESCHOOLS

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ABSTRACT

This study investigated how Malaysian preschool teachers implement nature-based learning (NBL) to foster children's creativity, socio-emotional development, and environmental stewardship. Guided by Education for Sustainable Development (ESD) and Sustainable Development Goals (SDG 3: Good Health and Well-Being; SDG 4: Quality Education), the research adopted a qualitative approach using thematic analysis to identify key patterns and themes, especially in examining teachers' implementation of nature-based learning. Data were gathered through semi-structured interviews, classroom observations, and curriculum document analysis, involving 18 teachers, one preschool officer, and three supervisors from Malaysian public and private preschools. Findings revealed teachers' creative use of natural materials and outdoor environments across nine modalities, supporting holistic development and environmental awareness. Despite resource limitations, teachers displayed strong agency in adapting ESD principles to the preschool context, highlighting NBL as an essential bridge between digital learning and ecological connectedness.

Keywords: nature-based learning, environmental stewardship, creativity, socio-emotional development, education for sustainable development, digital childhood

INTRODUCTION

The rapid digitalisation of childhood has fundamentally reshaped young children's everyday experiences, introducing unprecedented levels of screen exposure while simultaneously reducing opportunities for outdoor play and direct engagement with the natural environment. Although digital technologies offer new possibilities for learning and interaction, excessive reliance on screens has raised global concerns regarding children's physical health, socio-

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emotional development, and diminishing connections with nature. Scholars have argued that early disconnection from the natural world may undermine children's well-being and long-term environmental responsibility, a phenomenon widely conceptualised as *nature-deficit disorder* (Louv, 2008).

From a developmental perspective, early childhood represents a critical period for fostering emotional regulation, social competence, creativity, and environmental sensitivity. Wilson's (1984) biophilia hypothesis posits that humans possess an innate tendency to affiliate with nature, suggesting that regular and meaningful interactions with natural environments are essential for healthy development. A growing body of empirical research demonstrates that nature-based experiences support children's cognitive, physical, and socio-emotional development, while simultaneously nurturing pro-environmental attitudes and behaviours (Kellert, 2002; Ives et al., 2018). Despite this evidence, opportunities for children to engage with nature have declined globally due to urbanisation, academic pressures, safety concerns, and the increasing dominance of digital media in children's daily lives.

In response to these challenges, nature-based learning has gained prominence as a pedagogical approach that reconnects children with the living world through experiential, play-based, and inquiry-oriented activities. Such approaches align closely with the principles of Education for Sustainable Development (ESD), which emphasise holistic learning, environmental stewardship, and the cultivation of values and competencies necessary for sustainable futures. Within the global education agenda, these priorities are reflected in the Sustainable Development Goals (SDGs), particularly SDG 3 (Good Health and Well-Being) and SDG 4 (Quality Education), both of which highlight the importance of early educational interventions that promote well-being and lifelong learning.

In the Malaysian context, early childhood education is guided by the National Preschool Curriculum Standard (KSPK), which aspires to develop holistic, creative, and environmentally responsible learners. However, empirical studies suggest that pedagogical practices in Malaysian preschools remain largely teacher-directed and worksheet-based, with limited integration of play-based, experiential, and nature-oriented approaches (Lan & Abu Bakar, 2024; Qi & Mohamed, 2024). Although prior research has documented the developmental benefits of nature-based learning, there remains a significant gap in understanding how preschool teachers in Malaysia implement nature-based pedagogy in everyday classroom practice, particularly in resource-constrained, digitally saturated environments.

The newly revised *Kurikulum Standard Prasekolah Kebangsaan (KSPK 2026)* further strengthens this imperative by incorporating elements of Kelestarian Alam Sekitar (Environmental Sustainability) and Pembelajaran Bermakna (Meaningful Learning). These revisions explicitly promote inquiry, play, and outdoor interaction, underscoring the relevance of nature-based pedagogy within Malaysia's evolving preschool framework.

