

## Review

# How Do Nature-Based Outdoor Learning Environments Affect Preschoolers' STEAM Concept Formation? A Scoping Review

Nazia Afrin Trina <sup>1,\*</sup>, Muntazar Monsur <sup>1,\*</sup>, Nilda Cosco <sup>2</sup>, Stephanie Shine <sup>3</sup>, Leehu Loon <sup>1</sup> and Ann Mastergeorge <sup>3</sup>

- <sup>1</sup> Department of Landscape Architecture (DoLA), Davis College of Agricultural Sciences and Natural, Texas Tech University, 2904 15th St., Lubbock, TX 79409, USA; ntrina@ttu.edu (N.A.T.); leehu.loon@ttu.edu (L.L.)  
<sup>2</sup> Department of Landscape Architecture and Environmental Planning, College of Design, North Carolina State University, 50 Pullen Road, Raleigh, NC 27695, USA; ngcosco@ncsu.edu  
<sup>3</sup> Department of Human Develop and Family Sciences, College of Human Sciences, Texas Tech University, 1301 Akron Avenue, Lubbock, TX 79415, USA; stephanie.shine@ttu.edu (S.S.); ann.mastergeorge@ttu.edu (A.M.)  
\* Correspondence: mmonsur@ttu.edu

**Abstract:** This scoping review examined the impact of nature-based outdoor learning environments on the formation of STEAM (science, technology, engineering, arts, and mathematics) concepts in preschoolers. Preschool age (3–5 years) is the time when physical interaction with surrounding built environments increases, and spontaneous learning from the environment intensifies—making it an ideal age range to promote nature-based informal learning. An outdoor learning environment can influence STEAM concept formations of preschoolers with an intentional design that offers STEAM learning affordances. Despite the rising interest in early STEAM education, there is still limited literature on how the outdoor environment may influence STEAM learning behaviors of preschoolers (3–5 years old). This scoping review intended to evaluate the existing knowledge regarding the physical factors contributing to STEAM learning affordances in an outdoor environment for children aged three to five. The review included studies from the last twenty years. This scoping review was conducted following the criteria outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR). For this scoping review, 843 citations were discovered across four databases (JSTOR, Scopus, EBSCOhost, and Web of Science), ProQuest, and Google Scholar, and 31 articles were considered eligible for inclusion. The paper synthesized those 31 studies to identify the key STEAM learning behaviors of children and STEAM-activity-supportive settings that may positively influence preschoolers' STEAM concept development.

**Keywords:** preschooler; STEAM concept; landscape elements; informal learning; affordances



**Citation:** Trina, N.A.; Monsur, M.; Cosco, N.; Shine, S.; Loon, L.; Mastergeorge, A. How Do Nature-Based Outdoor Learning Environments Affect Preschoolers' STEAM Concept Formation? A Scoping Review. *Educ. Sci.* **2024**, *14*, 627. <https://doi.org/10.3390/educsci14060627>

Academic Editors: Amber Simpson, Alice Delserieys Pedregosa and Maria Kampeza

Received: 29 March 2024

Revised: 24 May 2024

Accepted: 5 June 2024

Published: 11 June 2024



**Copyright:** © 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

## 1. Introduction

Understanding the impact of nature-based outdoor learning environments on the formation of STEAM (science, technology, engineering, arts, and mathematics) concepts in preschoolers is essential for many reasons. Early childhood is a critical period for cognitive and social development, and experiences during this time can shape future learning and interest in STEAM disciplines. Nature-based environments, as a source of diverse opportunities for experiential learning, can promote children's curiosity, problem-solving, and creativity through direct interaction with natural elements [1]. There are endless possibilities for reimagining childcare 'playgrounds' as nature-based outdoor informal STEM learning environments in 188,000 licensed and family childcare facilities in the U.S., where more than 13 million [2] children aged zero to five spend the majority of their waking hours every day. Nature, being a constant source of varied environmental learning opportunities, has gained a wide range of attention in early childhood education, but there are no established guidelines on measuring and enhancing 'nature' in early outdoor environments with low-cost interventions or curriculum guidance/courses/certificates to

promote nature-based informal early STEAM learning. STEAM is linked with developing early interests in science, technology, engineering, and math, which can lead to future interests and address the growing concern that the U.S. is falling behind in STEAM (ranked 13th in mathematics and 31st in science [3] test scores internationally and with more than 1 million STEM jobs unfilled). A scoping review of the current empirical research on the impact of nature-based learning environments on early STEAM concept formation in preschoolers may guide preliminary understanding and insights regarding this critical aspect of early childhood education tied to national interests.

The Experiential Learning Theory (ELT), as explained by Armstrong and Fukami [4], emphasizes the importance of direct experiences in early childhood learning. This theory views learning as a dynamic process that integrates children's ideas, their ability to experiment and refine concepts, and the construction of new knowledge. It highlights the continuous interaction and adaptation between children and their environments where thoughts, feelings, experiences, culture, physical sensations, emotions, inquiry, and reflection are constantly in flux, influencing and reshaping everyday learning [5]. Furthermore, other researchers [6] support that firsthand experiences with nature allow children to observe the complex interdependencies within ecosystems. Such direct, hands-on experiences are more impactful than simulated ones, as they allow children to fully engage with their senses and interact directly with the natural world. In children's direct interaction with their surroundings, items like play equipment, [7] trees, plants, various landscape features, and water can impact their behavior. Also, the topography and the paths that link these elements to the children's homes emphasize the importance of these small-scale environmental aspects in a child's interaction with their environment [8].

Measuring the quality of the cognitive development of young children is more difficult than older ones because young children experience vast variations in the different personal, developmental, and environmental factors affecting their behaviors [9]. The educational quality is determined not only by the educators (who) and the curriculum (what) but also by the physical setting (where) of the educational service. This environmental aspect of learning is now acknowledged as a key factor in delivering high-quality early childhood education and care [10,11]. The importance of the physical environment in early childhood education was first emphasized by Loris Malaguzzi, the founder of the Reggio Emilia approach, who described it as the "third teacher". He suggested that, in addition to family and educators, the design and organization of educational spaces are crucial in shaping early childhood developmental trajectories [12]. In this paper, we emphasized environmental "affordances" as a key concept in understanding STEAM learning environments. While constraints refer to what may be lacking in a child's environment, affordances refer to the possibilities that the environment offers or affords to children/learners in the shape of learning opportunities. It does not mean what the child is learning or doing, but only whether the possibility exists [13]. An environment with an abundance of diverse affordances for exploration and discovery is essential for maximizing children's learning capacity, behaviors, and attitudes [14]. Research indicates that outdoor environments significantly enhance children's symbolic play more than indoor environments due to their natural materials, open-endedness, and spaciousness. The complexity and richness of natural environments offer a level of stimulation that cannot be replicated indoors [15]. Although outdoor play was relatively less researched in the latter decades of the twentieth century, many studies [16] emphasized the critical role of outdoor play spaces and provided insights into spatial organization, showing how spatial design can be a powerful tool in education and enhance the overall quality of children's daily experiences.

According to the author of the book *Spaces for Children* [14], children typically interact with their physical surroundings in a straightforward and observable manner. For infants, who find joy in exploring and moving, and preschoolers, who are focused on mastering muscle skills, their immediate environment serves as the primary source of learning motivation. However, the impact of the physical context, particularly the built environment, has often been overlooked. Recent studies aim to challenge this perspective,

arguing that while the built environment may not be a primary factor in child development, it can significantly affect the developmental process, especially for young children who have little control over their surroundings and may be more engaged with the physical than the social environment [14]. Before formal education shapes their learning, young children naturally seek to understand the world through observation, investigation, and social interaction, particularly in informal environments like childcare playgrounds, museums, and parks. While this self-driven learning is valuable, it is not sufficient on its own. Structured educational settings (physical environment) and deliberate teaching are crucial in children's learning. To effectively shape these environments, it is important to integrate an understanding of children's learning processes with clear objectives and content for science education [17]. Children's initial understanding develops from limited experiences, necessitating exposure to formal and informal learning environments. While traditional educational tools like demonstrations and textbooks are valuable, they cannot replace the hands-on experiences crucial for deep learning. Without these, children might grasp facts and excel in tests but will be at risk of viewing science as a rigid, disconnected set of instructions, undermining their confidence in experimentation, and fostering a belief that science is an elusive realm, understood only through external authority rather than personal exploration and understanding [17].

Young children actively engage with their environment to develop a fundamental understanding of the phenomena they are observing and experiencing [18]. Children form their own theories to make sense of everyday experiences, which assists them in embracing a more scientific perspective of their world. Cognitive research reveals that children's explorations are rooted in tangible contexts, utilizing their senses to observe, investigate, and draw conclusions from the world around them. This natural curiosity leads them to constantly ask questions and seek understanding, not in an idealized or laboratory setting but within the complexities of their everyday lives [17]. The saying "I hear, and I forget. I see, and I remember. I do, and I understand" suggests that children learn most effectively through hands-on experiences. This approach aligns with children's natural curiosity and capacity for self-discovery, marking their initial engagement with science [19]. Engaging in scientific activities helps young children appreciate and understand their environment and develop key scientific skills. These skills include curiosity, questioning, investigation, discussion, reflection, and forming ideas and theories [19,20]. STEM (science, technology, engineering, and mathematics) opportunities in early childhood take learning to the next level by adding affordances related to math, engineering, and technology. Every child deserves STEM learning environments that are wondrous, stimulating, and innovative, and that value their astonishments, curiosities, questions, and observations [21]. Exploring the natural world is a core element of childhood, making science/STEM a natural fit in early education. The increasing awareness of children's early cognitive abilities and eagerness to understand the natural world makes a compelling case for early childhood environments that offer rich and challenging opportunities for STEM learning. As Worth [22] noted, children's inquiry into natural phenomena lays the groundwork for science learning and appreciation of nature and serves as a valuable context for developing learning approaches, practicing basic literacy and math skills, and learning collaboration [23].

