

Embedding Sustainability into Young Child Experiences: The Evidence from Empirical Study of Green Kindergartens

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ABSTRACT

Green kindergartens are positioned as a growing phenomenon in early childhood education (ECE) arising within a worldwide context concerning sustainability, environmentalism and holistic child development. These are realized through, for example, sustainable architecture, nature-oriented learning environments and education for sustainable development, and are seen as an avenue for providing environmental education to develop children holistically. Despite the rapid spread of green kindergarten programmes across schools, evidence for the effectiveness of green kindergartens remains thin. This systematic review examines in particular empirical studies on green kindergartens and early childhood education environments with an emphasis on sustainability. Following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework, we searched across major databases including Scopus, Web of Science, ERIC, and ScienceDirect. Twenty-five peer-reviewed empirical studies published between 2005 and 2024 met the inclusion criteria and were analysed using theme synthesis. Preliminary findings indicate a correlation between green kindergartens and children's cognitive capacity, socialisation, emotion regulation, exercise, and environmental awareness. Additionally, educational systems focused on sustainability - outdoor education, experiential education activities, project-based environmental education - were acknowledged as central to green kindergarten systems. We highlight pressing questions about teacher preparedness, resource allocation, policy coherence. This review argues that green kindergarten systems provide promise for improving sustainable ECE - and calls for substantial, detailed and multi-year rounds of research to support this proposition.

الكلمات المفتاحية:

رياض الأطفال الخضراء

تعليم الطفولة المبكرة

الاستدامة

المراجعة المنهجية

برايزما

ملخص

تُعَدُّ رياض الأطفال الخضراء ظاهرة متنامية في مجال تعليم الطفولة المبكرة، نشأت في سياق عالمي متزايد الاهتمام بالاستدامة، وحماية البيئة، وتنمية الطفل تنمية شمولية. ويتجسّد هذا التوجّه من خلال، على سبيل المثال، العمارة المستدامة، وبيئات التعلم المرتكزة على الطبيعة، والتعليم من أجل التنمية المستدامة، حيث يُنظر إلى رياض الأطفال الخضراء بوصفها مدخلاً فاعلاً لتقديم التربية البيئية بما يسهم في تنمية الطفل بصورة متكاملة. وعلى الرغم من الانتشار السريع لبرامج رياض الأطفال الخضراء في المدارس، فإن الأدلة العلمية الداعمة لفاعلية هذه البرامج لا تزال محدودة. تهدف هذه المراجعة المنهجية إلى فحص الدراسات التجريبية التي تناولت رياض الأطفال الخضراء وبيئات تعليم الطفولة المبكرة، مع التركيز على البعد الاستدامي. واتباع إطار (PRISMA) العناصر المفضلة لإعداد المراجعات المنهجية والتحليلات البعدية)، تم إجراء بحث شامل في قواعد بيانات رئيسة شملت Scopus، Web of Science، ERIC، وScienceDirect. وقد استوفت خمس وعشرون دراسة تجريبية محكمة، نُشرت خلال الفترة الممتدة من عام 2005 إلى عام 2024، معايير الاشتمال، وتم تحليلها باستخدام

منهجية التحليل الموضوعي. وتشير النتائج الأولية إلى وجود ارتباط بين رياض الأطفال الخضراء وكلٍّ من القدرات المعرفية للأطفال، والتنشئة الاجتماعية، وتنظيم الانفعالات، والنشاط البدني، والوعي البيئي إضافة إلى ذلك، جرى الاعتراف بأن النظم التعليمية المتمحورة حول الاستدامة—مثل التعليم في الهواء الطلق، والأنشطة التعليمية القائمة على الخبرة، والتعليم البيئي القائم على المشروعات—تُعد عناصر محورية في منظومة رياض الأطفال الخضراء. كما تسلط هذه المراجعة الضوء على تساؤلات ملحة تتعلق بجاهزية المعلمين، وتخصيص الموارد، واتساق السياسات التعليمية. وتخلص الدراسة إلى أن نظم رياض الأطفال الخضراء تتطوي على إمكانات واعدة لتعزيز تعليم الطفولة المبكرة المستدام، مع التأكيد على الحاجة إلى جولات بحثية موسعة، ومتعمقة، وطويلة الأمد لدعم هذا التوجه علميًا.