Addressing this gap is essential for advancing both theory and practice in early childhood education. While much of the existing literature focuses on the outcomes of children's exposure to nature, fewer studies examine the pedagogical strategies, teacher creativity, and contextual adaptations that enable nature-based learning to occur in real-world preschool settings. Accordingly, this study aims to examine how Malaysian preschool teachers implement nature-based pedagogy and how such practices facilitate children's engagement with nature in fostering creativity, socio-emotional development, and environmental

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stewardship. Grounded in the framework of Education for Sustainable Development (ESD), the study further explores the alignment of these pedagogical practices with Sustainable Development Goals SDG 3 (Good Health and Well-Being) and SDG 4 (Quality Education).

The study is guided by the following research questions:

i) How is nature-based pedagogy implemented by preschool teachers in Malaysia?
ii) How do these pedagogical practices support children's connection with nature in advancing Education for Sustainable Development and the selected Sustainable Development Goals?

LITERATURE REVIEW

Nature-Based Learning in Early Childhood Education

Nature-based learning in early childhood education encompasses pedagogical methods that deliberately incorporate natural environments, materials, and processes into children's educational experiences. Rooted in experiential and play-based traditions, these approaches emphasize hands-on exploration, sensory engagement, and child-led inquiry within outdoor or nature-rich settings. A substantial body of research indicates that nature-based learning supports holistic development by promoting physical activity, curiosity, creativity, and social interaction among young children (Kellert, 2002; Reese et al., 2019).

In early childhood contexts, learning through nature extends beyond outdoor play to include the purposeful use of natural and recycled materials in classroom activities, gardening projects, and sustainability-oriented routines. These experiences allow children to engage with tangible, living systems, fostering deeper understanding and emotional connections compared to abstract or worksheet-based instruction. Empirical studies have shown that children who participate in nature-based activities demonstrate higher levels of engagement, cooperation, and intrinsic motivation, alongside improved emotional well-being (Charan et al., 2024). Collectively, these findings underscore the pedagogical value of nature-based learning as a meaningful counterbalance to increasingly sedentary and screen-mediated childhoods.

Biophilia and Nature-Deficit Disorder

The theoretical foundations of nature-based learning are strongly informed by Wilson's (1984) biophilia hypothesis, which posits that humans possess an innate affinity for the natural world shaped through evolutionary processes. From this perspective, regular contact with nature is not merely beneficial but essential for healthy psychological and emotional development. Complementing this view, Louv (2008) introduced the concept of *nature-deficit disorder* to describe the behavioral, emotional, and developmental consequences associated with children's diminished exposure to natural environments.

A growing body of empirical research supports these theoretical perspectives, demonstrating that interactions with nature can reduce stress, enhance emotional regulation, and foster prosocial behaviors in children. Moreover, early experiences with nature have been consistently linked to the development of environmental values and stewardship in later life

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(Ives et al., 2018). In the context of rapid digitalization, these frameworks underscore the urgency of intentionally re-establishing children's relationships with nature through educational practices that meaningfully counterbalance screen-based learning.

These theoretical perspectives (Biophilia and Nature-Deficit Disorder) provide the foundation for ESD-aligned teaching practices that link environmental experience with sustainable values, framing nature-based learning as both pedagogical and ethical education.

Nature-Based Learning, Education for Sustainable Development, and the Sustainable Development Goals

Nature-based learning is closely aligned with the principles of Education for Sustainable Development (ESD), which advocates learning experiences that integrate environmental, social, and economic dimensions of sustainability. In early childhood education, ESD places particular emphasis on cultivating awareness, values, and dispositions that support responsible action and care for the environment. Through activities such as gardening, recycling, and composting, young children begin to develop an understanding of ecological interdependence and their role within living systems (Rahman & Yusop, 2020).

At the global level, these pedagogical aims resonate strongly with the Sustainable Development Goals (SDGs), particularly SDG 3 (Good Health and Well-Being) and SDG 4 (Quality Education). Nature-based learning contributes to children's physical and mental well-being while promoting inclusive, equitable, and quality education that supports lifelong learning. Importantly, early childhood represents a foundational stage for embedding sustainability-oriented mindsets, suggesting that nature-based pedagogy plays a critical role in advancing long-term sustainability objectives.