How can we provide children with the best possible learning environment during their preschool years? To answer this question, recent research in early childhood science education and outdoor learning environments has attracted renewed attention to improving outdoor environment quality through design. However, very few studies have discussed how the nature-based outdoor learning landscape influences the STEM concept formation of children and which physical factors of an outdoor landscape impact childhood learning. This scoping review focuses on STEAM, which integrates the 'arts' with STEM, expanding the acronym to include the "A". By including disciplines such as arts, music, literature, and dance, this inclusion expands to a comprehensive early learning philosophy that not only boosts children's technical proficiency but also cultivates their creative aptitude. According to a plethora of research, how children informally learn, especially through

play, is influenced by nature, architecture, and policies that govern how school grounds are used [20]. Physical factors of a natural outdoor learning landscape can prompt early childhood STEAM learning.

The domains of this scoping review encompass “affordances of outdoor learning environment for early childhood” and “outdoor learning landscape design elements” in relation to “STEAM/STEM/Science learning activities and behaviors of children”(Figure 1).

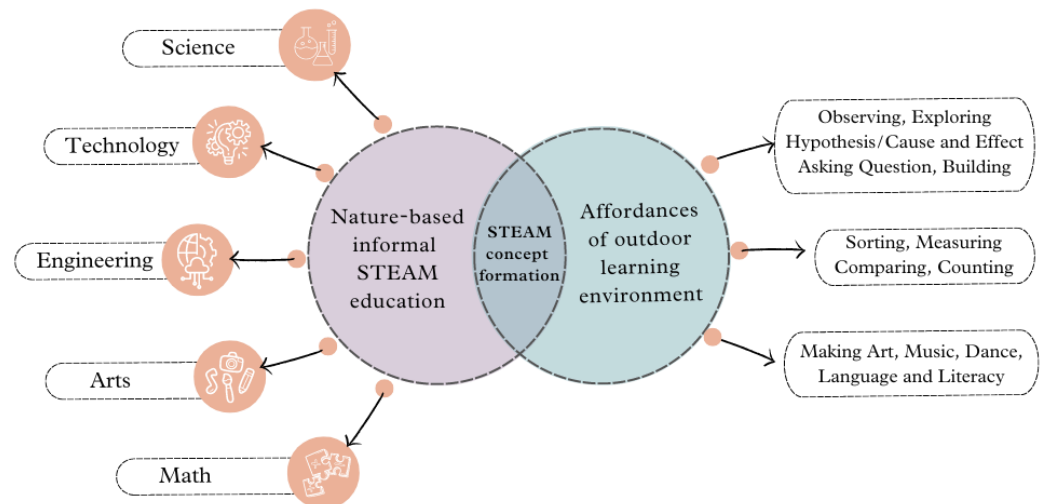


**Figure 1.** Study domains of reviewed resources.

A significant characteristic of outdoor play and learning is the relative independence of the child to explore and experiment. Compared to indoor formal learning and even indoor play, there are typically fewer restrictions and more freedom in outdoor times—and hence, greater opportunities for children to explore, experiment, solve problems of interest, and venture into activities that they enjoy when adults are not overseeing (messy, risk-taking, etc.). So, there is an interesting negotiation between the benefits of playing freely outdoors, which leads to discoveries, and the role of adults in curating children’s STEAM concept formation. This scoping review is an approach to setting a bridge between these domains.

## 2. Research Method

This scoping review was conducted in accordance with the criteria outlined in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR), using Arksey and O’Malley’s (2005) methodological framework [24], as seen in Figure 2. The methodology encompassed the subsequent stages: (1) identification of research questions, (2) identification of relevant studies, (3) selection of relevant studies, (4) data charting, and (5) collating, summarizing, and reporting the results.



**Figure 2.** Methodological framework (Arksey and O’Malley, 2005) [24].

### 2.1. Identification of the Research Questions

Due to its intricate characteristics, the concept of nature-based STEAM education for preschoolers has not yet been extensively investigated. Therefore, the research question that guided the investigation in this scoping review was: what empirical knowledge is available from the existing literature regarding the impact of nature-based outdoor learning landscape on preschoolers’ STEAM learning? The foundational research questions derived from the research objectives established within the PCC (population, concept, and context) framework [25] are presented in Table 1.

**Table 1.** Research questions based on PCC (population/concept/context).

| Research Question                                                                                                                                                                                                                                            | Specific Objective                                                                                                                                                                                                                                                                                                                                  |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| (1) Based on the discussion of the existing literature, which types of interaction with natural elements and materials (CX *) in outdoor environments enhance STEAM learning and curiosity (CP *) among preschoolers (P *)?                                  | Exploring different types of STEAM-related behaviors exhibited by children while interacting with the outdoor environment, such as questioning, exploring, building, or using STEAM-related language.                                                                                                                                               |
| (2) From the existing research, which characteristics of a nature-based outdoor learning landscape (CX) were identified that support STEAM learning opportunities (CP) for preschoolers(P)?                                                                  | Documenting the specific areas within the natural outdoor environment where STEAM learning behaviors occur and the context of these interactions. Also, the frequency of children’s engagement with different landscape elements in the natural outdoor environment (e.g., plants, water, and wildlife) could lead to STEAM learning opportunities. |
| (3) In the existing literature, what were teachers’ /caregivers’ (P) perceptions regarding the benefits and challenges of integrating (CP) nature-based outdoor STEAM learning into the preschool (P) curriculum across diverse environmental settings (CX)? | Gathering insights from educators on the perceived affordances of the natural outdoor environment for informal STEAM learning and on children’s STEAM learning behaviors.                                                                                                                                                                           |

\* CX = context, CP = concept, and P = population.

2.2. Identification of Relevant Studies

**Database Search.** Three sets of search terms were used in four selected databases: JSTOR, Scopus, EBSCOhost, and Web of Science. The title of this research was used to search for relevant studies on ProQuest Central. The search terms were carefully crafted by looking at the titles, abstracts, and keywords of papers already selected as relevant. The Boolean operator “OR” was used to segregate the search phrases inside each set, and the operator “AND” was used to join the different sets. The search terms are shown in Table 2 below.

**Table 2.** Search keywords.

|                                                     |                                                                                                                              |
|-----------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------|
| Population:<br>Preschoolers                         | Search terms:<br>Early child * OR preschool * OR kid OR kindergarten OR pre-K OR 3–5 years OR young child *                  |
| Concept:<br>STEAM/STEM/Science Learning             | Search terms:<br>STEM OR STEAM OR Science OR Education OR Learn * OR Science OR Technology OR Engineering OR Art * OR Math * |
| Context:<br>Nature-based Outdoor Learning Landscape | Search terms:<br>Outdoor OR Natur * OR Landscape OR Playscap * OR Childcare OR Daycare OR Playground OR Playspac *           |

Note: the asterisk “\*” is a truncation symbol that directs the search engine to find all forms of a given word.

**Grey Literature Search.** Recent advancements in preschool science and mathematics education have attracted renewed interest from researchers who are invested in pre-kindergarten education. Consequently, numerous independent research groups and educational institutions are engaged in outdoor STEAM learning and teaching activities and disseminate their findings. Incorporating non-commercially published material, also known as “grey literature”, in evidence reviews reduces publication bias and offers a more comprehensive and unbiased representation of the evidence [26]. This scoping review applied three approaches to locate grey literature that is relevant to this review: (1) a Google Scholar search using the title of this research to identify relevant studies; (2) searching known databases (e.g., [www.childrenandnature.org](http://www.childrenandnature.org) (accessed on 23 May 2024), [www.childhoodbynature.com](http://www.childhoodbynature.com) (accessed on 23 May 2024), [www.greenschoolyards.org](http://www.greenschoolyards.org) (accessed on 23 May 2024), and [www.texaschildreninnature.org](http://www.texaschildreninnature.org) (accessed on 23 May 2024)); and (3) searching websites explicitly focused on outdoor learning initiatives (e.g., Natural

Learning Initiative website: [www.naturalelearning.org](http://www.naturalelearning.org) (accessed on 23 May 2024)), and early childhood learning (e.g., “Science Preschool: ECLKC-Head Start”—<https://eclkc.ohs.acf.hhs.gov/school-readiness/article/science-preschool> (accessed on 23 May 2024)). The inclusion process prioritized peer-reviewed papers over grey literature if both sources provided identical information.

2.3. Study Selection

The search looked for journal articles published between 2004 and 2023 (20 years). Over the past 20 years, scientific research on nature-based early childhood education has shifted from perception-based to evidence-based. Initially driven by anecdotal observations and beliefs about the benefits of outdoor play, recent studies have provided robust empirical support for these practices. Research now highlights measurable improvements in cognitive development, emotional regulation, and physical health among children engaged in nature-based education. Advanced methodologies, such as longitudinal studies and randomized controlled trials, have validated these findings, leading to broader acceptance and integration of nature-based approaches in early childhood curricula. This transformation underscores the importance of empirical evidence in shaping educational practices and policies. Although it is practically impossible to pinpoint a particular year as the starting point of this paradigm shift, we believe the past 20 years is a significant timeframe to capture the critical resources for addressing the scope of this paper. Study inclusion criteria are provided in Table 3. Each title and abstract were read to screen the 843 citation records, based on the following inclusion and exclusion criteria, to decide to finalize related studies:

Table 3. Inclusion and exclusion criteria.

|    | Inclusion Criterion                            | Exclusion Criterion                                                                                               |
|----|------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| 1. | Articles published from 2004 to 2023           | Full text not attained                                                                                            |
| 2. | English language                               | Not related to learning/education                                                                                 |
| 3. | Focus on preschoolers/ 3 to 5 years old        | Study with toddlers/school-going children                                                                         |
| 4. | Focus on outdoor STEAM/STEM/science Learning   | STEAM/STEM/science learning inside the classroom                                                                  |
| 5. | Focus on outdoor play and learning environment | Studies about outdoor play and health/physical activity/restoration/social interaction/differently able children. |

2.4. Charting of Data

The final Microsoft Excel-based data charting form was developed to extract the following study attributes: Data Source, Reference Type, Publication Outlet, Study Topic, Publication Year, Research Type, Data Collection Methods, Study Location/Region, Facilitator, Children Age Range, Landscape Elements, STEM/STEAM/Science Learning Behavior, and STEAM-activity-supportive setting. Table 4 below represents the initial coding categories.

