Nature Based-Science Instruction: A Systematic Literature Review on the Best Practices in Science Education

Siti Nur Diyana Mahmud, Puvaneswary Vasuthevan, Jevitha Balasingam

Universiti Kebangsaan Malaysia

DOI: https://dx.doi.org/10.47772/IJRISS.2025.903SEDU0670

Received: 02 November 2025; Accepted: 08 November 2025; Published: 17 November 2025

ABSTRACT

This systematic review analyses the importance and potential of best practices for nature-based science instruction in science education. Nature-based instruction refers to teaching practices that incorporate the natural environment through outdoor activities, environmental exploration, and interaction with nature. The study identifies effective strategies that enhance student learning by leveraging environmental contexts. Following PRISMA guidelines, 20 empirical studies published between 2013–2024 were analysed. Findings highlight inquiry-based learning, project-based learning, field trips, outdoor and garden-based learning, and nature-integrated classroom settings as best practices. Empirical evidence demonstrates that nature-based instruction fosters deeper scientific understanding, engagement, and environmental stewardship across diverse student populations. Implications are discussed for curriculum design, teacher preparation, and education policy.

Keywords: Nature-based instruction, science education, outdoor learning, inquiry-based learning and phenomenon-based learning.

INTRODUCTION

Science education plays a crucial role in preparing students to understand and navigate the complex scientific and environmental challenges of the modern world. The goal of science education is to provide students with knowledge and skills that will help them adapt to and improve their surrounding environment (Maryanti et al. 2021). Based on the research paper of Jdaitawi (2019), it's stated that a traditional classroom is a physical location where a teacher teaches students in person. Globally, traditional classrooms appear to be the primary location in which students receive an education. Traditional classrooms are typically interactive, allowing students to ask questions and engage in activities to assimilate the latest knowledge. In the traditional classroom, students rely on the teacher, and learning activities only occur during class time.

Traditional classroom-based instruction, while effective in certain contexts, often falls short in providing students with immersive and experiential learning opportunities. To bridge this gap, educators are increasingly turning to nature-based instruction as a means to enhance science education and promote environmental awareness. Nature-based instruction incorporates the natural environment as a central component of the teaching and learning process, offering students hands-on experiences and direct interactions with the natural world (Kuo et al. 2019). By integrating outdoor experiences, environmental exploration, and ecological concepts into the science curriculum, nature-based instruction aims to foster a deeper understanding of scientific principles, cultivate a sense of environmental stewardship, and enhance overall student engagement (Kuo et al. 2019; Barnes et al. 2019).

While the benefits of nature-based instruction in science education are widely acknowledged, there remains a need to identify and understand the best practices associated with its implementation. What are the best practices for nature-based instruction in science education? How do these practices impact student engagement, learning outcomes, and environmental awareness? This research seeks to address these questions by examining and identifying the best practices for nature-based instruction in science education. By exploring existing literature, empirical studies, and practical examples, this study aims to provide evidence-based

insights and recommendations to educators, curriculum developers, and policymakers on integrating nature-based instruction into science teaching practices. By investigating the most effective approaches and strategies, this research will contribute to the advancement of science education by informing educators about the pedagogical methods that yield positive outcomes. Furthermore, this study will highlight the importance of incorporating nature into the science curriculum, promoting interdisciplinary learning, and fostering a deeper connection between students and the natural world.

The findings of this research will have implications for educators, curriculum designers, and policymakers, as they seek to enhance science education and cultivate environmentally conscious citizens. The identification of best practices for nature-based instruction in science education will empower educators to design more engaging and impactful learning experiences that leverage the power of the natural environment. Ultimately, the integration of nature-based instruction into science education holds the potential to inspire a new generation of scientifically literate individuals who are equipped to address the environmental challenges of our time.

Aims And Objectives

The goal of this comprehensive review of scientific literature is to explore the successful strategies for teaching science using nature as a context as discovered in prior investigations. Through analysing various academic papers from reputable journal websites including Scopus and Web of Science (WOS), the goal is to acquire understanding of the methods employed in the procedure of outdoor education. The goal is to comprehend the different approaches used and how well they promote educational results. The specific aims and objectives of this review are outlined below.

The aim of this study is to identify and examine the best practices for nature-based instruction in science education, with the objective of informing and improving science teaching methods that incorporate the natural environment. The research aim in this case is to investigate and explore the most effective and successful approaches, strategies, and techniques for implementing nature-based instruction specifically in the context of science education. The aim is to identify the "best practices," which refers to the most efficient and impactful methods that yield positive outcomes in terms of student engagement, learning outcomes, and the integration of nature into science education.

