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Making Provision for First-Hand Nature-Based Learning Within a Botanic Garden

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This paper reports on a study of nature play in two botanic gardens where there are normally strict rules about touching and handling plants. Features of nature-based play and learning are presented, and the available evidence is drawn together as the basis for a series of nature interventions trialed within a botanic garden. Data were recorded using three methods: time-sampled observations, annotation of intervention-specific maps, and follow-up feedback forms completed by adults. Findings evidence that the nature play can be fostered in botanic gardens and it is advantageous to support such interaction by carefully promoting play in designated spaces. Visitors embraced play opportunities and valued the freedom to behave and investigate in ways that are a departure from tradition and given the lack of research regarding such play and learning environments such findings ought to be noted as addressing a gap within the literature. Findings are relevant to comparable sites that encounter challenges when balancing differing agendas that include nature conservation with visitor experience. Botanic gardens can offer a useful route to examine conservation, environmental understanding, and stewardship with the youngest members of society as nature play experiences are first-hand and locally relevant.

Keywords: nature play, outdoor learning, botanic gardens, preschool (kindergarten), education, school, nature-based learning, environmental education

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INTRODUCTION

A contemporary aspect of botanic gardens involves the broadening of visitor experiences to extend opportunities for nature engagement. Human–nature interaction is a core feature of botanic gardens; however, it is typified by a traditional "showcase" approach (McIvor, 2001) and this is at odds with the encouragement of children to learn through play. Children spaces may not specifically aim to encourage nature play, but like botanic gardens, they are evolving in response to the demands of the societies they serve (Vergou and Willison, 2016). Interaction and direct engagement are viewed positively in environmental education (Kopczak et al., 2015). Such expectations are being embraced in some gardens (notably Minnesota Landscape Arboretum in the United States of America and Royal Botanic Gardens Melbourne in Australia); however, research that has examined how nature play interventions can be successfully managed to suit the needs of multiple groups within formal environments such as botanic gardens is scarce. Interest in the promotion of nature

play within Royal Botanic Garden Edinburgh (RBGE) involved a partnership between RBGE and the Calouste Gulbenkian Foundation and support provided by The Conservation Volunteers. The Edinburgh project focused on children's and their accompanying adults' experiences in an area of the botanic garden that encouraged nature play. A follow-on project at the Melbourne Royal botanic gardens (RBGM) gained knowledge regarding everyday interaction evident within an established nature play space to foster knowledge acquired during the Edinburgh project. In the following sections, this paper sets out what is meant by nature play, considers its relevancy within botanic gardens, and provides a theoretical basis for how botanic gardens as a public green space can help enrich the early experiences of children.

Nature-Based Learning: A Role in Early-Childhood and Environmental Education

This paper focuses on play that is based around nature, a distinct form of outdoor, early-childhood education. Nature play and learning is characterized by hands-on interaction and tactile exploration by young children and is recognizable in early-childhood, play-based learning including nature kindergartens (MacQuarrie et al., 2015; Nugent and Beames, 2015), Forest School (Knight, 2009) – in response to a Danish approach to nature play (Williams-Siegfredsen, 2012) – and forest kindergartens (Sobel, 2015; Walker, 2016). Nature play creates opportunities for children's inclination toward biophilia (Kellert, 2002) and is valuable to consider given the call to support teaching and learning that includes an environmental focus (Cutter-Mackenzie et al., 2014). Corresponding research investigating such themes is relatively scarce (Morgan et al., 2009), thus this paper addresses a gap in the literature and seeks to understand the role of such spaces when nature-based learning is being considered.

The decline in young children's access to nature is recognized (Hunt et al., 2017; Richardson et al., 2019). Parents are aware of the outdoor activity their families do and do not engage in Skår and Krogh (2009). One avenue to alleviate concerns is to select early-childhood education that includes outdoor experiences and nature play. However, there will be a range of families where participating in outdoor, play-based experiences is prioritized less often or can be managed infrequently at best (Roe, 2013). Thus, societal responsibility informs that public spaces support their immediate locality (Waite et al., 2016) and formed a feature of this study that considered social integration and the local community engagement in social and ecological agendas, following from earlier work (Edwards, 2006; Roe, 2013). Public spaces such as botanic gardens have a responsibility to offer family friendly accessible places and encourage participation amongst all areas of society (Vergou and Willison, 2016). Thus, the introduction of nature play spaces can support achievement of wider goals, going beyond the benefits of such provision for children and families, extending to consider the engagement and connection such spaces have with their communities. This paper provides empirical data about how families seek to engage with such spaces and can support changes in such provision ensuring that community engagement is realized and embraced.