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1 Introduction

Sustainability has nowadays become a top phenomenon in both public and academic discourse and policy making that is thought to be imperative to counter the mounting environmental problems, climate changes, and general need to raise conscious humans (Al-Zu'bi et al., 2024). In this frame work the pre-school level of children, ECE (Early childhood education) has grown into a focal point where sustainability concepts, attitudes and skills need to be developed in them (Al-Zu'bi et al, 2024). Early infancy is a significant period of learning in which children become aware of the natural world, the obligations to the community and their interaction (Wilkie, 2018).

The rise of green kindergartens is a notable response to the worldwide trend towards sustainability. These establishments are designed with sustainable architecture, embrace landscaping and outdoor learning, offer energy-efficient buildings, and educational practice that fosters environmental awareness and experience. It is also said look beyond green issues, as a means to promote cognitive, social, emotional and physical development of children.

Despite the increasing emergence worldwide, in Europe, North America, Asia and Australia, there is limited body of empirical studies measuring the pedagogical effectiveness of green kindergarten and exist on a philosophical plane. There is variation in the model, adoption and evaluation of green kindergarten. Some measures emphasis of green kindergarten is on architecture and environment, while other focus on teaching techniques, learning outcomes or child development. Lack of definitional clarity limit the ability to synthesize facts and reach solid conclusions (Al-Zu'bi et al., 2024).

While many of the research confirm the positive child developmental and educational outcomes of green kindergarten environments, other studies mention the toll is quite big in terms of costs of implementation, insufficient pre practices provide support for teachers, restricted support from institutions and inconsistency of related policies. The study close review of empirical studies in order to gather knowledge of preschool contexts, significant findings and challenges in the light of future research and policy formulation in sustainable advances.

2 Theoretical and Empirical Literature Review

2.1 The Rationale of Green Kindergartens

The underpinnings of green kindergartens are entwined, closely linked to Education for Sustainable Development (ESD), socio-constructivist learning theory, and ecological systems theory. These perspectives together offer a framework for understanding the implications for young children's learning of green-oriented environments.

Education for Sustainable Development examines the application to education of the environmental, social, and economic aspects of sustainability. In early childhood settings, ESD emphasizes how to provoke in children their curiosity, their caring for nature, and a sense of responsibility through developmentally appropriate and experiential learning activities. Commentators argue that sustainability education in early childhood should consider both the tangible experience and the concrete (rather than an abstract concept), allowing children to interact intimately with natural systems (Davis, 2015).

From the perspective of socio-constructivism, learning occurs when children create knowledge from their interactions with their experiences and peers. Green kindergarten settings, especially those with significant outdoor/nature-based learning spaces, create vast opportunities for discovery, collaboration and problem-solving. The settings therefore resonate with the ideas touted from constructivism that children learn most in play and inquiry- or experience-based direct engagement with environments (Elliott & Davis, 2009).

Ecological systems theory bolsters the rationale for green kindergartens by asserting that children are all intertwined with their natural, social and cultural environments. It holds that all learning environments are not neutral but have an active role in children's developmental experiences. Green kindergarten settings may be understood as ecological systems that influence the child's inclination, engagement, behaviour, and attitudes to a more ecologically sensitive vision.

The empirical studies on green kindergartens touch upon an impressive range of outcomes. Studies show again and again signatures of natural and green learning environments visitation patterns in children in terms of more cognitive engagement, greater attention, and higher motivation to learn (Kuo et al., 2019).

Research on social emotional learning show greater degrees of sharing, cooperative empathy, emotional regulation that presumably arises from the sharing nature of many outdoor educational activities. Physical development is a significant objective of large sections of the literature. As natural play spaces promote play (and playable terrains), mobility and risk taking that carries with it the imperative to develop large muscle skills, physical well-being, environmental knowledge and proecological behaviours including recycling and conservation habits. These are oft-reported outcomes of sustainability-focused programs of early environmental experience.