The research will focus on examining existing literature, empirical studies, and practical examples to identify and analyse different approaches to nature-based instruction in science education. It aims to provide educators, curriculum developers, and policymakers with evidence-based insights and recommendations for incorporating nature into science teaching practices. By achieving this aim, the research will contribute to the advancement of science education and provide guidance to educators on how to effectively integrate nature-based instruction into their teaching, thereby enhancing students' understanding of science concepts, fostering environmental literacy, and promoting a deeper connection with the natural world.

Research Question

1. What are the best practices for nature-based instruction in science education found in previous studies?

METHODOLOGY

Review protocol

The Systematic Literature Review (SLR) used a methodical approach to find appropriate articles for their inquiry. The group arranged the exploration method taking into account seven precise aims. The team meticulously chose suitable relevant search terms for every goal and utilised sophisticated investigation approaches on focused information repositories. These sources have Scopus and the Web of Science database. Moreover, hand searching took place on the specified databases, as well as Google Scholar database. The writers used the keyword search feature and applied Boolean operators (OR and AND) for combining

keywords in the process of the advanced search. The manual searching involved three techniques: picking manually, going back, and moving forward.

At the beginning when searching for keywords, a sum of 102 articles that could be relevant were acquired. In order to determine the criteria for inclusion, the researchers concentrated on the material in the picked publications, timeline of publication, and the written or spoken form. Taking into account the focus related to Nature-based Instructions guidance, the main purpose of the articles was to predominantly concentrate on approaches connected to Nature-based Instructions. Nevertheless, it's crucial to additionally incorporate additional relevant subjects that bolster and improve grasp and utilisation of Nature-oriented Guidelines. By exposing the core ideas and pioneering theories that have shaped the area of nature-based instruction, early studies establish the foundation for future investigations. These studies offer a foundation for comparing and assessing recent scientific advances. Additionally, looking into earlier studies enables the identification of enduring challenges and issues in nature-based instruction and offers a chance to evaluate how the field has handled these enduring concerns. We can learn more about the beginnings and current evolution of nature-based science instruction by choosing papers that were researched between 2013 and 2025 on the topic.

Afterwards, the researcher separately examined the papers to find those that meet the predefined requirements. The evaluation involved reviewing titles, summaries, along with findings and research methods. The only articles chosen were those that both parties and both examiners agreed upon. When choosing articles, all disagreements were resolved verbally. 50 articles were taken out as a result of this careful process. It provided the final batch, which included 20 written works, for judging excellence.

In the process of conducting this systematic literature review (SLR), the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) flow diagram is used to determine the selection of articles based on the stated research question. According to Selcuk (2019), PRISMA is a guideline that can assist in assessing validity and usability and also produce a more accurate and useful literature review. There are several phases involved in the article selection, namely the identification phase, screening phase, eligibility phase, and inclusion phase in this study. Therefore, this study involves several steps in determining the systematic search, including identification, screening, eligibility, quality appraisal, data extraction, and analyses.

Systematic searching strategies

As suggested by Shafril et al. (2018), this study used three systematic methods to efficiently collect pertinent articles: identification, screening, and eligibility. These procedures were used by the authors to discover and synthesise the research thoroughly, resulting in a systematic literature review (SLR) that was well-structured and transparent.

Identification

In systematic literature reviews, the initial phase, known as the identification phase following the PRISMA guidelines, involves the process of searching for relevant articles. To initiate the search, the author employed various strategies. Firstly, keywords were identified by utilising websites like thesaurus.com to explore synonymous meanings related to the research topic. Additionally, the author retrieved keywords from the Scopus database's keyword list. During the search process, several terms were used to search for relevant articles, including nature, instruction, education, science, STEM, STEAM, Biology, Chemistry, Physics, teaching approach, and pedagogy. To effectively combine these identified terms, the author employed search functions such as field code function, phrase search, wildcard, and Boolean operators for truncation and control, thereby obtaining a comprehensive and focused set of articles (refer to Table 1.0). To retrieve articles for this study, the author utilised the Scopus database. Through the article search conducted during the identification phase, a total of 108 articles were obtained from Scopus.

Table 1.0: Search string used in the selected database

Database	String
Scopus	TITLE-ABS-KEY ("nature-based" OR "nature inspired" OR "outdoor" OR "environmental education") AND ("instruction" OR "teaching" OR "pedagogy" OR "learning") AND ("science education" OR "science teaching" OR "STEM" OR "natural sciences") AND ("curriculum" OR "program" OR "approach" OR "method") AND ("engagement" OR "participation" OR "experience" OR "interaction")

Screening

The subsequent phase in the research process is the screening phase, which aims to select articles based on predefined criteria. The author established four specific criteria for this screening process: publication year, document type, language, and subject. These criteria are presented in Table 2, which outlines the basis for including or excluding articles from the study. Regarding the publication year criterion, the author opted to include articles published between 2013 and 2024, while excluding articles published before 2013. The document type criterion focused on selecting articles that contained empirical data, although certain exceptions were made for review articles, book chapters, books, and systematic literature reviews. Additionally, the author selected articles written in the English language as the third criterion. The researcher's decision-making process for eligibility and exclusions can be found in Table 2.0, providing an overview of the criteria employed in this study.