Table 4. Selected initial coding categories.

| Code           | Description of the Code                                              | Example                                          |
|----------------|----------------------------------------------------------------------|--------------------------------------------------|
| Data Source    | Source of the selected reviewed Journal Articles/Books/Book Chapters | JSTOR, Scopus, EBSCOhost, ProQuest Central, etc. |
| Reference Type | Type of review material recorded                                     | Journal Articles/Books/Book Chapters             |

**Table 4.** *Cont.*

| Code                                 | Description of the Code                                                                   | Example                                   |
|--------------------------------------|-------------------------------------------------------------------------------------------|-------------------------------------------|
| Publication Outlet                   | Journal/Book in which the study was published                                             | Redleaf Press/ Science and Children       |
| Study Topic                          | The focus areas discussed in each selected record                                         | Nature-based Outdoor/STEAM Learning       |
| Publication Year                     | The year in which the study was published                                                 | 2017, 2015                                |
| Research Type                        | Type of research conducted based on method and data                                       | Qualitative Research, Case-Study Research |
| Data Collection Methods              | Type of methods used for collecting data from the study site                              | Behavior Mapping, Interview               |
| Study Location/Region                | Name of the country where the study was conducted                                         | USA/Australia                             |
| Participant/Beneficiary of the Study | Description of who participated or benefited from the study                               | Teacher/Children                          |
| Children Age Range                   | Description of the age of the children                                                    | 3–5 years                                 |
| Landscape Elements                   | Available landscape elements present during research                                      | Trails, Garden, Wooden deck               |
| STEM/STEAM/Science Learning Behavior | Behavior of children, identified during outdoor play, which is relevant to STEAM learning | Art Building Exploring                    |
| STEAM Activity-Supportive Setting.   | Outdoor settings that support and enhance STEAM-related activity                          | Sand Play Area, Garden                    |

### 3. Reporting the Results

After searching, a total of 843 ( $n = 843$ ) resources (JSTOR: 286, Scopus: 197, EBSCOhost: 235, Web of Science: 96, and ProQuest Central and Google Scholar: 29) were identified. The total number of books and articles resulted in 814 from all databases except ProQuest Central and Google Scholar. A total of 198 records were screened by reading the heading and abstract, and after a relevancy check, 87 journal articles were excluded. The majority were excluded due to the focus on early childhood STEAM education within classroom environments; they were not nature-based outdoor environments and they were not preschoolers (3- to 5-year-old children). An additional 29 records were obtained through a combination of manual reference list searching, ProQuest Central, and Google Scholar searches for grey literature using the research's initial title. After a full body review of all 140 papers, 109 were removed according to eligibility criteria, and 31 were finally included in the scoping review. Figure 3 below represents the (PRISMA 2020) flow diagram showing literature and study selections.

The final scoping review included 19 journal articles, eight book chapters, and four books. Most of the study was focused on STEAM learning and nature-based outdoor environments. Few discussed the affordances of the outdoor learning environment. Although outdoor play and learning are common in all studies, play-focused studies were limited in this review (Figure 4).

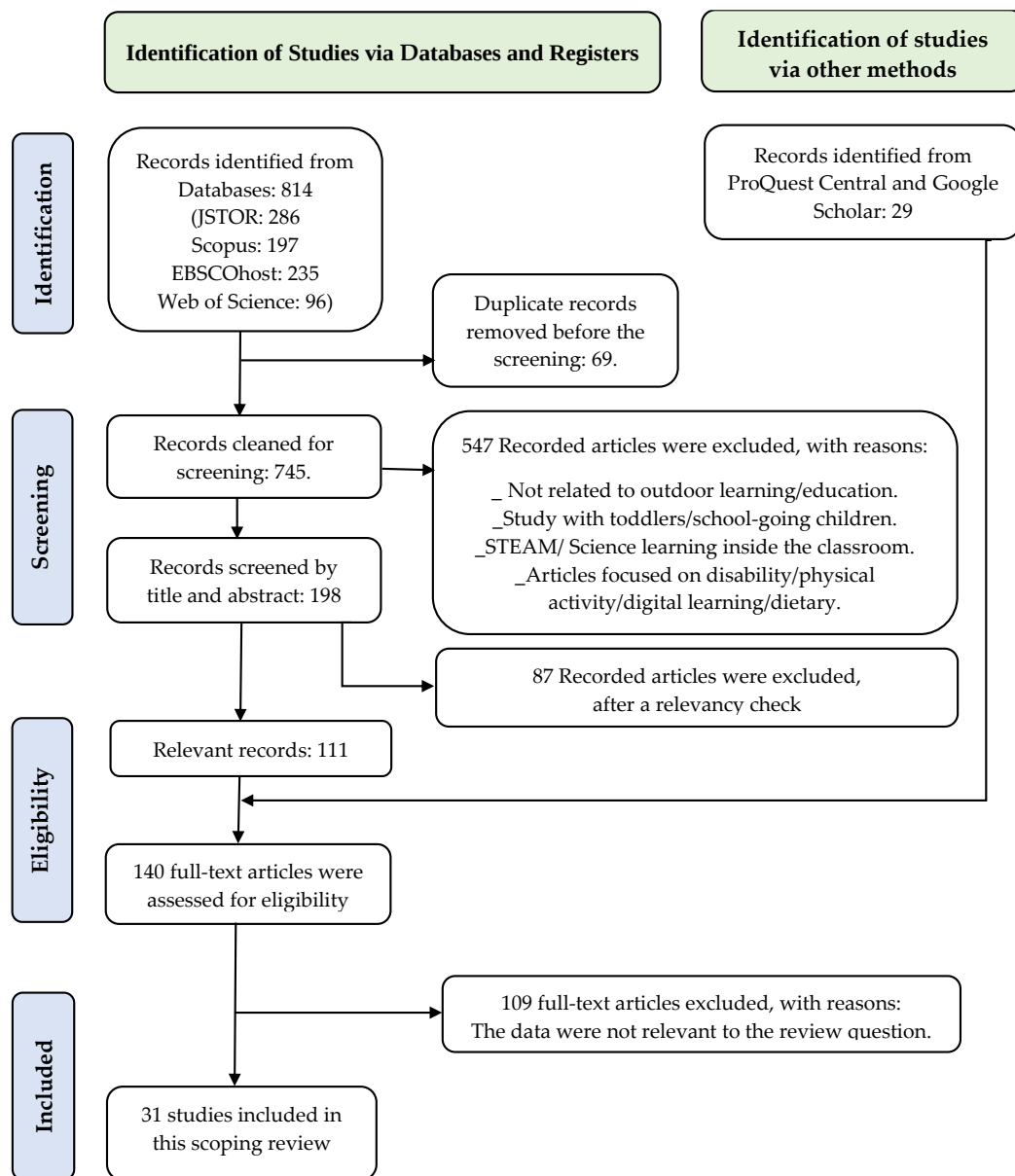


**Figure 3.** PRISMA 2020 flow diagram showing literature and study selection.

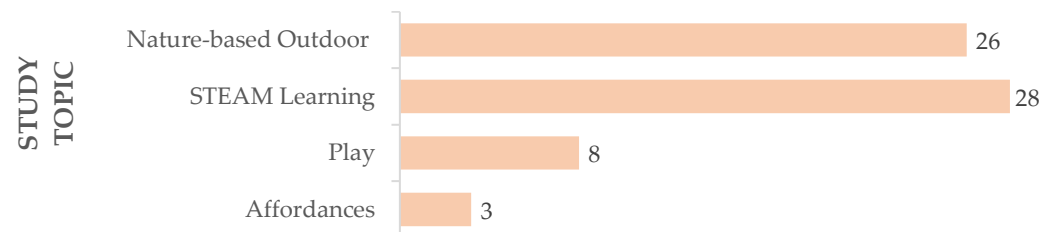


**Figure 4.** Study topic of reviewed studies.

### 3.1. Study Characteristics of the Reviewed Studies

Although search criteria show the timespan from 2004 to 2023, relevant documents included in the records were published from 2006. A growth trend is evident in the graph starting from 2016, whereas the quantity of published documents has multiplied from the preceding twelve years. Among the published papers after 2004, ten papers (32%) were published between 2006 and 2015 (10 years), ten papers (32%) were published in the time span of 2016 to 2019 (4 years), where eleven papers (36%) published in the most recent

four years of 2020–2023, which is quite consistent. The time distribution indicates that the convergence of early childhood science/STEM/STEAM education and outdoor learning has only recently occurred, and there is a surge in attention toward this intersection of those two fields. (Figure 5 represents the study characteristics summary.)