While nature-based learning (NBL), Education for Sustainable Development (ESD), and the Sustainable Development Goals (SDGs) are often discussed as distinct constructs, limited research has examined how these domains are operationalised collectively within early childhood pedagogy. NBL can be conceptualised as a practical pedagogical approach through which ESD principles are enacted, enabling young children to develop creativity, socio-emotional competencies, and environmental responsibility. In this context, SDG 3 (well-being) and SDG 4 (quality education) are not merely policy aspirations but are realised through everyday learning experiences that integrate natural environments, experiential engagement, and sustainability-oriented practices. This integrated perspective highlights the need to examine how teachers translate these interconnected frameworks into classroom practice.

Nature-Based Learning in the Malaysian Preschool Context and Research Gap

Despite growing international recognition of the value of nature-based learning, its implementation within Malaysian preschools remains uneven and underexplored. While the National Preschool Curriculum Standard (KSPK) advocates holistic development and environmental awareness, practical constraints—including limited resources, academic pressures, and insufficient professional training—often hinder the consistent integration of nature-based approaches in daily classroom practice (Saleh et al., 2018; Lan & Abu Bakar, 2024). Existing studies in the Malaysian context have tended to focus on curricular intentions

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or general developmental benefits rather than examining how teachers creatively adapt and implement nature-based pedagogy within authentic classroom settings.

Consequently, there is a critical need for empirical research that foregrounds teachers' lived experiences, pedagogical strategies, and contextual adaptations in implementing nature-based learning. Understanding these practices is essential for informing curriculum development, teacher education, and policy initiatives aimed at strengthening education for sustainable development in early childhood education. Addressing this gap, the present study examines how Malaysian preschool teachers implement nature-based pedagogy and how these practices support children's creativity, socio-emotional development, and emerging environmental stewardship within increasingly digitalized learning environments.

METHODOLOGY

This study employed a qualitative research design using thematic analysis to examine how preschool teachers implement nature-based learning (NBL) in Malaysian contexts. The approach was selected to allow for an in-depth exploration of teachers' practices, experiences, and pedagogical strategies within naturalistic settings.

Data were collected through semi-structured interviews, non-participant observations, and document analysis, enabling methodological triangulation. Participants comprised 18 preschool teachers, one preschool officer, and three preschool supervisors from government and private preschools. Interviews lasted between 45 and 90 minutes and were audio-recorded with participants' consent. Observations were conducted across multiple classroom and outdoor sessions to capture routine pedagogical practices. Supporting artefacts such as photographs and short video recordings were used to corroborate field notes and enhance contextual interpretation.

Data were analysed using thematic analysis following Braun and Clarke's (2006) six-phase framework. The process involved familiarisation with the data, initial coding, searching for themes, reviewing themes, defining and naming themes, and producing the report. Coding was conducted manually to ensure close engagement with the data. Themes were developed inductively and refined through constant comparison across interviews, observations, and curriculum documents.

Documents analysed included lesson plans, activity schedules, KSPK learning modules, and environmental project records. Triangulation across multiple data sources strengthened the credibility and consistency of the findings.

Trustworthiness and Ethical Considerations

This study ensured methodological rigor and ethical integrity by addressing credibility, transferability, dependability, and confirmability in accordance with established qualitative research standards (Lincoln & Guba, 1985). Credibility was enhanced through methodological and data source triangulation, integrating interviews, observations, and document analysis across multiple participants and settings. Member checking was conducted by sharing

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preliminary findings with a participant to verify accuracy and resonance with lived experiences (Denzin, 1978; Patton, 2002).

Transferability was supported through the provision of thick descriptions of the research context, participants, sampling strategies, and data collection procedures, enabling readers to assess the applicability of the findings to similar contexts (Korstjens & Moser, 2018). Dependability was addressed through systematic documentation of research processes and analytic decisions. While qualitative findings are inherently context-specific, transparent reporting strengthens methodological consistency (Marshall & Rossman, 2014). Confirmability was ensured through the maintenance of an audit trail documenting analytic decisions and interpretive processes, demonstrating that the findings were grounded in the data rather than researcher bias (Korstjens & Moser, 2018).

Ethical principles were strictly observed throughout the study. Ethical approval was obtained from the relevant university and governmental authorities, and formal permission was secured from preschool administrators, supervisors, and owners. All participants provided informed consent and were informed of the study's purpose, procedures, and voluntary nature. Audio and video recordings were conducted only with participants' consent. Confidentiality was maintained through the use of pseudonyms for all individuals, institutions, and locations, and all data were securely stored. Rapport was established through preliminary site visits to foster participant trust and engagement. Research findings were disseminated responsibly through academic publications and presentations, with necessary modifications made to preserve anonymity and uphold ethical standards.