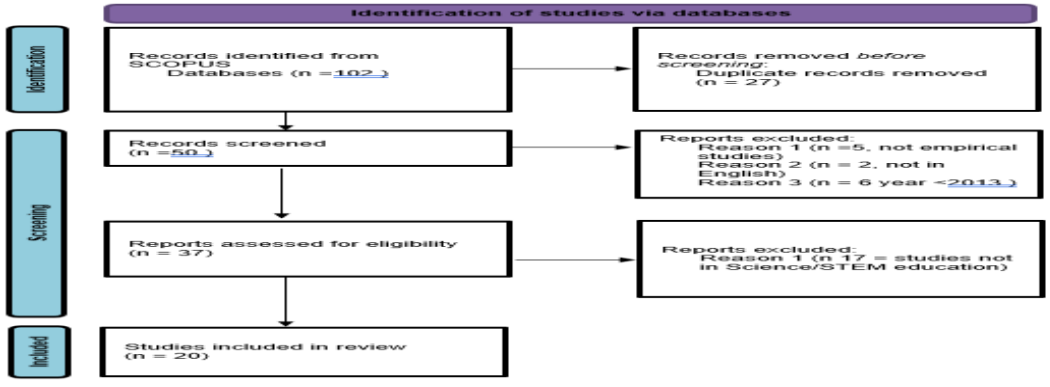
Table 2.0: Inclusion and exclusion criteria

Criterion	Inclusion	Exclusion
Timeline	2013–2024	2012 and earlier
Document type	Articles (with empirical data)	Review article, chapter in a book, book, conference proceeding, etc
Language	English	Non-English

Eligibility

During the eligibility phase, a total of 37 articles were identified as fully accessible for further examination. The author then proceeded to conduct a thorough quality assessment by reviewing the titles, study abstracts, and content of these articles to determine their relevance to the research being conducted. Following this assessment, it was determined that only 20 articles met the predefined criteria for inclusion (refer Figure 1.0).

Figure 1.0: Flow diagram of the searching process



Quality appraisal

The primary focus of the quality assessment was to ensure that the selected articles met satisfactory criteria in terms of methodology and analysis. To facilitate this assessment, the Mixed-Method Appraisal Tool (MMAT) provided by Hong et al. (2018) has been used. The MMAT offers a systematic framework that assists researchers in evaluating the quality of studies, enabling them to assess the strengths and weaknesses of the articles under review.

Within the MMAT framework, various research methods are considered, including qualitative studies, quantitative randomised controlled trials, quantitative non-randomized studies, quantitative descriptive studies, and mixed-method studies. This analysis specified screening questions that needed to be addressed before conducting the quality assessment for each research method. Once the screening questions were answered and met the established criteria, then it proceeded with assessing the research method and data analysis of the articles. To ensure adherence to the criteria, MMAT provided guidelines for each research method as outlined by Hong et al. (2018) (refer Table 3.0).

To mitigate bias in the article selection process, the references from experts who conducted reviews for each article undergoing quality assessment has been sought. This approach aimed to enhance the objectivity and reliability of the assessment process.

Table 3.0: The criteria used to determine the precision of the methodology and analysis used in the selected articles.

Research design	**Assessment criteria**
Qualitative	QA1- Is the qualitative approach appropriate to answer the research question? QA2- Are the qualitative data collection methods adequate to address the research question? QA3- Are the findings adequately derived from the data? QA4- Is the interpretation of results sufficiently substantiated by data? QA5- Is there coherence between qualitative data sources, collection, analysis and interpretation?
Quantitative (descriptive)	QA1- Is the sampling strategy relevant to address the research question? QA2- Is the sample representative of the target population? QA3- Are the measurements appropriate? QA4- Is the risk of non response bias low? QA5- Is statistical analysis appropriate to answer the research question?
Quantitative (non-randomised)	QA1- Are the participants representative of the target population? QA2- Are measurements appropriate regarding both the outcome and intervention (or exposure)? QA3- Are there complete outcome data? QA4- Are the confounders accounted for in the design and analysis? QA5- During the study period, is the intervention administered (or exposure occurred) as intended?
Mixed methods	QA1- Is there an adequate rationale for using a mixed methods design to address the research question? QA2- Are the different components of the study effectively integrated to answer the research question? QA3- Are the outputs of the integration of qualitative and quantitative components adequately interpreted? QA4- Are divergences and inconsistencies between quantitative and qualitative results adequately addressed? QA5- Do the different components of the study adhere to the quality criteria of each tradition of the methods involved?