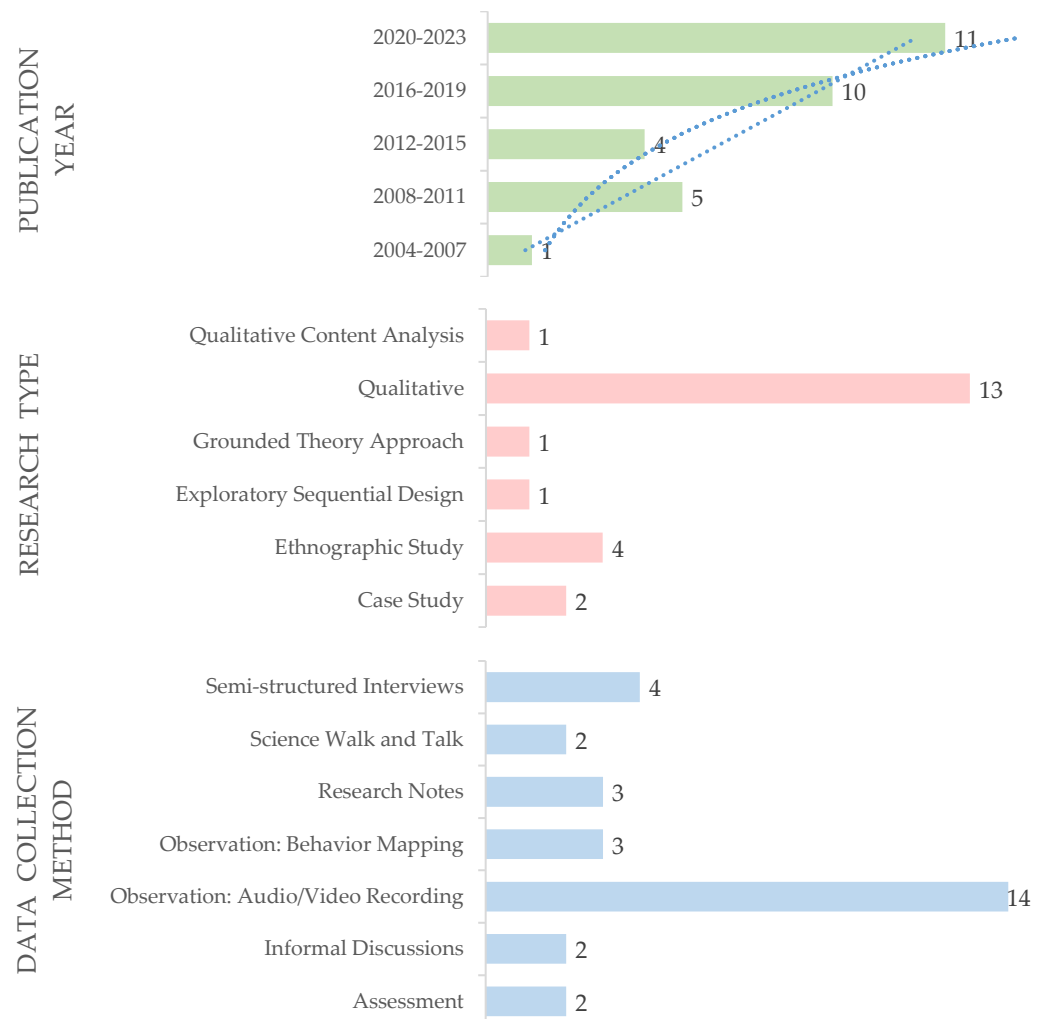


**Figure 5.** Study characteristics of the reviewed studies.

The qualitative approach was the most common type of research method for the selected papers (13 studies). Campbell and Speldewinde [7,27–29] conducted their four studies using a comparable methodology. These authors participated in ethnographies for one to five years of recurrent visits to Bush Kinder (preschool outdoor learning programs in Australia). Following the diverse array of data collection methods typically employed by ethnographies, they also utilized field notes, semi-structured interviews, and image recording. Miller, A. R. and Saenz, L. P. [30] published one of the three mixed-method research studies using exploratory sequential design, and Kiewra, C. and Veselack, E. [31] published case study research using observational data and teachers' nature notes as data collection methods.

In terms of geographical distribution, as presented in Figure 6, the reviewed studies were conducted in Italy: 1, Germany: 1, New Zealand: 1, Norway: 1, Sweden: 1, Australia: 5, and USA: 12. In addition to these, another 10 studies, comprising books and book chapters, examined the topic of STEAM and outdoor learning environment in a broad manner that is relevant to children worldwide. These additional studies included in this scoping review were mainly carried out in the United States and Australia. In general, all of the studies were conducted in developed countries.

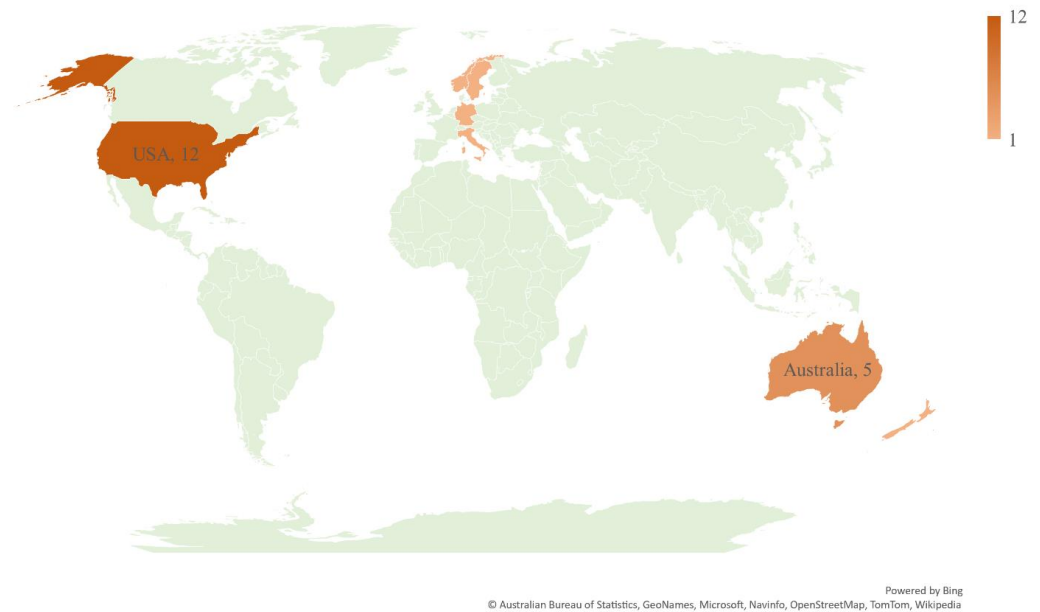


**Figure 6.** Study location/region.

### 3.2. Program Characteristics of the Reviewed Studies

Considering exclusively the reviewed articles that focus on preschoolers (3–5), this review also included a few studies with the age group of Infant/Toddler (0–2) and Primary/Elementary (4–11). Whenever research encompassed “children” as a general term, they were counted as Early Childhood (EC). A total of 28 studies of this review group included information about the participant or beneficiary of the study. Although different groups of people participated and benefited from the studies, children were the major participants in overall studies. The largest proportion of studies (18 studies, 64%) were children-led. Eight studies (29%) present both children and teachers as the facilitators, while only one study addressed other related groups, such as administrators and parents. Table 5 and Figure 7 illustrate the publication and program characteristics of the reviewed studies, respectively.

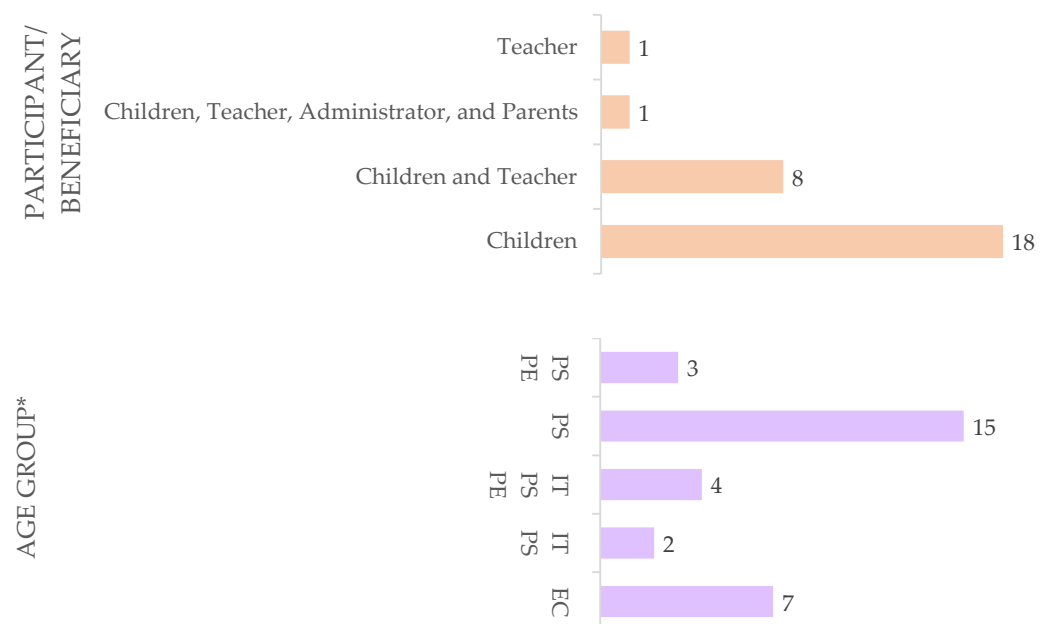


**Figure 7.** Program characteristics of the reviewed studies. \* (Infant/Toddler (0–2) = IT | Pre-School (3–5) = PS | Primary/Elementary (4–11) = PE | Early Childhood = EC).

**Table 5.** Publication characteristics of the reviewed studies.

| No. | Year | Authors                               | Study Title                                                                                                                                               | Publication Outlet                                                                          | Type | Data Source | ID   |
|-----|------|---------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|------|-------------|------|
| 1   | 2023 | Speldewinde, C. and Campbell, C.      | Bush kinders: developing early years learners’ technology and engineering understandings                                                                  | <i>International Journal of Technology and Design Education</i>                             | JA   | WOS         | [7]  |
| 2   | 2023 | Speldewinde, C., and Campbell, C.     | Bush kinders: enabling girls’ STEM identities in early childhood                                                                                          | <i>Journal of Adventure Education and Outdoor Learning</i>                                  | JA   | WOS         | [27] |
| 3   | 2022 | Campbell, C. and Speldewinde, C.      | Bush Kinders in Australia: A Creative Place for Outdoor STEM Learning                                                                                     | <i>Children’s creative inquiry in STEM</i>                                                  | BC   | GS          | [28] |
| 4   | 2022 | Weiser, L. E.                         | Young Children’s Free Play in Nature: An Essential Foundation for STEM Learning in Germany                                                                | <i>Play and STEM Education in the Early Years: International Policies and Practices</i>     | BC   | SCP         | [32] |
| 5   | 2022 | Worch, E., Odell, M., and Magdich, M. | Engaging Children in Science Learning Through Outdoor Play                                                                                                | <i>Play and STEM Education in the Early Years: International Policies and Practices</i>     | BC   | SCP         | [33] |
| 6   | 2021 | Bartolini, V. C.                      | Creating a Reggio-inspired STEM Environment for Young Children                                                                                            | <i>Creating a Reggio-inspired STEM Environment for Young Children</i>                       | BK   | EH          | [21] |
| 7   | 2021 | Skalstad, I. and Munkebye, E.         | Young children’s questions about science topics when situated in a natural outdoor environment: a qualitative study from kindergarten and primary school  | <i>International Journal of Science Education</i>                                           | JA   | EH          | [34] |
| 8   | 2021 | Miller, A. R. and Saenz, L. P.        | Exploring relationships between playspaces, pedagogy, and preschoolers’ play-based science and engineering practices                                      | <i>Journal of Childhood, Education &amp; Society</i>                                        | JA   | SCP         | [30] |
| 9   | 2020 | Campbell, C. and Speldewinde, C.      | Affordances for Science learning in “Bush kinders”                                                                                                        | <i>International Journal of Innovation in Science and Mathematics Education</i>             | JA   | SCP         | [29] |
| 10  | 2020 | Tunnicliffe, S. D.                    | Emerging biology in the early years: How young children learn about the living world                                                                      | <i>Emerging Biology in the Early Years: How young children learn about the living world</i> | BK   | PQ          | [35] |
| 11  | 2020 | Krogh, S. L. and Morehouse, P.        | The Early Childhood Curriculum: Inquiry Learning Through Integration                                                                                      | <i>The early childhood curriculum: Inquiry learning through integration</i>                 | BK   | PQ          | [36] |
| 12  | 2019 | Lee, C. K. and Ensel Bailie, P.       | Nature-based education: using nature trails as a tool to promote inquiry-based science and math learning in young children                                | <i>Science Activities</i>                                                                   | JA   | EH          | [37] |
| 13  | 2019 | Ernst, J. and Burcak, F.              | Young Children’s Contributions to Sustainability: The Influence of Nature Play on Curiosity, Executive Function Skills, Creative Thinking, and Resilience | <i>Sustainability</i>                                                                       | JA   | WOS         | [38] |