RESULTS

The findings presented in this section are derived from triangulated data sources, including interviews, observations, and document analysis.

Research Question 1: How Is Nature-Based Pedagogy Implemented By Preschool Teachers in Malaysia?

Teachers play a central role in curriculum implementation by interpreting learning objectives and translating them into meaningful classroom and outdoor experiences (Bongco & David, 2020). This study examined how preschool teachers implemented nature-based teaching and learning (NBTL) in Malaysian preschools. The findings indicate that teachers demonstrated strong curriculum knowledge and pedagogical agency in selecting content, materials, and instructional strategies that supported children's engagement with the natural environment.

Analysis of interview, observation, and document data revealed nine interrelated mediums through which NBTL was implemented: (1) lessons on plants, fruits, and vegetables; (2) teaching in the preschool garden; (3) nature-based field trips; (4) STREAM/STEM-integrated activities; (5) hands-on plant-based learning; (6) nature-based creative arts; (7) environmental sustainability projects; (8) nature-based programmes involving families and communities; and (9) physical activities linked to nature exploration. Together, these approaches illustrate how teachers positioned nature not merely as a backdrop, but as an active pedagogical resource embedded within daily instructional practices.

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Lessons on Plants, Fruits, and Vegetables

Nature-based learning was frequently integrated through lessons involving plants, fruits, and vegetables to support sensory engagement and conceptual understanding. Teachers utilised real-life examples to connect children with natural elements. For instance, one teacher used a coconut tree to introduce plant structures and environmental awareness, emphasising early exposure to nature (I7). These activities enabled children to explore textures, colours, and food sources through direct experience.

> *"When we explain to children about coconut plants and their parts… the coconut tree has many uses. Ideas from the natural environment should be exposed early so that children, when they grow up, will understand and appreciate the environment." (I7, 4)*

Classroom observations further documented children preparing *Buah Melaka* using freshly grated coconut, enabling direct engagement with natural materials and food preparation processes.

Figure 1. Children Prepare *Buah Melaka* with Grated Coconut

Similar sensory-rich activities were observed across preschools. Teachers encouraged children to explore the texture, taste, and colour of fruits and vegetables during hands-on food-related tasks. For example, I9 highlighted the value of authentic sensory experiences, while I12 involved children in preparing fresh fruit juice during thematic lessons. Likewise, I2 introduced vegetables through food preparation activities, such as making sardine sandwiches with fresh produce, as illustrated in the photo below.

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Figure 2. Children Learn about Fresh Vegetables before Preparing Sardine Sandwiches

These activities enhanced children's sensory awareness, familiarity with natural foods, and conceptual understanding of plants and nutrition, demonstrating how everyday materials can serve as effective pedagogical tools in nature-based learning.

This theme was consistently observed across three preschools and corroborated through curriculum documents and lesson plans emphasizing "Living Things" and "Healthy Food" modules.

Teaching in the Preschool Garden

Outdoor environments such as preschool gardens were widely used to extend classroom learning into authentic contexts. Teachers guided children to observe and interact with real plants, enabling experiential understanding beyond visual representations. As one teacher noted, *"Outdoors, they can see and feel the parts and the tree itself"* (I8, 2). Observations further indicated that outdoor sessions enhanced children's interest, engagement, and exploratory behaviour.

Figure 3. Children Explore the Preschool Garden to Learn about Banana Trees

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The other observations showed children touching plant parts, observing textures, and engaging in exploratory discussions. Observations showed children exploring bird nests and collecting natural materials for classroom projects.

Figure 4. Children Engage in Outdoor Exploration in the Preschool Area

In contrast, Teacher I1 regularly conducted outdoor learning sessions within the preschool compound, noting that prolonged indoor instruction often led to boredom, whereas outdoor exploration enhanced children's interest and engagement. As teacher I1 explained:

> *"Children feel happier and more interested. They appreciate real experiences more; it is different from regular activities, such as colouring, which often becomes boring" (I1, p. 60)*

Nature-Based Field Trips

Nature-based field trips further extended children's engagement with the natural world beyond the preschool setting. Teacher I17 described organising visits to the Taiping Zoo in collaboration with parents, emphasising that direct experiences enhanced children's understanding and memory:

> *"If we only tell them about animals, they won't remember." (I17, 38)*

Other teachers arranged visits to nearby farms and village environments, providing opportunities for children to observe plants and animals in situ. These experiences stimulated curiosity, strengthened observational skills, and reinforced connections between classroom learning and children's everyday environments.