Data extraction and analyses

Table 4.0 presents a summary of the design employed in the investigation of the 20 articles. The study revealed that out of the analysed articles, four utilised a quantitative method, eight employed a qualitative method, and three adopted a mixed-method approach. For future research, it is advisable for researchers to consider using qualitative methods due to their ability to gather in-depth insights, meanings, experiences, and attitudes. Qualitative methods involve techniques such as interviews, observations, textual analysis, and the examination and interpretation of case studies.

Table 4.0: Results of the quality assessment

Study	Research design	QA1	QA2	QA3	QA4	QA5	Number of criteria fulfilled	Inclusion in the review
Amy et al. (2013)	QN (DC)	√	√	√	√	√	5/5	√
Dilafruz & Scott (2013)	QL	√	√	√	√	×	4/5	√
Habibe (2014)	QL	√	×	√	√	√	4/5	√
Jennie et al. (2015)	MX	√	√	×	×	√	3/5	√
Louise (2015)	QL	√	√	√	×	√	4/5	√
Payam et al. (2015)	QN (DC)	√	√	√	×	√	4/5	√
Ulrich et al. (2015)	MX	√	√	√	√	√	5/5	√
Ulrich et al. (2017)	MX	√	√	√	√	√	5/5	√
Francesca et al. (2018)	QN (DC)	√	√	√	√	√	5/5	√
Giulia et al. (2018)	MX	×	√	√	√	√	4/5	√
Karen & Peer (2018)	QL	√	√	√	√	√	5/5	√
Kate & Mary (2018)	QL	√	√	√	√	√	5/5	√
Michael et al. (2018)	QL	√	√	×	√	√	4/5	√
Ming et al. (2018)	QN (DC)	√	√	√	√	√	5/5	√
Rachel et al. (2018)	QN (DC)	√	√	√	√	√	5/5	√
Cathy & Louise (2019)	QL	√	√	√	√	√	5/5	√
Ming & Catherine (2019)	QL	√	√	×	×	√	3/5	√
Ming et al. (2019)	QL	√	√	√	√	√	5/5	√
Ryan et al. (2020)	QN (DC)	√	√	√	√	√	5/5	√
Nicole et al. (2021)	QN (DC)	√	√	√	×	√	4/5	√

QA= Quality assessment; QN (DC)= Qualitative descriptive; QN (NR)= Qualitative non-randomised; QL= Qualitative; MX= Mixed-Method

RESULT AND DISCUSSION

The purpose of this Systematic Literature Review (SLR) is to identify the best approaches used in nature-based instruction to do teaching and learning in science education. The research findings from these articles indicate that 20 articles meet almost all the criteria established based on MMAT. In the nature-based instruction approach, the main focus is on incorporating outdoor experiences, environmental exploration, and interactions

with nature into the curriculum and instructional practices. The analysis of the selected articles revealed several key best practices for nature-based science instruction in science education. These best practices can be categorised into two main areas: curriculum design and pedagogical strategies. Curriculum design in science education, there are various types of curriculum design approaches that are commonly used to structure and organise the teaching and learning of science concepts. The identified best practices in pedagogical strategies emphasised student-centred approaches that encourage active learning and meaningful engagement with nature. Some effective strategies include outdoor field trips, nature walks, inquiry-based learning, project-based learning, and the use of technology to enhance students' exploration and understanding of the natural world.