Features of Nature-Based Learning Relevant to Botanic Gardens

Human–nature interactions that typify nature play include 'aimless exploration' (Heerwagen and Orians, 2002, p. 55) through first-hand contact with unstructured resources (Roe, 2013). "Loose parts" is a well-known hallmark of such interaction and refers to play with objects where the lack of structure about the object feeds play activity (Nicholson, 1972; Gibson et al., 2017). Such interaction can provide the basis of environmental learning but is subtle and in contrast to environmental awareness borne of more abstract means say, knowledge gleaned from the media of global warming or the conservation of tropical rainforests (Ghafouri, 2014). Advocates of nature play and learning experiences emphasize the role of first-hand exploration of nature, noting such "immediate and direct" experiences can involve stones, water, fallen leaves, and other features (Beames et al., 2012, p. 61). The sensory elements of such experience are noteworthy as children may explore water with their toes, and make footprints in the mud. We would expect to see the interaction that involved digging, rearranging, counting, pouring, mixing, and transporting. By adopting an underused play area and introducing different opportunities for play features of nature play can be considered and evaluated in the context of a botanic garden. Encouraging children to touch, handle and examine nature is well-intentioned but needs to be carefully considered so that a sustainable and ecological approach can be achieved (Mullins, 2013). For example, in a managed environment such as the RBGE, a high value is placed on the plants and general features of the garden; touching and handling of these plants is usually restricted. Thus, developing a series of opportunities that include different arrangements of items regularly available in nature to encourage interaction is a strategic approach to encourage nature play. Thus, the interventions developed and provided in this research form a potential contribution to knowledge as they aim to intrigue visitors, introduce nature play as an anticipated feature of visitors' experience, be feasible for gardens to manage, and be designed with minimal to no environmental impact.

Fjørtoft (2001) notes the value of untamed play spaces in relation with physical engagement and interaction and the role of the adult – who, in the present context are parents or guardians of participating children – is known to be significant (Nugent and Beames, 2015). Children will tailor their activity and engagement in accordance with the preferences expressed by adults when playing near their home (Carver et al., 2008). Children may understand these preferences through adults' direct immediate influence (adult offers rules or interrupts play) (Skår and Krogh, 2009). Alternatively, how adults engage and select experiences to share with young children may be influenced by their former experiences and recollections of nature in their childhood (Sebba, 1991; Chawla, 1998; Waite, 2007; Laird et al., 2014). Part of the understanding communicated from adult to child refers to risky play opportunities, where concerns regarding safety can

override and change the play opportunities on offer to children (Stephenson, 2003; Sandseter, 2009). In line with awareness of such potential barriers the understanding that risk should be equated with challenge rather than safety was incorporated to encourage children and adults interaction with materials available in the play space (Nugent, 2015). Across such studies is the expectation that children will seek out nature when they play in spaces surrounded by nature (Truscott, 2020). However, there is a scarcity of studies considering how young children respond to and interact with nature when given such opportunities. A combination of reporting methods was devised so as to capture relevant data and record nature play as it unfolded in response to each intervention.

Research Context

A project team was recruited in Edinburgh comprising a lead and assistant researchers, a Community Engagement Officer, and a filmmaker. A Community Engagement Officer was employed for the duration of the study with a remit dedicated to the engagement of local, harder-to-reach groups. Parts of each intervention were filmed to create a short film[1] encouraging dissemination across stakeholders, including visitors. The project aimed to investigate the feasibility of nature play at a botanic garden[2]. A series of nature play-orientated interventions were designed and developed in line with considerations such as available space in the garden (an overview is offered in **Table 1**). The available space included a mixture of vegetation ranging from mature, native trees and shrubbery with pathways, a small meadow area (that was allowed to grow during the summer of the project), and a small man-made pond. On intervention days, staff were asked to overlook usual play behaviors such as running in the long grass, picking flowers, scrambling over fallen tree trunks, and movement of sticks/logs/stones – that are perhaps out of character with Botanic gardens. Each intervention was devised to take into account the characteristics of nature play and included ecological considerations. This included evaluation of nature play in the face of competing interests such as the balance between impact and nature conservation in the context of RBGE. The project also sought to encourage engagement with populations who do not routinely choose to visit RBGE to participate in nature play. This paper aims to primarily report on the nature play that was introduced at RGBE and has specific research questions "How do adults and children visitors to a nature play site at RBGE interact with nature?" and "How do nature play behaviors impact nature conservation in the context of a botanic garden?"