STREAM/STEM Integration

Nature-based learning was frequently integrated with STREAM/STEM education. Teachers designed inquiry-based experiments using natural materials alongside simple scientific concepts. For instance, I3 conducted a colour-dissolving experiment using M&M chocolates, while I6 facilitated a cabbage experiment to demonstrate water movement and colour absorption.

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Figure 5. Children Do a Cabbage and Water Experiment

In addition, some teachers strategically combined digital tools with tangible natural objects. Teacher I13, for example, used real twigs and leaves alongside digital visuals to support children's understanding of plant structures. These practices demonstrate that nature-based learning can coexist productively with contemporary STEM approaches, reinforcing the study's emphasis on pedagogical integration rather than opposition between digital and natural learning.

Figure 6. Teacher I13 Shows Real Twigs During a Plant Lesson

Hands-On Learning with Plants

Hands-on engagement with plants was a defining characteristic of NBTL. Teachers designed activities that required children to manipulate, classify, and organise natural materials. Teacher I6 described an activity in which children collected leaves outdoors and arranged them according to size to understand serration:

> *"Before this, they learned about serration using the collected leaves from outdoors; they arranged leaves from short to long." (I6, 2)*

Similarly, teacher I16 facilitated gardening activities involving soil exploration and plant handling, which supported fine motor development and embodied learning:

> *"We grow plants in pots in front of the classroom… I let children explore, feel the soil, and get messy using their own hands." (I16, 70)*

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These experiences strengthened children's cognitive engagement while simultaneously supporting physical and sensory development.

Nature-Based Creative Arts

Creative arts emerged as a significant medium for nature-based learning. Teachers incorporated natural materials such as okra, coconut fronds, beans, twigs, and leaves into stamping, collage, and construction activities. Teacher I14 highlighted how sensory exploration preceded artistic creation;

> *"Children can first observe the texture of leaves and stems before using them to create art, which allows them to connect creativity with the natural world." (I14, 2)*

Similarly, teacher I6 integrated collected twigs and leaves into tree-themed art projects, enabling children to explore patterns, textures, and design while reinforcing environmental awareness.

Figure 7. Children Make Tree-Art with Leaves and Twigs

Environmental Sustainability Projects

Sustainability practices were embedded within daily routines through activities such as composting, recycling, and the reuse of materials. These practices introduced children to ecological concepts while fostering responsibility and care for the environment. For example, one teacher described using papaya skins for composting to demonstrate decomposition processes (I6). Such activities supported the development of early environmental awareness and stewardship.

> *"We use papaya skins to make compost, allowing children to understand decomposition and sustainability in practice." (I6, 112)*

Teachers also used recycled materials such as egg cartons and twigs in creative projects (Figure 8 and 9). These practices fostered early environmental stewardship and aligned with

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the National Preschool Curriculum Standard's emphasis on environmental ethics and awareness (Document Analysis, 2017).

Figure 8. Examples Of Children's Recycled Nature Projects

Figure 9. Children with Natural Twigs and Leaves Bird Nest Projects

Nature-Based Programmes with Families and Communities

Nature-based learning was further strengthened through collaboration with families and community institutions. Programmes such as *Pintar Botani* and *Kebun Dapur* involved joint participation from teachers, children, parents, and community members. As one teacher explained:

> *"Yes, Kebun Dapur involves teachers, children, parents, and the local community… with the association, it can be done." (I22, 32)*

In addition, partnerships with *Perpustakaan Desa* (Rural Libraries) enriched nature-based creative activities. Teacher I1 collaborated closely with a librarian-teacher to design and implement art projects using natural materials:

> *"She is creative and highly interested in crafts; I simply informed her of the plan, and she planned the activity." (I1, 182, 188)*

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Observations documented co-teaching sessions involving leaf and flower crafts, such as leaf owl projects (Figure 9), illustrating the value of community partnerships in expanding pedagogical possibilities.