Main theme	**Sub-theme**	**No. of papers**	**Brief description (with examples from manuscript)**
Teaching & Learning (T&L) approaches	Inquiry-based learning	2	Student-led questioning, exploration, and discovery in outdoor contexts; e.g., Udeskole lessons blending open-ended inquiry with science/maths outdoors; kindergarten schoolyard inquiry linking play spaces to investigations.
	Problem-/Project-based learning (PBL)	2	Real-world problems/projects anchored in nature; sustained work cycles; e.g., outdoor education kindergartens showing richer developmental opportunities; “living wall”/green infrastructure as a project anchor to integrate STEM and authentic data use.
	Field trips / nature walks	2	Short, immersive, place-based visits that heighten novelty and authenticity; associated with improved engagement, concentration, prosocial behavior, and environmental understanding (e.g., one-day environmental education trips; woods/forest walks).
	Outdoor learning (general)	10	Regular learning outside the classroom (school grounds, local parks, naturalized spaces). Evidence links outdoor sessions to improved attention, reduced stress, higher participation/fitness, better self-discipline, and positive motivational profiles; effective for both social and academic outcomes; includes “fieldwork,” school ground greening, and residential programs.
	Garden-based learning (school grounds)	3	Use of school gardens/habitat plots to teach science and cross-curricular outcomes; associated with gains in science achievement/grades and broader academic outcomes; promotes autonomy, decision-making, and kinesthetic learning via authentic tasks.
	Technology-integrated nature learning	1	Mentioned as a supporting strategy (e.g., using digital tools to extend investigation), but not a dominant focus of the included empirical set; appears mainly as enhancement rather than primary intervention in this corpus.
	Indoor nature-based settings (e.g., green walls)	1	Bringing nature indoors to counter attentional fatigue and improve behavior/engagement; project-based, hands-on interaction with “indoor nature” supporting STEM practices and collaborative work
Learning audience	Pre-school / early childhood	2	Kindergarten cohorts in outdoor education models and schoolyard pedagogy demonstrating personal relevance, inquiry, and socio-emotional benefits.
	Primary / elementary (incl.	4	Primary students show cognitive benefits from exposure to greenspace; habitat programs and garden-based lessons relate

	Grades 5–6)		to improved science outcomes; broader quantitative review supports academic/engagement gains at the primary level.
	Lower secondary / middle (incl. Grades 7–8)	2	Middle-school field trip studies reporting stronger outcomes when time outdoors is maximized; place-based authenticity matters for environmental learning.
	Special education / diverse needs (ECBD)	1	Outdoor EE associated with improved attention and reduced disruptive behavior among students with emotional, cognitive, and behavioral disabilities, with science learning outcomes at least comparable to traditional settings.
	Multiple levels / mixed samples	9	Several studies/reviews span multiple grades or report system-level/whole-school effects (e.g., teacher-education, coordinated agendas, cross-stage syntheses), hence not confined to a single band.

Inquiry-based Approach

Inquiry-based curriculum design places emphasis on student inquiry, exploration, and discovery. It focuses on developing scientific inquiry skills and fostering a deep understanding of scientific processes and methods. Students actively engage in hands-on investigations, experiments, and problem-solving activities to construct their own knowledge and develop critical thinking skills. According to the research by Barford & Daugbjerg (2018), Udeskole instruction applied, which is teaching outside of the conventional classroom setting, was the focus of this paper's attempt to investigate the prevalence of inquiry-based instruction in outdoor settings. The study involves five teachers, and the results indicate that almost half of the Udeskole instruction for students between the ages of 8 and 11 consisted of non-instructional, inquiry-based activities. Five of the teachers observed outdoor maths and science lessons, which exhibited a mixture of closed training assignments and open-ended, inquiry-based work. The findings suggest that Udeskole instruction has the potential to support inquiry-based learning, supporting a child-activating method of science and maths instruction. Moreover, the research of MacDonald & Breuning (2018) also suggests that the inquiry-based outdoor classroom methodology provides kindergarten kids with a platform to connect with their learning in a personally relevant way. The setting used for this research study's investigation of the effects of full-day classes was the playground. The schoolyard is a sizable, open green area that is open to the public, and it is the perfect place for the "greening" project because it has established play equipment close to its entrance as well as open fields for unstructured play. Thus, students can make connections between their surroundings and their educational experiences and develop relationships with their peers by spending time in less structured learning environments. This study proved that inquiry- based learning methods enable cross-disciplinary learning opportunities that strengthen all aspects of student engagement in the learning process.

Problem-Based/Project-Based Curriculum

This type of curriculum design revolves around real-world problems or projects that students work on collaboratively. This approach encourages students to apply scientific knowledge and skills to solve authentic problems or engage in project-based activities. The curriculum design often involves open-ended tasks, research, data analysis, and the development of solutions or presentations. The study presents compelling evidence that supports a cause-and-effect relationship between experiences with nature and improved learning (Kuo et al. 2019). The authors highlight the growing concern about the decline in children's engagement with nature and its potential consequences on their cognitive development. The author suggested that students may take part in project-based learning activities in schools that are centred around a living wall in their classroom, participate in outdoor sessions, and have access to a green outdoor space. By incorporating nature-based instruction in science education, it can serve as a promising strategy to enhance learning outcomes. It emphasises the need for educators to incorporate more outdoor and experiential learning opportunities to optimise students' engagement and understanding of science. The study by Agostini & Mandolesi (2018), investigated how teachers in two distinct types of kindergartens viewed students' developmental growth over

the course of two academic years. The approaches that were used to test the significance were Outdoor Education (OE) and traditional education by using project based techniques in two different kindergartens. The findings show that, in the opinion of the teachers, the OE activities offered more chances to encourage children's development at different levels, especially in younger children. Children who attended OE kindergartens appeared to gain a lot from this educational strategy because they participated in more ongoing and project-based OE activities throughout their school years than kids who attended more traditional kindergartens. Overall, this project-based activities in outdoor learning indicates to provide the kids with more immediate advantages.