Data recorded at the Edinburgh Botanic garden focused on considering how participants would respond to nature play opportunities. Analysis of these data was supported by visiting an international comparator Botanical garden in Melbourne to consider how nature play unfolds in an established nature play area. The Melbourne Royal botanic gardens (RBGM) was visited by an independent researcher to record data regarding naturally occurring play within their designated space known as the "children's area." Botanic gardens will likely have regular visitors as well as families who visit more sporadically. Indirect observation was appropriate for the Melbourne project as it sought to record naturally unfolding interaction. In contrast, the Edinburgh project required a targeted approach to collect data and support finding out who were the visitors. With such variance in mind, the technique to record visitor experience needed to be flexible. Two forms were used to record participants' experience in Edinburgh. Visitors made notes on a bespoke map during their time at the garden and reflections on visits were captured *via* a brief feedback form distributed after visits.

MATERIALS AND METHODS

Design

Across the 6 months project, the designated area within the Edinburgh botanic garden hosted an intervention designed to target nature play suited to a botanic garden. A qualitative multi-method approach encompassed observation and intervention-specific maps (both completed on-site), combined with follow-up feedback form sent to adult participants after attending an intervention (an overview of the six interventions is offered in **Table 1**). Each intervention provided the opportunity to record data (comprising two 2-h sessions per intervention, within each 2 h a schedule of 3 min observations every 15 min was followed, field notes and photographs were made at the researchers' discretion across each intervention). At each intervention, two researchers were in place to capture data and these were timed with the anticipated use of the play space by families at 10:30–12:30 and 14:30–16:30. Data collection at the Melbourne garden focused on two visits during 1 month (June) collected by a sole researcher totaling 12 h of data collection. In each case, participants were free to choose where to spend their time and could move between areas of the site at will and in each space no formal activities were offered.

Participants

Ethical considerations were a key part of the research. At no time was any individual obliged to take part and participants were aware that their participation was voluntary and this was managed sensitively given that adults and children were involved. Upon arrival at either nature play area, both adult and child participants were invited to sign in at the designated "entrance" and take a name sticker. By voluntarily wearing a sticker (that could be removed at any time) adults and children alike gave their informed consent and provided a means of clearly identifying participants who consented to being included in the study (having their behavior observed). Families were free to choose when they could visit and attendance without prior notice was offered, thus some families may have visited the play space with little information prior to encountering the area within the Edinburgh botanic garden. Families visiting the Melbourne garden were aware of the project at the time of their visit, whereas efforts to share invitations and awareness of the Edinburgh project were regularly instigated. Participation was advertised

[1] https://vimeo.com/sabinehellmann/natureplay

[2] An area of RBGE known as the demonstration garden area was used as a base for the nature play interventions.

TABLE 1 | Description of interventions and participant attendance.