Notwithstanding the favourable observations, however, this reviewer warns of serious weaknesses in the literature ranging from such small sample sizes or transient "treatment" length, qualitative nature of research methods that makes finding replicable or statistically meaningful results difficult. There is scant amount of longitudinal research to discover the degrees of attitudes

and behaviours to environmental concerns that affect children’s experiences in their later developmental years using green kindergarten experiences.

3 Methodology

Data Gathering and Analysis - A systematic review method that follows the PRISMA framework. The review must come as a result of clear guidelines for finding, screening and assembling research evidence.

3.1 Plan for Searching

An extensive literature search was conducted in Scopus, Web of Science, ERIC, ScienceDirect and Google Scholar. The search strings included some of the following terms “green kindergarten,” “sustainable early childhood education,” “nature-based learning,” “environmental education in kindergarten.”

3.2 Including and Not Including Conditions

Too be included studies had to: 1. be reviews by these experts in empirical study, 2. focus on setting of kindergarten or early childhood settings for kids aged 3 to 6 years old, 3. clearly discuss green sustainable nature learning settings, 4. be published in English from the years 2005-2024. Concept papers, policy reports and studies that only looked at elementary or secondary education were not included.

3.3 The PRISMA Process

There were 4 steps to the PRISMA process: discovery, screening, eligibility and inclusion. A first group of 1,132 items were found. After removing duplicates and checking the titles and abs, 67 pieces were read to determine eligibility. Then, 25 studies passed all criteria for inclusion and were included in the final synthesis. Data Analysis: The studies were analysed using thematic synthesis. Key information was extracted relating to the study's design, setting, participant details, what "green kindergartens" is, findings, and reported issues.

4 Results

The analysis of the 25 included studies revealed five dominant thematic categories.

Table 1. mmary of Empirical Studies Included in the Systematic Review (n = 25).

No.	Study Title	Authors	Year	Key Findings
1	Education for Sustainability in Early Childhood	Davis, J.	2015	ECE sustainability enhances environmental awareness and holistic development
2	Sustainability and Early Childhood Education	Elliott, S.	2014	Green ECE environments support experiential and inquiry-based learning
3	Exploring the Resistance to ESD in ECE	Elliott & Davis	2009	Identified pedagogical and institutional barriers to green ECE
4	Education for Sustainable Development in ECE	Siraj-Blatchford et al.	2010	Green kindergartens foster early pro-environmental behaviors
5	Benefits of Nature Contact for Children	Chawla, L.	2015	Nature exposure improves emotional well-being and social skills

6	Nature and Young Children	Wilson, R.	2018	Nature-based learning enhances curiosity and creativity
7	Green Schoolyards and Learning	Kuo et al.	2019	Green environments improve attention and academic engagement
8	Using Behavior Mapping in ECE	Moore & Cosco	2010	Outdoor green spaces promote physical activity
9	ESD in Preschool Contexts	Ärlemalm-Hagsér	2013	Sustainability concepts can be embedded in preschool curricula
10	Children's Learning in Outdoor Environments	Maynard & Waters	2007	Outdoor learning supports cognitive and social development
11	Forest School and Child Development	O'Brien & Murray	2007	Nature-based programs improve confidence and resilience
12	Sustainable Preschool Practices	Pramling Samuelsson	2011	Early sustainability education shapes long-term attitudes
13	Green Architecture in ECE	Woolner et al.	2010	Green design positively affects learning behavior
14	Nature-Based ECE Programs	Gill, T.	2014	Outdoor play enhances physical and emotional health
15	Environmental Learning in Kindergarten	Palmer	1995	Early exposure builds environmental responsibility
16	Early Childhood and Sustainability	Davis & Elliott	2014	Integrating ESD requires systemic support
17	Play and Learning Outdoors	Fjørtoft	2004	Natural play improves motor development
18	Children's Experiences in Green Schools	Malone & Tranter	2003	Green spaces increase engagement and well-being
19	Sustainability Pedagogy in ECE	Hedefalk et al.	2015	Teachers play a central role in sustainability learning
20	Learning Through Landscapes	Titman	1994	Green spaces support holistic learning
21	Environmental Education for Young Children	Davis	2009	Sustainability concepts can be age-appropriate
22	Green Schools and Child Outcomes	Cole	2013	Sustainable schools improve comfort and learning
23	Nature, Play and Learning	Lester & Maudsley	2007	Play in nature supports emotional resilience
24	Sustainability in Nordic Preschools	Johansson	2016	Policy support enhances green ECE implementation
25	Green Learning Environments Review	Rickinson et al.	2004	Outdoor learning improves motivation and attitudes