Table 5. Cont.

| No. | Year | Authors                                                     | Study Title                                                                                                           | Publication Outlet                                                                                                  | Type | Data Source | ID   |
|-----|------|-------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------|------|-------------|------|
| 14  | 2019 | Earle, S. and Coakley, R.                                   | Outdoor learning in science and technology                                                                            | <i>Teaching science and technology in the early years (3–7)</i>                                                     | BC   | GS          | [39] |
| 15  | 2019 | Worth, K.                                                   | Science in early learning environments                                                                                | <i>STEM in Early Childhood Education: How Science, Technology, Engineering, and Mathematics Strengthen Learning</i> | BC   | GS          | [23] |
| 16  | 2019 | Wiedel-Lubinski, M.                                         | STEM IN OUTDOOR LEARNING Rooted in Nature                                                                             | <i>STEM in Early Childhood Education: How Science, Technology, Engineering, and Mathematics Strengthen Learning</i> | BC   | GS          | [40] |
| 17  | 2019 | Ashbrook, P.                                                | The Early Years Teaching the M in STEM                                                                                | <i>Science and Children</i>                                                                                         | JA   | JS          | [41] |
| 18  | 2018 | Anders, Y.                                                  | Goals at the Level of the Children                                                                                    | <i>Early Science Education—Goals and Process-Related Quality Criteria for Science Teaching</i>                      | BC   | JS          | [42] |
| 19  | 2017 | Carr, V., Brown, R. D., Schlembach, S., and Kochanowski, L. | Nature by design: Playscape affordances support the use of executive function in preschoolers                         | <i>Children, Youth and Environments</i>                                                                             | JA   | JS          | [43] |
| 20  | 2016 | Wight, R. A., Kloos, H., Maltbie, C. V., and Carr, V. W.    | Can playscapes promote early childhood inquiry toward environmentally responsible behaviors? An exploratory study     | <i>Environmental Education Research</i>                                                                             | JA   | EH          | [44] |
| 21  | 2016 | Kiewra, C. and Veselack, E.                                 | Playing with nature: Supporting preschoolers' creativity in natural outdoor classrooms.                               | <i>The International Journal of Early Childhood Environmental Education</i>                                         | JA   | EH          | [31] |
| 22  | 2015 | Tippins, D. J., Neuharth-Pritchett, S., and Mitchell, D.    | Connecting Young Children with the Natural World: Past, Present and Future Landscapes                                 | <i>Research in early childhood science education</i>                                                                | BC   | GS          | [45] |
| 23  | 2014 | Fleer, M., Gomes, J. and March, S.                          | Science Learning Affordances in Preschool Environments                                                                | <i>Australasian Journal of Early Childhood</i>                                                                      | JA   | WOS         | [46] |
| 24  | 2014 | Klaar, S. and Öhman, J.                                     | Children's meaning-making of nature in an outdoor-oriented and democratic Swedish preschool practice                  | <i>European Early Childhood Education Research Journal</i>                                                          | JA   | EH          | [47] |
| 25  | 2014 | Carr, V. and Luken, E.                                      | Playscapes: a pedagogical paradigm for play and learning                                                              | <i>International Journal of Play</i>                                                                                | JA   | GS          | [48] |
| 26  | 2011 | Worch, E. A. and Haney, J. J.                               | Assessing a Children's Zoo Designed to Promote Science Learning Behavior through Active Play: How Does It Measure Up? | <i>Children, Youth and Environments</i>                                                                             | JA   | JS          | [49] |
| 27  | 2011 | Lynne and Bianchi, F.                                       | Science Beyond the Classroom Boundaries for 3–7 Year Olds                                                             | <i>Science Beyond the Classroom Boundaries for 3–7 Year Olds</i>                                                    | BK   | GS          | [50] |

Table 5. Cont.

| No. | Year | Authors                                       | Study Title                                                                                                            | Publication Outlet                                         | Type | Data Source | ID   |
|-----|------|-----------------------------------------------|------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------|------|-------------|------|
| 28  | 2011 | Luken, E., Carr, V., and Brown, R. D.         | Playscapes: Designs for Play, Exploration and Science Inquiry                                                          | <i>Children, Youth and Environments</i>                    | JA   | JS          | [51] |
| 29  | 2010 | Hoisington, C., Sableski, N., and DeCosta, I. | A walk in the woods                                                                                                    | <i>Science and Children</i>                                | JA   | JS          | [52] |
| 30  | 2010 | Waters, J. and Maynard, T.                    | What's so interesting outside? A study of child-initiated interaction with teachers in the natural outdoor environment | <i>European Early Childhood Education Research Journal</i> | JA   | EH          | [53] |
| 31  | 2006 | Tu, T.                                        | Preschool science environment: What is available in a preschool classroom?                                             | <i>Early Childhood Education Journal</i>                   | JA   | EH          | [19] |

Note: types “Journal Article”, “Book”, and “Book Chapter” are abbreviated as JA, BK, BC, respectively; data sources “Web of Science”, “Google Scholar”, “Scopus”, “EBSCOhost”, “ProQuest”, and “JSTOR” are abbreviated as WOS, GS, SCP, EH, PQ, and JS, respectively.

#### 4. Discussion

This review aims to identify the physical factors that contribute to STEAM learning affordances in an outdoor environment for children aged three to five. Also, we wanted to explore how the addition of the ‘A’ (for arts) in STEAM contributed to preschoolers’ outdoor learning. While this research did not find any studies specifically focused on STEAM education, which includes the arts, few studies did discuss the relationship between the arts, play, and learning environments.

Reviewed articles of this scoping review showed a multi-faceted approach, including empirical evaluation of landscape elements, pre- and post-intervention assessments through observational studies, longitudinal studies to observe sustained impacts, and comparative studies, etc., to explore the influence of outdoor environment on children’s STEAM/STEM/science learning. Studies also represented educators’ perceptions through surveys and interviews to understand their role during outdoor STEAM activities. Synthesis of information from those articles generated a list of STEM/STEAM/science learning behaviors of children and STEAM-activity-supportive settings. Table 6 consolidates the major outcome categories reported by the reviewed articles, highlighting the primary areas of focus within the studies. It underscores the key aspects of STEAM learning behaviors, activity-supportive settings, and the role of teachers and caregivers, providing a comprehensive overview of the findings from the reviewed literature.

Table 6. Outcome reported in reviewed papers.

| Outcome Major Categories                                                                                        | % of the Overall Sample | Paper ID                                 |
|-----------------------------------------------------------------------------------------------------------------|-------------------------|------------------------------------------|
| Discussion related to the STEAM learning behavior and activities of children in an outdoor learning environment | 39%                     | [31,33–35,38,41,42,44,47,49,50,52]       |
| Discussion related to the STEAM-activity-supportive settings and STEAM concept development                      | 42%                     | [23,28,30,32,36,37,39,43,45,46,48,51,53] |
| Discussion related to the role of teacher and/or caregiver in nature-based STEAM learning of children           | 19%                     | [7,19,21,27,29,40]                       |

##### 4.1. STEAM Learning Behaviors and Activities of Children in Outdoor Learning Environments

The reviewed articles provided a comprehensive understanding of the complementary relationships between preschool STEAM concept formation and the outdoor, natural learning landscape. According to Earle, S. and Coakley, R. [39], the foundations of science,

technology, engineering, and math (STEM) are deeply connected to the natural world. Through outdoor learning that children lead, they naturally engage in key STEM processes like experimentation, inquiry, observation, problem-solving, and comparison, thereby enhancing their understanding and knowledge in these areas [23]. Tu (2006) developed tools to examine science material availability and use them in twenty ( $n = 20$ ) childcare centers, finding common materials like vinyl animals and plants but limited engagement with them [19]. Young children actively engage with their environment to develop a fundamental understanding of the phenomena they are observing and experiencing [47]. Children form their own theories to make sense of everyday experiences, which assists them in embracing a more scientific perspective of the world. Cognitive research reveals that children's explorations are rooted in tangible contexts, utilizing their senses to observe, investigate, and draw conclusions from the world around them. This natural curiosity leads them to constantly ask questions and seek understanding, not in an idealized or laboratory setting but within the complexities of their everyday lives [17]. Engaging in scientific activities helps young children to appreciate and understand their environment and develop critical scientific skills. These skills include curiosity, questioning, exploration, investigation, discussion, reflection, and the formation of ideas and theories [19].

Reviewing the existing literature, this research identified different science /STEM/ STEAM learning behaviors of children covering specific learning domains that offer the most impactful experiences for children aged three to five. For future research, these behavior codes could help to observe, understand, and measure concept formations in science, technology, engineering, art, and math of young children in outdoor learning environments.