Date	Focus	Description	Intervention-specific resources	Number of families	Feedback form	Maps
April	Wood	A clear, bright day with temperatures ranging from 12 to 15°C. The site is richly resourced by both green and deadwood and includes a stand of Scots Pine, a fallen trunk of [species] and extensive shrubbery.	Ten cuts of tree trunk were brought to the area of the site. At the start of the day, these were left on the ground, randomly in amongst the leaf litter by RBGE staff. Several large branches and logs were also moved to the area for the day	24	4	24
May	Listen	A dry, sunny day with scattered clouds and temperatures in the range 12–14°C.	Three hammocks were introduced at the site: two suspended between mature trees on one side plus one other in an area of shrubbery near to the meadow. Sit mats and blindfolds were also made available	39	3	39
June	Stone	An overcast, but dry day with temperatures in the high teens. Careful mowing exposed a small section of low wall integral to the meadow. To the left of the site, there was a series of stepping stones formed by a long collapsed section of wall and a further section of the same wall in the area.	A pit (2.5 m diameter) was dug and filled with smooth pebbles of various sizes	24	–	24
July	Meadow	A hot, dry day with temperatures of 16°C at 10 am rising to 24°C at 4pm. Meadow had been planned for July, as this was the time of year that grass growth would be at its best. An anthill, found by RBGE ground staff, was clearly shown on the annotated map.	The long, meadow grass was mown to form pathways through the grass. Sit-mats and hammocks offered	20	–	20
August	Earth*	A dry day with a light breeze and blue skies and temperature between 12–14 degrees for the morning session and 21°C for the afternoon. Extensive leaf litter was a feature of the hedge line in the space.	Two child-sized brooms were placed in the area of leaf litter. Two patches of earth were exposed by RBGE ground staff in the area of the site previously used for Stone and as the weather forecast predicted dry days a dripping tap was installed. This tap offered a continuous trickle of water. Thus, one patch of earth afforded dry soil and the second afforded mud. Several small containers were also provided.	12	-	12
September	Water*	A warm and dry day RBGE has a small pond within the Nature Play site. The water level was topped up by hosed water in the absence of rainfall	A purposefully designed dipping platform where adults and children could stand and use the dipping trays, nets and magnifying glasses. Lengths of bamboo were placed in the meadow area (freshly mown) with a hose pipe and small containers to hand. Sit-mats were offered.	28	1	28

**For the Earth and Water sessions participants were advised to wear waterproof clothing or bring a change of clothing*

online and promoted by the Community Engagement Officer. In addition to encouraging visitors familiar with RGBE, recruitment through phone calls, emails, and personal visits, targeted families who lived locally (within a two-mile radius) but rarely visited the Botanic Gardens and considered "harder-to-reach groups." The Community Engagement Officer contacted by phone and email groups during the project. Representatives from two local libraries liaised with the Community Engagement Officer about participation. Families were encouraged to attend as often or as little as it suited them. The interventions were deemed to have been well attended, with 141 families[3] signed up to attend, leading to a total of 371 participants (inclusive of adults and children) that attended a minimum of one intervention and the spread of attendance is captured in table one. Families attended involved a range of groupings. Families as a term is applied loosely to arrangements that tended to reflect caregivers (female and male caregivers) accompanying early years and young children (both boys and girls). These groupings ranged in size from two (caregiver with a child) up to six (two caregivers with four children). While no participants attended all six sessions, participants did attend multiple sessions: one family attended five of the six interventions, two families attended four of the six sessions and two families attended three of the six sessions.

Interventions

Each intervention had a different focus to highlight a particular natural resource or characteristic of nature play and was named Wood, Listen, Stone, Meadow, Earth, and Water. An overview is offered in **Table 1**. Careful consideration was given to the selection and preparation of each intervention. Anticipated seasonal changes were incorporated into the project and interventions were timetabled in accordance with expected

[3] "Family" is used to refer to one or two parents with up to three children.

weather conditions. Visitors were able to access adjacent areas as unstructured, free access is a defining feature of nature play. Accordingly, data collection incorporated children's interaction with the intervention and adjacent areas. Selecting a pre-existing play space was a sustainable, environmentally orientated strategy to support play occurring in the vicinity of the interventions. During the project, interventions were offered in a specific sequence in relation to weather expectations for each month and the season. For example, the Meadow intervention in July was timed to make full use of the long grass. The area designated for the nature play study was situated in the north-east section of the gardens. The L-shaped site is unfenced. During the Edinburgh intervention days, RBGE staff were responsible for tasks ahead of each intervention including risk assessments, establishing hammocks (meadow), placement of bamboo pipes (water), and pebble pits (stone). There was a temporary registration point where participants collected maps and name badges, prams could be left behind at this point. While no permanent seating nor signage was incorporated, sit mats and picnic rugs were offered on some of the interventions. The intention was to encourage participants to explore freely throughout the site in more contemplative, child-led interactions.