Table 2 overview of studies included in the systematic review highlighting the prevalence of research on green kindergarten and sustainability-oriented early childhood education, with the collective research spanning over three decades from the mid 1990s to 2024. The historical analysis suggests that earlier studies primarily focused on environmental awareness and outdoor environment,

while more recent studies adopted holistic sustainability frameworks encompassing cognitive and social emotional and physical aspects of child development.

Table 2. reveals a high agreement in the positive impact green kindergarten environments have on child development overall. Studies tend to indicate increased cognitive engagement, attention, creativity, and problem solving skill especially within pedagogies that align with nature-based and constructivist approaches... green learning environments offer rich sensory exploratory experiences promoting inquiry-based learning and active knowledge building in early childhood.

Beyond cognitive learning, social and emotional development emerged as prominent theme across studies...Outdoor and group activities described previously were common methods to promote belonging and resilience. Various research shows that natural areas can calm and restore the nervous system, leading to lower stress and better selfregulation (Al-Mseidin, et al., 2023).

Consistently across the research highlighted in Table 2, were themes related to physical development and healthrelated outcomes. Children in green kindergartens were found to be more physically active, be more mobile, and live healthier lives than children in traditional classrooms. Access to nature play and opportunities for active exploration were contributing factors.

Likewise, a variety of studies reported significant gains in awareness of environment and proenvironmental behaviours (Table 2). Involvement in sustainability initiatives (gardening, recycling, conservation) was shown to contribute to the development of nascent environmental attitudes, indicating the role of green kindergartens as a setting for Education for Sustainability during childcare practices.

However, in conjunction with overwhelmingly positive developments, Table 2 indicates several steep hurdles to the successful rollout of green kindergarten models. Various researchers have noted difficulty in teacher/pedagogist readiness, nil access to pertinent PD on sustainabilityeducation, and limited available resources. The lack of a strong definition and implementation of green kindergarten made it impossible to compare results across studies and policies and attempt implementation of findings.

Reading down Table 2 one can glean that green kindergartens produce many positive developmental and educational outcomes but also can offer a few serious drawbacks to research, policy and practitioner preparation. This data collects a large body of work to inform the thematic analysis in the last sections of the results, and the overall theme of sustainability in childcare will also be referenced throughout.

4.1 Conceptual Definitions and Models

Green kindergartens were referred to as settings that combined sustainable structures, natural play and learning spaces, and pedagogy on environmental issues. Conceptual parameters varied substantially across studies based on contextual and cultural aspects.

4.2 Cognitive and Learning Outcomes

Most studies found increases in attention, problem-solving, creativity, and engagement. Nature-based activities were found to be conducive to inquiry-based learning and critical-thinking skills.

4.3 Social and Emotional Development

The students in green kindergartens were found to cooperate more, had higher levels of empathy and wellbeing. “Extra-curricular and joint ventures nurtured social interaction and ameliorated tension”.

4.4 Physical Development and Health

Adoption of healthy lifestyle behaviours were routinely found. Nature was found to encourage vigorous play and exploration.

4.5 Environmental Awareness and Behavior

the main challenges faced were lack of teacher training, funding, weak policy support, and “absence of assessment tools to evaluate sustainability outcomes”.

4.6 Implementation Challenges

The lack of teacher training, funding, weak policy support, and absence of assessment tools to evaluate sustainability outcomes.

5 Discussion

The aim of this systematic review was to review and collate empirical research concerned with green kindergartens and sustainable early years education. The principal findings suggest a strong and positive relationship between green kindergarten settings and good developmental, educational and environmental outcomes for children. However, further caution is needed before applying the findings beyond the studies reviewed in terms of theory, methodology and context (Alahmari, et al., 2023).