Figure 10. Preschool Teacher I1 and a Librarian Teacher from Perpustakaan Desa

Physical Activities Linked to Nature

Teachers also integrated nature-based physical activities, including outdoor tele-matches and literacy games conducted in open spaces. These activities promoted gross motor development, cooperation, and social interaction while maintaining children's engagement with the natural environment, as illustrated in Figures 11 and 12 below.

Figure 11. Children Play Literacy Games in the Preschool Field

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Figure 12. Children Play Literacy Games in the Preschool Outdoor Hallway

Overall, Malaysian preschool teachers implemented nature-based pedagogy through an integrated and multifaceted approach encompassing outdoor exploration, sensory engagement, hands-on learning, creative arts, sustainability practices, and community collaboration. Teachers deliberately embedded nature within daily routines and STEAM-related activities, supporting children's holistic development across cognitive, social, emotional, and physical domains.

Findings from interviews and observations indicate that NBTL in Malaysian preschools is implemented through a coherent set of interconnected practices, synthesised in Figure 13. The proposed model conceptualises nature as an active pedagogical agent that mediates children's learning experiences rather than serving merely as a contextual backdrop.

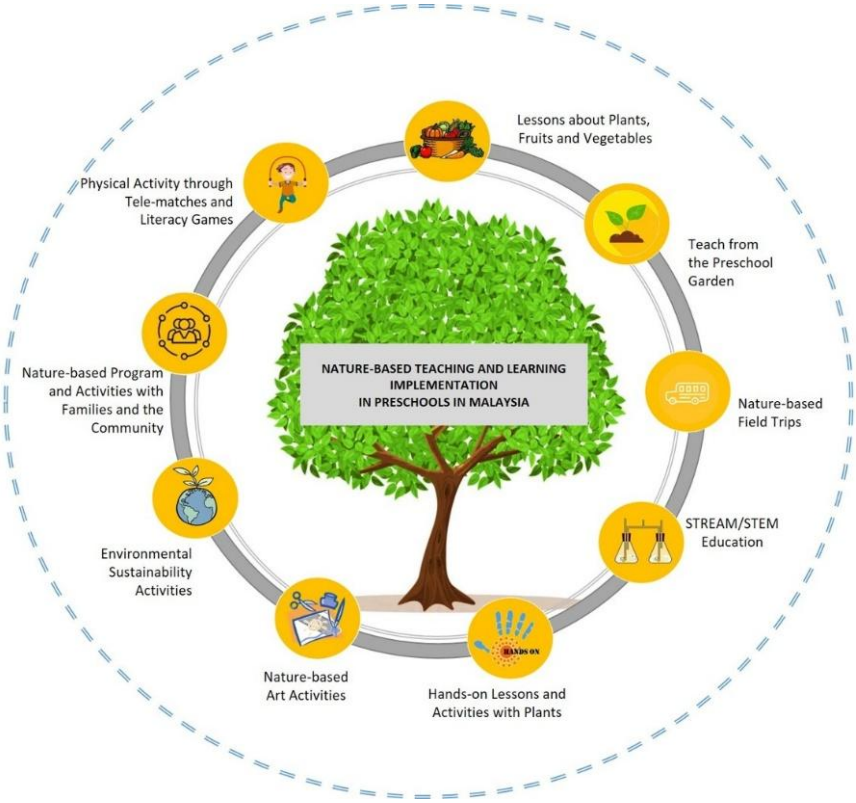

Figure 13. Model 1: Nature-based Teaching and Learning Implementation in Preschools in Malaysia

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Research Question 2: How Do These Pedagogical Practices Support Children's Connection with Nature in Advancing ESD and Selected SDGs?

Creative Integration of Natural Materials

Findings indicate that preschool teachers consistently integrated natural and recycled materials into everyday learning activities across subject areas, including art, mathematics, science, and language development. Commonly used materials included leaves, twigs, stones, seeds, flowers, and organic waste, which were often collected by children from their immediate surroundings.