Table 7 shows that the overall identified behaviors that support STEAM learning were observing, exploring, describing/prescribing, exploring cause and effect (hypothesizing and experimenting), asking questions, building, manipulating, sorting, measuring, comparing, counting, and balancing objects. Behaviors related to arts that enrich and enhance STEM to STEAM are making art, music, language and literacy, and learning new signs and symbols.

**Table 7.** STEAM (science + technology + engineering + art + mathematics) behavior coding (derived from the scoping review).

| Science + Technology + Engineering | Behavior Coding                                       | Brief Description                                                                                                                              | Reviewed Study ID                    |
|------------------------------------|-------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------|
|                                    | Observing                                             | A child watches closely, hands-off (e.g., focused visual and/or auditory attention on an object or another individual).                        | [19,21,28–34,37–41,43–47,49,52]      |
|                                    | Exploring                                             | The play focuses on exploring a play material's physical properties: hands-on/touching/lifting/dropping, etc.                                  | [7,19,21,23,27–33,37–41,43–47,49,52] |
|                                    | Describing/Prescribing/<br>Predicting/Concluding      | Children observe, explore, plan to act, and share their ideas with other children or teachers.                                                 | [7,19,21,30,37,39,44,47,52]          |
|                                    | Cause and effect (hypothesizing<br>and experimenting) | The child makes a deliberate action and expects a certain outcome involving gravity, force, weight, distance, and height with those materials. | [7,19,21,27–34,37,39–41,44–47,49]    |
|                                    | Asking questions                                      | Ask other kids or adults about certain properties of play material.                                                                            | [7,19,21,30,31,34,37,38,44–47,52]    |
|                                    | Building/Construction                                 | Building blocks, making a teepee with sticks, making a bridge, laying rocks on the ground, etc.                                                | [7,21,23,27–33,38–40,43,44,46,47]    |
|                                    | Manipulating                                          | Any type of manipulation of objects like moving, building, modifying, changing, etc.                                                           | [23,29,44]                           |

Table 7. Cont.

|             | Behavior Coding                      | Brief Description                                                                          | Reviewed Study ID                  |
|-------------|--------------------------------------|--------------------------------------------------------------------------------------------|------------------------------------|
| Mathematics | Sorting/Classifying                  | Any sort of sorting of materials based on their types, colors, textures, sizes, etc.       | [7,19,21,27,29,31,32,37–41,43–46]  |
|             | Measuring                            | Any measuring activity includes concepts of small/big, thick/thin, etc.                    | [19,21,27–30,32,37–41,44,45,47,52] |
|             | Comparing                            | Comparison of two or more objects or situations based on sorting, counting, and measuring. | [7,19,21,27–30,32,37–41,43–45,52]  |
|             | Counting                             | Any play/activity that involves counting items/objects.                                    | [21,27,29,30,32,37–41,43–45]       |
|             | Balancing                            | Any activity to create balance with objects.                                               | [21,28,32,41,44]                   |
| Arts        | Art                                  | Making art—painting, sand art, loose-part art, art with leaves, etc.                       | [7,19,21,23,28,39,40,47]           |
|             | Music                                | Making music, singing, or making sounds.                                                   | [21,39]                            |
|             | Language and Literacy, Signs/Symbols | Reading, reciting, learning new words, new symbols or signage, etc.                        | [19,21,27,30,32,37,39,40,43–46,52] |

#### 4.2. STEAM-Activity-Supportive Settings and STEAM Concept Development

The scoping review expanded our ideas of how natural outdoor environments accommodate diverse STEAM affordances to advance preschoolers' concept development in science, engineering, math, etc. They can be seen as a living school—dynamic and full of wonders for young children. It is an effective educational setting for young children, fostering science learning through exploration and discovery. It encourages critical thinking and problem-solving as they investigate elements like leaves, puddles, or insects, turning the outdoors into a practical scientific laboratory for development [37]. The outdoor environment offers a broader range of experiences than the indoor classroom. With their ever-changing elements and seasonal variations, outdoor learning environments offer a less predictable setting than a traditional classroom, fueling curiosity and interest in STEM concepts [52]. This constantly evolving natural backdrop encourages deeper inquiry and exploration, with nature readily presenting surprises to those who engage with the outdoors [40]. In a natural outdoor setting, children can interact with natural elements like leaves and sticks, engage with tactile experiences such as soil, and foster a connection with the natural world, fostering a sense of appreciation. Such environments allow children to enhance their creative abilities and critical thinking skills, which are crucial for scientific and technological exploration [35]. Observations suggest that naturalistic play settings can enhance behaviors like creativity, social interaction, and detailed observation, which are advantageous for early STEM (science, technology, engineering, and mathematics) education [35].

The scoping review reveals that in an outdoor environment, young children actively explore and manipulate objects, and also closely examine their characteristics like texture, size, or material. These properties influence how children use landscape elements during outdoor time; for instance, they use large, sturdy branches for constructing hut walls and softer materials for making a spider's cushion [49]. Analyzing the selected resources, this review associated the STEAM learning behaviors and activities (identified in Table 7) with specific outdoor STEAM-activity-supportive settings (Table 8).

**Table 8.** STEAM learning behaviors and activities are associated with the outdoor STEAM-activity-supportive settings.

| No. | ID                                            | STEAM-Activity-Supportive Setting                                 | STEAM Learning Behaviors                                                                    | STEAM Concept Formation                                                                                                                                                                                                                                                    |
|-----|-----------------------------------------------|-------------------------------------------------------------------|---------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1.  | [23,27,30–33,40,43,44,46–48,51]               | Sand Play/ Earth Play/ Mud/ Digging                               | Cause/Effect, Construction, Manipulative, Observation, Exploration                          | Sand engages children because it is easy to move, manipulate, mold, dig, shift, sculpt, and pour. Also, they learn about forces, mixing, and material properties.                                                                                                          |
| 2.  | [7,23,30,32,33,40,41,43,46–48,51]             | Water Play                                                        | Cause/Effect, Construction, Manipulative, Observation, Exploration                          | Children can solve problems while predicting which items will float or sink in a water-filled container.                                                                                                                                                                   |
| 3.  | [30,43,44,46,48,51]                           | Primary Pathways                                                  | Exploration                                                                                 | Tactile properties of materials.                                                                                                                                                                                                                                           |
| 4.  | [27,30,43,44,46,48]                           | Sensory Pathway                                                   | Observation, Exploration.                                                                   | Tactile properties of materials; senses: soft, smooth, slippery, shiny, etc.                                                                                                                                                                                               |
| 5.  | [7,19,23,27–34,40,43–46,48,51–53]             | Plants: Trees, Shrubs, Edible Garden                              | Observation, Exploration, Experiments, Natural Art, Counting, Sorting, Measuring, Comparing | Gardens provide a workspace for children to raise questions about the natural world, take hands-on action, and seek answers through observation, exploration, and data collection.                                                                                         |
| 6.  | [27,31,33,43,46,53]                           | Sensory Garden/ Grass Mazes and Tall Grass Areas                  | Observation, Exploration, Experiments, Natural Art, Counting, Sorting, Measuring, Comparing | Sensory exploration outdoors can include touching the bark of a tree or the grass, seeing the birds building nests or leaves blowing, hearing the sounds carried by the wind or the honking of a car horn nearby, smelling freshly cut grass, or the fragrance of flowers. |
| 7.  | [23,39,40,46]                                 | Compost Pile                                                      | Observation, Exploration, Experiments, Construction, Teamwork                               | Children can place leaves, plant cuttings, and food scraps in a compost bin or pile, along with worms, to help “mix up” the compost.                                                                                                                                       |
| 8.  | [29,33,34,37,43]                              | Dry Creek Beds                                                    | Observation, Exploration, Experiments, Construction, Teamwork                               | Varied textures and materials in the creek bed aid sensory development, observing the flow and effects of water on the landscape.                                                                                                                                          |
| 9.  | [23,29–31,44,51]                              | Large Blocks and Natural Construction (Construction/ Engineering) | Experiment, Exploration, Observation, Construction, Teamwork                                | Making towers and bridges, recognizing shapes in buildings, fences, triangles, squares, diagonals, rectangles, and circles.                                                                                                                                                |
| 10. | [7,23,27,28,30–33,37,40,41,43,44,46,48,51–53] | Loose Parts Play                                                  | Experiment, Exploration, Observation, Counting, Sorting, Measuring, Comparing               | The properties of items can be investigated using a magnifying glass to examine shells, rocks, feathers, or objects discovered in nature.                                                                                                                                  |
| 11. | [19,23,28,29,33,34,39,43,44,53]               | Wildlife/ Bird, Butterfly, and Pollinator Habitat                 | Observation, Exploration, Language, Signs                                                   | Using their naturalist intelligence, children can discriminate among living things (plants and animals) and develop sensitivity to the features of the natural world (clouds and rock configurations).                                                                     |
| 12. | [31]                                          | Acoustic Play Settings                                            | Music, Language, Exploration, Observation, Teamwork, Signs                                  | Preschoolers can experiment cause-and-effect relationships, such as exploring how different materials and actions produce varied sounds.                                                                                                                                   |
| 13. | [23,30,31,48,51]                              | Art Area                                                          | Art, Language, Exploration, Observation, Teamwork, Signs                                    | Children can manipulate different materials—paints, clay, papers, and natural objects—and learn about textures, colors, shapes, and spatial relationships.                                                                                                                 |

Table 8. Cont.