Field Trip

Studies based on educational field trips approach in learning also discovered new favourable effects on learning outcomes. Several prior studies in this field provide support for these results. For instance, research on field trips in environmental education (EE) by Dale et al. (2020) show that elements like the authenticity and distinctiveness of the setting, the use of place-based education, and a stronger emphasis on outdoor experiences as opposed to interior ones are connected with excellent student outcomes. This study's main goal was to find out whether middle school students who went on one-day EE field trips experienced favourable learning outcomes in relation to the natural environment. According to the study, using nature-based strategies and immersing students in the outdoors helped to raise the novelty of the learning experience, which was directly related to successful learning results. Overall findings of this study suggested that programmes that made the most of outside time had noticeably better benefits. Additionally, To support this, research by Chawla (2015) proves that there is a significant impact on learners by executing learning experiences by field trips and nature walks to woods. The author supported that during the field excursion to the woods, the participants showed enthusiasm, cooperative social behaviour, and improved concentration in contrast to minimal social behaviour, increased inattention, and impulsivity in the town. Notably, after the nature excursion, each group significantly improved on a test of concentration. Extending nature access outside of parks is crucial for effectively promoting health and wellbeing. Finally, the presence of trees and other natural features in the near vicinity of homes, schools, and childcare facilities, where children spend a lot of time, is essential for a number of beneficial outcomes for health and wellbeing.

Outdoor learning

The current review found emerging positive impacts for nature-based learning in science education when the outdoor learning approach is applied in schools and learning centres. The finding supported those of previous reviews by Acar (2014); Aronsson et al. (2015); Dadvand et al. (2015); Dettweiler et al. (2015); Dettweiler et al. (2017); Amicone et al. (2018); Kuo et al. (2018); Szczytko et al. (2018); Kuo & Jordan (2019); Miller et al. (2021); Jordan & Chawla (2022).

These papers primarily focus on the approach of outdoor learning that signifies the learning outcomes. To support this, research by Kuo et al. (2019) proved that students who had difficulties in regular classes perform better and exhibit more self-control when they are placed in more stimulating learning environments. The study shows that the perception of the instructor as a learning partner on a more level playing field helps students and teachers cooperate and feel comfortable in the natural setting. Additionally, learning outside appears to improve a number of educational outcomes, including improved concentration, lowered stress levels, higher self-discipline, increased interest and enthusiasm in the subject matter, and increased participation in physical exercise and fitness has been proven in this study. The author concluded that the natural environment also offers a calm, secure, and serene background for learning, encouraging a friendlier and more collaborative learning environment.

The research paper by Acar (2014) emphasises the importance of the physical environment in children's learning by focusing on relationships between children and their environments as well as learning environments. It gives examples to demonstrate what makes up a learning environment, how to design physical environments that are favourable to children's learning, and which environmental features have a good influence on learning. The study also emphasises the value of creating learning environments and lists the crucial factors to take into account when doing so. By doing this, it provides designers who are tasked with

developing premium outdoor areas for kids that promote the best learning experiences with useful knowledge (Dettweiler et al. 2017; Kuo & Jordan, 2019). This paper emphasises the value of outdoor learning spaces and discusses how play and learning interact as well as how learning environments affect kids' educational paths. This approach is also supported by the research of Kuo et al. (2019) that studies on specific activity that is conducted outside of the classroom shows a positive impact on students' learning. The data for this study is based on activities like "cohabiting with a wild animal" or "being in solitude in nature" which was conducted outside of the classroom to promote healthy growth. The study summarised here shows the various benefits of engaging with nature in a variety of contexts and methods. A wide range of fields, including education, teacher preparation, early childhood development, design, and planning, as well as health and mental health care, among others, can benefit from these particular studies, reviews, and conceptual pieces.

There is a research study used a quasi-experimental approach to examine how a programme affected various ECBD (Emotional and Behavioural Disorders) indicators, including student behaviour and attention span, as well as science efficacy, understanding of the nature of science, and academic achievement for ECBD students supported that outdoor learning approach in natured-based instruction in education (Szczytko et al. 2018). This study involves Online questionnaires given to teachers and students who had been diagnosed with ECBD in order to evaluate these factors. Additionally, surveys were sent to the kids and instructors from matched control schools. The quantitative data showed that when students were learning outside, teachers noticed a significant improvement in their attention spans and a decline in disruptive behaviours. Additionally, students in the treatment group maintained their levels of knowledge about the nature of science, their efficacy in science, and their grades in science, which were comparable to those of their peers in the control group. These results indicate that outdoor Environmental Education (EE) can be at least as productive for science instruction as traditional classroom instruction. Moreover, this is proven that outdoor EE seems to be an effective tactic for boosting student learning outcomes for addressing ECBD symptoms.