One teacher explained:

> *"When I organise collage activities, I ask children to collect small gravel. We do not need to use items like green beans that may be wasted after the activity." (I6, 126)*

Similarly, teachers used natural materials for numeracy and classification tasks:

> *"For most counting activities, I use leaves, pebbles, and sticks, treating them like money. Children count betel nuts (buah pinang), which are abundant here, and learn to identify their colour and texture." (I14, 28)*

> *"I take them outside to collect pebbles or flowers. They gather leaves and flowers and classify them." (I15, 5)*

Observations showed that children actively explored textures, colours, shapes, and patterns through hands-on manipulation of materials. Children displayed high levels of engagement and curiosity during these activities and frequently initiated conversations with peers about the materials they collected. Teachers reported that children who were less responsive during worksheet-based activities appeared more engaged during these hands-on sessions.

> *"When children brought different materials into the classroom, it will arouse other peers' curiosity and they enquired about the materials, from there we can see children improve their communication skills." (I17, 72)*

Figure 14. Children Cooperate to Complete the Tree-Arts Project

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Sustainability Practices Embedded in Daily Routines

A second set of findings highlighted the embedding of sustainability-oriented practices within daily preschool routines. Teachers reported engaging children in composting food waste, recycling materials, and caring for garden plots as part of regular classroom activities rather than as isolated lessons.

One teacher described involving children in composting papaya skins:

> "*Children showed the feeling of disgust and children also avoid touching the skin. After an explanation that the skins came from the papaya they have eaten, they became somewhat cooperative." (I6, 112, 118)*

Gardening activities were also commonly observed. Children participated in planting, watering, and maintaining garden plots, where they learned about plant growth, water needs, and care for living organisms. Teachers noted that over time, children became more attentive to plants and more cautious about damaging them.

Observations indicated that children increasingly demonstrated protective behaviours toward plants and greater awareness of waste management practices. Teachers reported that children reminded peers not to damage plants and showed interest in observing changes in plant growth.

Observed Outcomes on Children's Connection to Nature

Across settings, observational data indicated that children exhibited increased engagement, curiosity, and enjoyment during activities involving direct interaction with natural elements. Teachers described noticeable changes in children's attitudes toward plants and outdoor environments.

One teacher noted:

> *"When children are engaged with Kebun Dapur, they can learn about chili and spinach, how they grow, and how to care for them. Only then will they care for plants and would not destroy them when they grow up." (I20, 12)*

Children were also observed engaging in collaborative problem-solving, negotiating roles during group activities, and expressing ideas during discussions involving natural materials. Teachers reported improvements in children's communication, cooperation, and willingness to participate during nature-based activities.

DISCUSSION

Nature-Based Learning in Malaysian Preschools

This study demonstrates that nature-based learning in Malaysian preschools simultaneously fosters children's creativity, socio-emotional development, and environmental stewardship,

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while illustrating how teachers operationalize these experiences in daily practice. Across activities—including lessons on plants, fruits, and vegetables; garden-based exploration; field trips; STREAM/STEM integration; hands-on plant work; creative arts; sustainability projects; family- and community-based programs; and nature-linked physical activities—children engaged in sensory, collaborative, and open-ended experiences. These activities nurtured curiosity, joy, perseverance, and cooperative behaviors, while promoting early environmental awareness and responsibility.

Implementation was shaped by contextual factors such as institutional routines, space constraints, scheduling priorities, and concerns regarding food safety or hygiene. Teachers navigated these challenges creatively, embedding natural materials into daily practice, fostering experiential engagement, and balancing structured guidance with child-led exploration. This operational focus underscores that the pedagogical implementation of nature-based learning, rather than abstract instruction, is central to its effectiveness.

The relational and affective dimensions of learning were particularly salient. Children's socio-emotional growth emerged through collaboration, shared problem-solving, and joyful engagement with natural materials, indicating that socio-emotional development is a core mechanism of nature-based pedagogy. By activating children's innate affinity for nature (Wilson, 1984) and addressing tendencies associated with nature-deficit disorder (Louv, 2008), teachers fostered environmental stewardship in contextually feasible ways, gradually moving children from passive observation to active care of plants and sustainable practices.

These findings align with Education for Sustainable Development (ESD) and selected Sustainable Development Goals (SDGs 3 and 4). Nature-based activities supported children's well-being, emotional engagement, and social interaction (SDG 3), while providing developmentally appropriate, inclusive, and meaningful learning experiences (SDG 4). The study also introduces the concept of *"bridging digital and natural worlds,"* demonstrating that digital tools can complement rather than replace nature-based learning by supporting reflection, documentation, and communication.