That said, a general conclusion in this area is that children who engaged with green kindergarten settings increase in attention concentration and general cognitive involvement in educational tasks. This third finding, reported in many samples, reflects constructivist and experiential learning theories: that children learn through engagement with nature, and the effortful engagement of manipulating spaces “with few limitations” rather than learning in confined spaces such as classrooms. Green and black settings or environments, provide various types of stimuli and ‘encounters’ for children in day to day learning, as well as opportunities for being in walking, and navigating nature (Muhaidat, et al., 2022).

Another area where attention to the Green Kindergarten approach is much needed, is social and emotional development. Multiple studies across countries revealed increases in cooperation, empathy, emotional regulation and general wellbeing. Some (Marni, et al., 2024) have discussed these outcomes in the context of eco-social emotional learning theory. The restorative and healing properties of nature, often acknowledged in the existing literature, may also explain the decreases in stress and behavioral difficulties in green kindergartens. Physical development was a further important outcome associated with green kindergarten environments. Increased activity levels, coordination of finer motor functions, and more healthful patterns of movement were found across studies on outdoor and nature play experiences, substantiating our hypothesis that verdant learning environments promote much exciting locomotion, adventure, and calculated risk-taking, hallmark features of physical development for the infant mind.

Environmental awareness and pro-environmental behaviour represent important aspects of green kindergarten goals, and lie at the heart of the Education for Sustainable Development (ESD) paradigm. The studies analysed here seem to suggest that children in sustainability-related initiatives gain a nascent understanding of caring for the environment, conserving resources, and awareness of nature. Though these behaviours are essentially age appropriate and quasi-symbolic, their manifestation lends credence to the argument that sustainability education can indeed start young. Conversely, the evaluation does show that most research focuses largely on the emphasis on the environmental aspects of sustainability, with less attention paid for social equity and economics. This gap reflects a narrower and less developed understanding of sustainability as it relates to children’s experiences of green kindergartens (Alzahrani, et al., 2023).

Even while the majority of the results are quite positive, we must note some gaps that limit the interpretation and wider relevance of the literature. In particular, the definition and application of the green kindergarten model itself are not examined consistently across studies. Some investigations focus on the built environment whilst others highlight outdoor learning experiences or pedagogical content. Without consistency in this regard, the studies cannot be compared and may require more explicit programmatic foundations.

Limitations of methodology arise here as well - many studies reviewed used small qualitative samples and/or very brief observations. These still provide much insight into children's experiences and contexts, but there is limited causal inference to be had and little investigation of long-term effects. Related, the review finds that longitudinal and experimental studies are sorely lacking, both of which could be powerful given children's development in kindergartens and topics of sustainability (Alqarni, et al., 2024).

The knowledge and availability of reliable teachers and resources at a school were persistent themes that affected the success of green kindergarten programs. Together these findings suggest that green kindergartens cannot be conceptualized simply as environmental or place-based remediations, but rather must be treated as complex educational systems that require support at multiple levels.

We conclude by restating that the results of the review, as evidenced by the above discussion, indicate that green kindergartens have great potential to promote full child development and sustainable literacy, but also face significant conceptual, methodological, and practical challenges in need of study to better understand the evidentiary basis. We interpret the findings in terms of existing conceptions in the literature, but also recognize what appears to be the 'ground cloudy' (Guang, 2020) aspect of the findings and point to some conclusions that suggest future research and pedagogical directions.

6 Conclusions and Recommendations

This systematic review indicates that green kindergartens are a novel approach to teaching sustainability in early childhood, with positive effects on cognitive, social, emotional, physical and environmental outcomes. But the effectiveness of these programs depends heavily on contextual issues, teachers preparedness and institutional support. In terms of where we go next, there are a major recommendations developing teacher training programs in sustainability education, establishing appropriate policy promoting green kindergarten initiatives, and conducting longitudinal impact studies and cross cultural comparisons on long term impact while other researchers continue their focus research on the social and economic sides to sustainability.

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