Furthermore, a research study by Jordan & Chawla (2022) suggests that fieldwork in education supports the educational process. Fieldwork in the natural world is a well-established practice in environmental and science education, and the first tradition has a long history. Initiatives like school gardens and ground greening have also seen a comeback, providing possibilities for "fieldwork" just outside of schools. Numerous studies have compared the advantages of studying outside with those of traditional classroom education and learning in largely hardscaped settings, where nature is less common. These studies seek to gain a deeper understanding of the benefits of nature-based learning and how it might improve the educational process. The research of Kuo et al. (2018) supported by literature on education outside the classrooms, which demonstrates successful outcomes for social and academic experiences. A change of environment and a break from routine classroom activities are required in all outdoor education research, which examines education not only in natural settings but also in museums and other outdoor venues.The instruction in nature's setting involved a change in scenery, which is likely what helped students feel refreshed afterward.

The study by Dettweiler et al. (2017) compared the analysing data on students' motivational behaviour in relation to the satisfaction of their fundamental psychological needs shows that hands-on outdoor residential programmes utilising explorative learning techniques can significantly improve students' learning attitudes. The main lesson to be learned from this analysis of a residential outdoor scientific education programme is to occasionally but consistently incorporate the teaching strategies that were tried and tested in this and comparable residential programmes into the regular school curriculum. Only lately have the benefits of these frequent teaching sessions outside of the classroom been investigated and documented. To profit from them, it is advised to incorporate such outdoor learning opportunities into the daily schedule of the school. This study sheds light on the importance of outdoor learning approach into education. According to the research by Dettweiler et al. (2015), collectively highlight the value of stepping up efforts to create educational ideas that promote autonomy and convey competence through "hands-on" teaching of science. This pedagogic method in schools seems to be best promoted and implemented outdoors.

Another research supports the fundamentals of outdoor learning through investigating how nature might restore children's cognitive abilities in the context of school, an important setting in their everyday life (Amicone et al. 2018). The research team involved in the study carried out the recess activity either in the

complete built environment area or in a piece of the school garden of a similar size in order to minimise potential disparities resulting from playing in larger settings. The kids in this trial normally took their after-lunch breaks outside and their morning recesses inside in their schools. Only the chosen class of kids played outside during the morning break while the others stayed inside. This study highlights the critical importance of giving students access to outdoor learning environments that can support their psychological and physical health while fostering pleasant learning experiences.

Based on the research of Dadvand et al. (2015), school children's cognitive development was positively impacted by exposure to green spaces outside. Benefits were consistently seen in working memory, superior working memory, and inattentiveness, among other cognitive domains. Additionally, the connections with positivity were stronger when the school itself was green. Furthermore, In-depth research supporting outdoor activities is presented in this systematic literature review (Miller et al. 2021). According to the review, nature-based education has a chance to improve primary school students' academic performance. Physical activity (PA), mental health and wellbeing, educational performance, engagement, and social outcomes were used to categorise the included studies in this review. Finally, according to the study by Aronsson et al. (2015), students are likely to spend time in the woodland with their family after school, engaging in physical activities including walking to and within the woods and participating in playful activities, according to evidence gleaned from the WHY program reflective journal. Families' rising interest, understanding, and confidence in using the woodland for natural learning opportunities can be related to this rise in outdoor time. According to the study, students may draw motivation from their experiential learning in the natural world and end up spending more time outside after school, which would enhance their overall levels of physical activity.

Garden-based learning

To support the current review, studies on learning in school gardens suggest that when education takes place outside in natural settings, student engagement and motivation may increase (Kuo et al. 2018; Kuo & Jordan, 2019). This might be explained by the greater autonomy and opportunity for social contact offered by the majority of garden-based courses. With the help of such strategies, students can actively use outdoor settings to put their theoretical learning to use and to make decisions and solve problems in the real world. Compared to other teaching approaches, these procedures are probably more effective at promoting long-term knowledge acquisition. Lessons in nature are also particularly well adapted to curriculum that can benefit from learning modes other than auditory and visual techniques. Natural landscapes present special potential for kinesthetic learning experiences because of their varied topography and vegetation.