| No. | ID                                 | STEAM-Activity-Supportive Setting                                                         | STEAM Learning Behaviors                                           | STEAM Concept Formation                                                                                                                                                                                                                              |
|-----|------------------------------------|-------------------------------------------------------------------------------------------|--------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 14. | [19,23,30]                         | Outdoor Reading and Language Play                                                         | Language, Literacy, Reading, Signs                                 | Children can create outdoor stories, identify, match, speak, make symbols, and write. Naming/identifying birds and insects including spiders, ladybirds, beetles, ants, worms, caterpillars, butterflies, and centipedes.                            |
| 15. | [19,31]                            | Signage: Directional, Informational, Identification, Regulatory, and Inspirational signs. | Language, Literacy, Reading, Signs                                 | Provide a comprehensive communication system of information that children of all ages, cultural backgrounds, and abilities can easily read and understand; signed description to explain the observed phenomenon.                                    |
| 16. | [23,30,31]                         | Outdoor Classroom                                                                         | Cause/Effect, Construction, Manipulative, Observation, Exploration | High-quality play spaces incorporate diverse natural elements for children to play and learn with, such as trees, stumps, boulders, tall grass, water, pebbles, mounds, and slopes. Learning takes place outdoors and differs from learning indoors. |
| 17. | [23,30,49]                         | Pretend and Performance/ Decks, Platforms, and Stages                                     | Performance, Signs, Language, Observation                          | Role-play props, e.g., tea-sets, dolls, soft animals. Children learn to question, predict, and experiment with different roles and observe outcomes.                                                                                                 |
| 18. | [23,29,31–33,41,43,44,47,48,51,53] | Topography and Landforms / Mounds and Slopes                                              | Cause/Effect, Exploration                                          | Forces, push-pull, twists, taut, friction, construction, gravity, speed acceleration, deceleration.                                                                                                                                                  |
| 19. | [31,39,43,48,51]                   | Multipurpose Lawn                                                                         | Diverse Affordances                                                | Open, grassy spaces support various types of play and exploration foundational for early science learning.                                                                                                                                           |
| 20. | [28,30–32,43,44,46,47,49]          | Fixed Play Structures                                                                     | Diverse Affordances                                                | Understanding friction, running up and down to explore physical properties like gravity, etc., using different sizes and loads, and rolling down (gravity, force, motion, etc.).                                                                     |
| 21. | [19,44,46,48,51,53]                | Moveable Play Structures/ Portable Toys and Equipment                                     | Diverse Affordances                                                | Crawling through tunnels, running, chasing, sitting, dancing, hopping, and jumping. Rolling, balancing, throwing, catching (gravity, force, motion, etc.).                                                                                           |
| 22. | [30,31,43,44,48,51]                | Natural Healing and Relaxation Area                                                       | Observation, Exploration, Experiments, Natural Art                 | Light, shadows, weather variations, etc. Scenic settings rich in natural elements like plants, water features, and soft, natural textures afford young children to engage in mindful observation and exploration.                                    |

#### 4.3. The Role of Teacher/Caregiver in Nature-Based STEAM Learning of Children

The primary focus of the scoping review was to identify nature-based affordances in outdoor learning and associated STEAM behaviors/activities of preschoolers. However, the review provided valuable insights regarding the critical role of teachers/caregivers. Teachers play the most important moderator role in this environment–behavior relationship of nature-based early STEAM concept formation. Loris Malaguzzi, a key figure in the development of Reggio Emilia’s approach to early childhood education, emphasized the

importance of children's active engagement in learning. Malaguzzi believed that learning is a dynamic process, significantly shaped by children's experiences, interactions, and the environment provided to them. His perspective underlines that education is not just about transmitting knowledge from teacher to student but involves a more complex interplay where children construct knowledge through their activities, exploration, and the resources available to them. This review highlights the "environment as a third teacher" concept introduced by the Reggio Emilia approach in Italy [21]. Nature encompasses everything around us—the ground, sky, wind, rocks, and rain—including all elements of the ecosystem and people. It is everywhere in cities, suburbs, and rural areas, making it accessible for educational purposes. This understanding is crucial for teachers looking to integrate nature into outdoor learning. Nature is not distant; it is a vital part of every community and an aspect of daily life. Recognizing and embracing this concept is key for educators to effectively utilize nature in its various forms within their school environments [42].

Both indoor and outdoor learning require teachers to organize and support children's educational journey effectively. Teachers must be aware of the children's experiences, the play they create, and what captivates or fails to engage them. It is also important for educators to interpret the potential significance of children's inquiries, the concepts they are formulating, and their methods of expressing their thoughts. To achieve this, teachers should take on the roles of observers, closely monitoring the children's explorations [23]. Teachers can actively engage children in nature-based education by guiding them to use their senses to observe, listen, smell, and touch, similar to the methods used by scientists [37]. The inclusion of nature-based affordances in early learning often stems from teachers' understanding of it and their capacity or inclination to utilize the resources available at their current location. At the other end of the spectrum, the misconception of teachers that nature is a distant entity restricts their imagination and efforts to include nature in the learning process.

#### *4.4. Limitations, Delimitations, and Future Research*

Firstly, the specification of the outcomes of search terms remained broad, and this was done deliberately to obtain a broad overview of how the nature-based outdoor learning landscape influences STEAM learning of preschoolers. However, this scoping review showed that STEAM-based outdoor learning is quite a new topic, and there are no assessment guidelines that can give us an idea of which opportunities in the outdoor learning landscape can maximize STEAM learning and how we can define/observe/measure the STEAM learning behaviors of preschoolers. Moreover, the inclusion of arts with STEM identified different affordances in outdoor learning environments, potentially influencing cognitive and creative development differently than STEM-focused formal programs. Future research can benefit from using the meta-analysis technique to identify appropriate approaches for evaluating children's learning progress during STEAM-based outdoor activities and the affordances of a preschool outdoor learning landscape.

There was also the fact that the domains of this review hardly coincided with each other altogether in the reviewed studies, and only two studies discussed the affordances of science learning [15,32]. However, the target of this study was to find the relationship between STEAM learning of preschoolers and the outdoor learning landscape. The reviewed studies covered a range of learners, including infant/toddler and primary/elementary children. Numerous papers mentioned outdoor learning environments and play affordances. To keep focused on STEAM learning, this scoping review eliminated those articles that did not mention anything about STEAM/STEM/science learning. Although those affordances were closely related to cognitive development. The lack of inclusion of those studies could be identified as a significant limitation. Additionally, the study characteristics identified in this review revealed that all the research was conducted in developed countries, limiting the generalizability of the findings to developing regions. This context constrains the applicability of the results across diverse socioeconomic backgrounds and education systems. This scoping review did not address the specific learning needs of children with

learning disabilities, such as those with ASD, dyslexia, ADHD, and others. Acknowledging the significant individual differences in learning levels among children, we recommend that the nature-based learning opportunities for children with learning disabilities be researched and reviewed separately to comprehensively understand their unique needs and benefits. The research topic is interdisciplinary. A scoping review is an appropriate methodology in the interdisciplinary field of outdoor learning environment research, incorporating articles from diverse disciplines that have enriched the conclusions drawn.

## 5. Conclusions

The integration of science and technology into outdoor play areas provides children with unique features and opportunities that are not available in a traditional kindergarten setting [7]. The design of outdoor learning environments can significantly impact STEAM education through intentional design elements. These elements can provide STEAM learning opportunities and create informal settings essential for STEAM education. Children are presented with diverse natural resources to incorporate into their play, fostering creativity, social interaction, and complex activities such as construction projects. On the other hand, playgrounds are not as effective in encouraging STEM-related play because the fixed nature of playground equipment restricts children's freedom to explore and implement their ideas [32]. This review identified the STEAM learning affordances of an outdoor learning environment that enhances preschool-aged children's engagement in science, technology, engineering, arts, and mathematics (STEAM) learning through their interactions with nature. This could encompass cognitive development by fostering curiosity, creativity, and problem-solving skills in early childhood.

This scoping review identified several STEAM learning behaviors of children and STEAM-activity-supportive settings, which can guide design modification efforts to transform mundane playgrounds into engaging and affordance-rich outdoor learning landscapes to stimulate young children's STEAM learning. These settings and affordances that foster a conducive learning atmosphere could significantly enhance the quality of early childhood STEAM education. The outcomes of this scoping review could potentially inform policy and curriculum development in early childhood education by integrating more outdoor, nature-based STEAM learning experiences into preschool formal/informal education. Adapting these STEAM-learning-supportive settings to develop existing childcare/preschool outdoor environments could be a significant and pivotal step in moving towards more experiential and environment-based learning approaches in early childhood education.

**Author Contributions:** Conceptualization, N.A.T. and M.M.; methodology, N.A.T.; formal analysis, N.A.T.; investigation, N.A.T. and M.M.; resources, M.M.; data curation, N.A.T.; writing-original draft preparation, N.A.T.; writing-review and editing, N.A.T., M.M., N.C., S.S., L.L. and A.M.; visualization, N.A.T.; supervision, M.M. and N.C.; project administration, M.M. and N.A.T.; funding acquisition, M.M. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding.

**Conflicts of Interest:** The authors declare no conflicts of interest.

## References

1. Louv, R. *Last Child in the Woods: Saving Our Children from Nature-Deficit Disorder*; Algonquin Books: Chapel Hill, NC, USA, 2008.
2. Cui, J.; Natzke, L. Early Childhood Program Participation: 2019. First Look. NCES 2020-075. Available online: <http://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2020075REV> (accessed on 23 May 2024).
3. Is the, U.S. Falling Behind in STEM Education? Available online: <https://www.codewizardshq.com/us-behind-in-stem-education/> (accessed on 23 May 2024).
4. Armstrong, S.J.; Fukami, C.V. *The SAGE Handbook of Management Learning, Education and Development*; Sage: London, UK, 2009.
5. Cohen, L.E.; Waite-Stupiansky, S. *STEM in Early Childhood Education*; Routledge: New York, NY, USA, 2020.
6. Torquati, J.; Cutler, K.; Gilkerson, D.; Sarver, S. Early childhood educators' perceptions of nature, science, and environmental education. *Early Educ. Dev.* **2013**, *24*, 721–743. [CrossRef]
7. Speldewinde, C.; Campbell, C. 'Bush kinders': Developing early years learners technology and engineering understandings. *Int. J. Technol. Des. Educ.* **2023**, *33*, 775–792. [CrossRef]