Open-Ended Natural Resources to Stimulate Children's Creativity

Many preschool teachers implemented creative activities using natural materials collected from gardens or brought in by teachers and children. Observed activities included owl leaf crafts, vegetable stamping, seed collages, twigs and leaves art projects, bird's nest creations, and mini aquariums using leaves and seeds. Children actively collaborated with teachers to prepare materials and received guidance on combining and manipulating resources for art creation.

These practices reflect experiential learning principles (Kolb, 1984) and Vygotsky's social constructivist framework (1978), where children construct knowledge through hands-on engagement and social interaction. Through iterative experimentation with natural materials, children developed creative thinking, problem-solving skills, and collaboration abilities. Open-ended activities—valuing diverse ideas and emphasizing the creative process over the final product—encouraged exploration, experimentation, and individual expression. By embedding natural materials into daily practice and balancing structured guidance with child-led exploration, teachers operationalize nature-based learning to foster creativity, socio-emotional growth, and environmental stewardship.

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These findings are consistent with recent studies which emphasise that nature-based and experiential learning approaches significantly enhance children's socio-emotional development, engagement, and environmental awareness (Chawla, 2020; Ernst & Burcak, 2019; Adams & Savahl, 2017). The integration of natural elements into daily learning activities supports holistic development while fostering sustainability-oriented values from an early age.

Paving Children's Innate Desire to Learn, Make Connections, and Explore

Opportunities to interact with real natural materials enabled children to connect abstract or symbolic representations (books, flashcards, films) with tangible experiences. Handling fruits, vegetables, and plants supported multisensory understanding, fostering deeper conceptual knowledge. For instance, children distinguished real carrots and salads from their flashcard depictions, illustrating the advantages of learning through direct experience. These practices align with Dewey's experiential learning theory and support Vygotskian principles of scaffolded exploration.

Children also engaged in hands-on scientific experiments, including cabbage water absorption and M&M dissolution, allowing playful exploration of STREAM/STEM concepts. Through observation, measurement, and problem-solving, children integrated mathematics and science naturally, fostering curiosity, perseverance, and joy in learning. Notably, effective early science education relied not on elaborate materials but on active engagement and guided exploration.

Interactions with plants and animals further contributed to socio-emotional development. Children learned patience, responsibility, and empathy while caring for living things, experiencing both success and failure. These processes encouraged reflection, emotional regulation, and memory formation, demonstrating that socio-emotional growth is intertwined with experiential, nature-based learning.

Collectively, these findings reinforce the value of experiential learning, constructivism, and ESD in early childhood education. Nature-based interactions promote curiosity, joy, cooperative behaviors, and environmental stewardship, integrating holistic development across cognitive, emotional, and social domains. These findings indeed extend existing literature by demonstrating how nature-based learning can be pragmatically integrated within resource-constrained preschool contexts, offering a contextually grounded model for ESD implementation in early childhood education.

CONCLUSION

This study demonstrates that nature-based learning in Malaysian preschools is implemented through diverse and contextually adaptive pedagogical practices, enabling children to develop creativity, socio-emotional competencies, and environmental stewardship. The findings highlight that even within resource-constrained settings, teachers exercise strong pedagogical agency in integrating natural materials, outdoor environments, and sustainability-oriented practices into daily learning experiences.

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This study underscores that even in resource-constrained preschools, teachers can creatively embed environmental learning through everyday natural materials and outdoor pedagogy. To sustain and scale these practices, three key priorities emerge:

i) Curriculum integration: Embed nature-based learning explicitly in KSPK 2026 modules under Kelestarian Alam Sekitar.
ii) Teacher capacity-building: Strengthen preservice and in-service training on experiential and outdoor learning approaches.
iii) Family–community partnerships: Enhance home–school–community collaboration to extend environmental learning beyond preschool settings.

Overall, this study contributes to the growing body of literature on Education for Sustainable Development by demonstrating how nature-based pedagogy can be pragmatically implemented in early childhood education, offering a contextually grounded model for aligning classroom practice with SDG 3 and SDG 4.

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