Based on McFarland et al. (2013)’s study, it is aimed to determine whether fourth-grade primary school students in Houston, Texas, who participated in the Schoolyard Habitat Programme (SYHP), garden-based activity of the National Wildlife Federation (NWF) affected their science grades or test results. The results of this study are consistent with those of prior investigations on the connections between students' academic success, interdisciplinary or integrated curriculum with environment. It is proven that outdoor activities that incorporate learning in school are highly significant for students. Additionally, the findings by (Williams & Dixon, 2013) provide details on effects of garden-based learning on students' academic performance in topics like science, language arts, arithmetic, writing, and social studies. The information presented here is important for academics, professionals, and policymakers in these grade levels, and it emphasises the need for additional research in the grades that have mostly been ignored in studies about the effects of school gardens on academic achievement. In light of this, we support well-designed research that will distribute information that will advance the subject and lead to a more thorough understanding of garden-based learning, which is consistent with nature-based instruction in educational settings. Similar to the above analysis, the research paper of (Kuo et al. 2018) suggests that teachers can think about experimenting with moving their classes to the gym for a lesson or switching classrooms with another instructor given the possibility that brief breaks from classroom activities and changes of environment will result in gains in subsequent classroom engagement.

Nature-based classroom setting.

This approach in learning methods showed a positive impact in students' progress level. This finding is largely consistent with the literature which suggests that nature-based setting in the classroom can aid study

investigates how direct contact with nature enhances learning and fosters better behaviour and attentiveness in students. This article's major goal is to give a possible strategy for using green walls in the classroom to implement a nature-based learning programme. According to the study, a green wall, project-based curriculum model can encourage hands-on interaction with indoor nature and foster real-world thinking in the domains of science, technology, engineering, art, and mathematics in an indoor learning setting. By bringing nature indoors, this classroom design presents a potential remedy to lessen the impacts of directed attention fatigue and improve student behaviour. By turning abstract ideas into concrete shapes, it gives students the chance to better comprehend green technology, promote cooperative social behaviour, and enhance their design-process skills. Through project-based learning that is guided, active, and mode, all of these goals are accomplished.

The results of this systematic literature review underscore the importance of incorporating nature-based science instruction in science education and offer valuable insights into the best practices for its implementation. Nature-based instruction presents unique opportunities for students to forge a profound connection with the natural world, nurturing their scientific curiosity and comprehension of ecological concepts. Integrating nature-based instruction into the curriculum provides students with genuine experiences that bridge theoretical knowledge and real-world applications. The research article of Kuo & Jordan (2019) proves that by applying nature based instruction in pedagogical approach and actively engaging with nature, students are stimulated to explore and improve motor skills, inquire, and observe, leading to a deeper grasp of scientific principles. In addition to helping students with disabilities, nature-based learning has been shown to increase interest in learning (Szczytko et al. 2018), and improve their understanding of learning. Additionally, the reviewed articles emphasise the significance of educators adopting student-centred pedagogical approaches that foster active learning and critical thinking. Nature-based instruction facilitates the development of vital skills such as problem-solving, teamwork, and communication, which are essential for scientific inquiry and future STEM careers. However, it is crucial to acknowledge the potential challenges in implementing nature-based science instruction, including limitations in resources, safety considerations, and access to natural environments. Collaborative efforts between educators and policymakers are necessary to address these challenges and provide sufficient support and resources for the effective implementation of nature-based science instruction.

CONCLUSION

This comprehensive evaluation of the literature highlights the value and potential of nature-based science instruction in science education. The study found and examined numerous best practices that, by using the environment in science education, effectively improve student learning. The research highlights several important approaches through a thorough review process that involves inquiry-based learning, project-based learning, field trips, outdoor learning, garden-based learning and nature-based classroom design setting. These best approaches provide useful direction for teachers who want to develop and deliver science courses focused on nature that encourage students' understanding, respect, and stewardship of the natural world. Nature-based instruction enhances students' scientific understanding while also fostering a closer relationship with and appreciation for nature by including the natural environment as a key component of the teaching and learning process. This study has consequences for curriculum design, teacher development programmes, and educational policies in addition to the classroom. By encouraging more involvement, critical thinking, and long-term environmental consciousness in students, a nature-based approach to science teaching has the potential to revitalise and enrich their educational experience. This review also highlights the need for additional investigation and evaluation of the results of nature-based learning in science education. Future research could examine how these practices over time affect students' aptitude for science, attitudes towards the natural world, and dedication to environmental preservation. Additionally, studies exploring the most effective ways to incorporate nature-based techniques into various learning environments and grade levels would be of great use to educators. As a result, the evidence highlighted in this systematic review encourages educational stakeholders to embrace and support the application of these best practices. It also highlights the importance of nature-based instruction in science education. By doing this, we can help create a generation that is more aware of the environment and knowledgeable about science and able to handle all the complicated environmental problems of the future.

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