8. Moore, R.C.; Marcus, C.C. Healthy planet, healthy children: Designing nature into the daily spaces of childhood. In *Biophilic Design: The Theory, Science, and Practice of Bringing Buildings to Life*; Wiley: Hoboken, NJ, USA, 2008; Volume 385.
9. Gullo, D.F. *Understanding Assessment and Evaluation in Early Childhood Education*; Teachers College Press: New York, NY, USA, 2005; Volume 95.
10. Melhuish, E.C. *Provision of Quality Early Childcare Services: Synthesis Report*; BIROn—Birkbeck Institutional Research Online, University of London: London, UK, 2016.
11. Gibson, E.J.; Pick, A.D. *An Ecological Approach to Perceptual Learning and Development*; Oxford University Press: Oxford, UK, 2000.
12. Edwards, C.P.; Gandini, L. The Reggio Emilia approach to early childhood education. In *Handbook of International Perspectives on Early Childhood Education*; Routledge: New York, NY, USA, 2018; pp. 365–378.
13. Cameron, C.E. *Hands on, Minds on: How Executive Function, Motor, and Spatial Skills Foster School Readiness*; Teachers College Press: New York, NY, USA, 2018.
14. David, T.G.; Weinstein, C.S. *Spaces for Children: The Built Environment and Child Development*; Springer: Greer, SC, USA, 2013.
15. Ernst, J. Early Childhood Educators' Preferences and Perceptions Regarding Outdoor Settings as Learning Environments. *Int. J. Early Child. Environ. Educ.* **2014**, *2*, 97–125. Available online: <https://eric.ed.gov/?id=EJ1108039> (accessed on 23 May 2024).
16. Striniste, N.A.; Moore, R.C. Early childhood outdoors: A literature review related to the design of childcare environments. *Child. Environ. Q.* **1989**, *6*, 25–31. Available online: <https://www.jstor.org/stable/41514704> (accessed on 23 May 2024).
17. Worth, K. *The Power of Children's Thinking*; National Science Foundation: Arlington, VA, USA, 1999; Volume 2.
18. Trundle, K.C. Teaching science during the early childhood years. In *Best Practices and Research Base*; Springer: New York, NY, USA, 2010. [CrossRef]
19. Tu, T. Preschool science environment: What is available in a preschool classroom? *Early Child. Educ. J.* **2006**, *33*, 245–251. [CrossRef]
20. Chalufour, I.; Worth, K. *Discovering Nature with Young Children: Part of the Young Scientist Series*; Redleaf Press: Saint Paul, MN, USA, 2003.
21. Bartolini, V.C. *Creating a Reggio-Inspired STEM Environment for Young Children*; Redleaf Press: Saint Paul, MN, USA, 2021.
22. Worth, K. Science in Early Childhood Classrooms: Content and Process. 2010. Available online: <https://ecrp.illinois.edu/beyond/seed/worth.html> (accessed on 23 May 2024).
23. Worth, K. Science in early learning environments. In *Stem in Early Childhood Education: How Science, Technology, Engineering, and Mathematics Strengthen Learning*; Routledge: New York, NY, USA, 2019; pp. 3–21.
24. Arksey, H.; O'malley, L. Scoping studies: Towards a methodological framework. *Int. J. Soc. Res. Methodol.* **2005**, *8*, 19–32. [CrossRef]
25. Peters, M.; Godfrey, C.; McInerney, P.; Soares, C.B.; Khalil, H.; Parker, D. Methodology for JBI scoping reviews. In *The Joanna Briggs Institute Reviewers Manual 2015*; Joanna Briggs Institute: Adelaide, Australia, 2015; pp. 3–24.
26. Paez, A. Gray literature: An important resource in systematic reviews. *J. Evid.-Based Med.* **2017**, *10*, 233–240. [CrossRef] [PubMed]
27. Speldewinde, C.; Campbell, C. Bush kinders: Enabling girls' stem identities in early childhood. *J. Adventure Educ. Outdoor Learn.* **2023**, *23*, 270–285. [CrossRef]
28. Campbell, C.; Speldewinde, C. Bush kinders in Australia: A creative place for outdoor stem learning. In *Children's Creative Inquiry in STEM*; Springer: Berlin/Heidelberg, Germany, 2022; pp. 185–204.
29. Campbell, C.; Speldewinde, C. Affordances for Science learning in "Bush kinders". *Int. J. Innov. Sci. Math. Educ.* **2020**, *28*, 1–13. [CrossRef]
30. Miller, A.R.; Saenz, L.P. Exploring relationships between playspaces, pedagogy, and preschoolers' play-based science and engineering practices. *J. Child. Educ. Soc.* **2021**, *2*, 314–337. [CrossRef]
31. Kiewra, C.; Veselack, E. Playing with Nature: Supporting Preschoolers' Creativity in Natural Outdoor Classrooms. *Int. J. Early Child. Environ. Educ.* **2016**, *4*, 70–95. Available online: <https://eric.ed.gov/?id=EJ1120194> (accessed on 23 May 2024).
32. Weiser, L.E. Young Children's Free Play in Nature: An Essential Foundation for STEM Learning in Germany. In *Play and STEM Education in the Early Years: International Policies and Practices*; Springer: Berlin/Heidelberg, Germany, 2022; pp. 85–103.
33. Worch, E.; Odell, M.; Magdich, M. Engaging Children in Science Learning Through Outdoor Play. In *Play and STEM Education in the Early Years: International Policies and Practices*; Springer: Berlin/Heidelberg, Germany, 2022; pp. 105–122.
34. Skalstad, I.; Munkebye, E. Young children's questions about science topics when situated in a natural outdoor environment: A qualitative study from kindergarten and primary school. *Int. J. Sci. Educ.* **2021**, *43*, 1017–1035. [CrossRef]
35. Tunnicliffe, S.D. *Emerging Biology in the Early Years: How Young Children Learn about the Living World*; Routledge: New York, NY, USA, 2020.
36. Krogh, S.L.; Morehouse, P. *The Early Childhood Curriculum: Inquiry Learning Through Integration*; Taylor & Francis: Abingdon, UK, 2020.
37. Lee, C.K.; Ensel Bailie, P. Nature-based education: Using nature trails as a tool to promote inquiry-based science and math learning in young children. *Sci. Act.* **2019**, *56*, 147–158. [CrossRef]
38. Ernst, J.; Burcak, F. Young children's contributions to sustainability: The influence of nature play on curiosity, executive function skills, creative thinking, and resilience. *Sustainability* **2019**, *11*, 4212. [CrossRef]
39. Earle, S.; Coakley, R. Outdoor learning in science and technology. In *Teaching Science and Technology in the Early Years (3–7)*; Routledge: New York, NY, USA, 2019; pp. 57–75.

40. Wiedel-Lubinski, M. STEM in outdoor learning: Rooted in nature. In *STEM in Early Childhood Education*; Routledge: New York, NY, USA, 2019; pp. 182–205.
41. Ashbrook, P. The Early Years: Teaching the M in STEM. *Sci. Child.* **2019**, *56*, 16–17. Available online: <https://www.jstor.org/stable/26901400> (accessed on 23 May 2024). [CrossRef]
42. Anders, Y.; Hardy, I.; Pauen, S.; Steffensky, M.; Ramseger, J.; Sodian, B.; Tytler, R. Goals at the Level of the Children. In *Early Science Education—Goals and Process-Related Quality Criteria for Science Teaching*, 1st ed.; “Haus der kleinen Forscher” Foundation, Ed.; Verlag Barbara Budrich: Opladen, Germany, 2018; Volume 5, pp. 41–74.
43. Carr, V.; Brown, R.D.; Schlembach, S.; Kochanowski, L. Nature by design: Playscape affordances support the use of executive function in preschoolers. *Children, Youth Environ.* **2017**, *27*, 25–46. Available online: <https://www.jstor.org/stable/10.7721/chilyoutenvi.27.2.0025> (accessed on 23 May 2024). [CrossRef]
44. Wight, R.A.; Kloos, H.; Maltbie, C.V.; Carr, V.W. Can playscapes promote early childhood inquiry towards environmentally responsible behaviors? An exploratory study. *Environ. Educ. Res.* **2016**, *22*, 518–537. [CrossRef]
45. Tippins, D.J.; Neuhauser-Pritchett, S.; Mitchell, D. Connecting young children with the natural world: Past, present and future landscapes. In *Research in Early Childhood Science Education*; Springer: Dordrecht, The Netherlands, 2015; pp. 279–297. [CrossRef]
46. Fleer, M.; Gomes, J.; March, S. Science learning affordances in preschool environments. *Australas. J. Early Child.* **2014**, *39*, 38–48. [CrossRef]
47. Klaar, S.; Öhman, J. Children’s meaning-making of nature in an outdoor-oriented and democratic Swedish preschool practice. *Eur. Early Child. Educ. Res. J.* **2014**, *22*, 229–253. [CrossRef]
48. Carr, V.; Luken, E. Playscapes: A pedagogical paradigm for play and learning. *Int. J. Play* **2014**, *3*, 69–83. [CrossRef]
49. Worch, E.A.; Haney, J.J. Assessing a Children’s Zoo Designed to Promote Science Learning Behavior through Active Play: How Does It Measure Up? *Child. Youth Environ.* **2011**, *21*, 383–407. Available online: <https://www.jstor.org/stable/10.7721/chilyoutenvi.21.2.0383> (accessed on 23 May 2024). [CrossRef]
50. Bianchi, L.; Feasey, R. *Science Beyond the Classroom Boundaries for 3–7 Year Olds*; Open University Press: Maidenhead, UK, 2011.
51. Luken, E.; Carr, V.; Brown, R.D. Playscapes: Designs for Play, exploration and science inquiry. *Child. Youth Environ.* **2011**, *21*, 325–337. Available online: <http://www.jstor.org/stable/10.7721/chilyoutenvi.21.2.0325> (accessed on 23 May 2024). [CrossRef]
52. Hoisington, C.; Sableski, N.; DeCosta, I. A walk in the woods. *Sci. Child.* **2010**, *48*, 27. Available online: <https://foundationsofscienceliteracy.edc.org/wp-content/uploads/2019/07/SC-Vol48-2.pdf> (accessed on 23 May 2024).
53. Waters, J.; Maynard, T. What’s so interesting outside? A study of child-initiated interaction with teachers in the natural outdoor environment. *Eur. Early Child. Educ. Res. J.* **2010**, *18*, 473–483. [CrossRef]

**Disclaimer/Publisher’s Note:** The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.