Observation

An observation schedule was adapted from previous studies (MacQuarrie et al., 2015). The protocol used time-sampled observations where a 3-min scan was completed every 15 min. The positions and grouping of the participants and the children's play behaviors during the sessions were recorded[4]. An agreed key was used to systematically collect data and complete the schedule following the protocol. During a scan, all relevant participants were recorded, where they were, what they appeared to be engaging in, and with whom. The protocol involved recording a range of observations, reflecting whether hands-on contact with nature/other objects (such as toys), creative or fantasy play, and risk-taking behaviors featured. Risk-taking behaviors are regarded as being linked to age, for example, a child who is learning to walk may see a tree root as a risk for them to encounter and respond to when in an untamed space. Whereas for an older child risk may extend to climbing a tree or touching a plant that appears to have spiky leaves. A further aspect was noting interaction and whether it involved children being independent of their guardians, children inviting adults to engage with them, children moving to play with other children as well as being quiet in the space. Each of these aspects is informed by the literature referred to in the introduction. In the Melbourne garden, data collection was captured across two visits by the same researcher. In the Edinburgh garden observation was completed by two researchers at each intervention, allowing researchers to operate from different vantage points to accurately capture events across the site. Field notes and photographs were made at the researchers' discretion during each data collection opportunity. Such content aimed to ensure a rich depiction of activity being recorded, support accurate recording and interpretation of behavior and thus feed into the analysis. Each researcher completed observation schedules separately and checks were undertaken at the end of each session to ensure sustained consistency of data recording across the project and supported dealing with ambiguity of interpretation of events as they unfolded. Accommodating such ambiguity and variability is known to be challenging; hence, sustained conversations between the research team were a feature of the qualitative data collection during the initial stages of becoming familiar with the protocol (in effect a training stage) as well as during data collection in each site. Similarly, the adoption of the multi-method qualitative approach helped ensure that such data collection and interpretation was supported by appropriate evidence sourced across each intervention enriching the study and offering additional contextual clarification.

Intervention-specific maps were adapted from the RBGE site plan to specifically represent the Nature Play site. The map was tailored to each intervention highlighting intervention-specific annotations, for example, the trees where hammocks were hanging in the Listen intervention and the location of the mud pit for the Earth intervention. Each map helped communicate to participants where to go to find the intervention as well as provide a data-sharing mechanism. Participants were offered a map, clipboard, and pencil upon signing in to a session and asked to annotate the page with any thoughts and help document their experience. Completed maps were collected from participants at the point of departure; there were no blank returns. Examples of maps have been provided as **Supplementary Materials**.

Feedback forms were emailed to families that attended an intervention within 48 h. This follow-up approach was included to ensure insights regarding experience were obtained from all participants no matter their circumstances. The feedback form prompted reflections covering access to the botanic gardens, joining the nature play intervention, and provided a means to support participants to share aspects they found less favorable. Such an approach is inclusive and reflects the multi-tasking demands on parents and carers before, during, and after their visits who may have not had extra time to share their impressions on the day. However, poor returns throughout were notable, and in total, eight responses were received and when viewed in the context of **Table 1** this is much lower than the number of families that visited each intervention.

Analysis

For the Edinburgh project data regarding each intervention comprised: observation schedules completed by two researchers (including photographs and field notes); participant maps regarding each intervention that were completed during a visit while onsite. Examples of completed maps are provided in the **Supplementary Material**. Follow-up feedback forms were requested from adults that attended each intervention; however, as noted in **Table 1**, there was a low response rate. Data sourced from each intervention were examined in tandem upon completion of the six sessions. Six months had elapsed between the first and sixth intervention and this period was useful for reflecting on the data in advance of analysis. A specific coding

[4]The intervention sessions were shorter (2-h duration) relative to previous research that involved an entire day of early years provision (approximately 6-h). The frequency of the scans were increased to suit the present context.

framework was developed to support analysis that targeted the interaction and engagement that involved children. For the Melbourne garden data, analysis involved the application of the coding framework and knowledge from the Edinburgh project to determine if nature play in Edinburgh was related to play at the Melbourne garden.

Development of the Coding Framework

A hybrid analytical approach was adopted and involved coding cycles that led to theme development. Provisional Coding (Miles and Huberman, 1994) was used to establish a predetermined list of codes, prior to data collection to accommodate this context-specific qualitative inquiry that fueled initial coding (Saldaña, 2012). This approach has been shown to be of value particularly in this instance when a pilot study fueled the research being reported (Roe, 2013). Initial codes were fueled by the pilot study as well as keywords, phrases, and concepts emerging from previous studies employing similar methods (Mannion et al., 2011; MacQuarrie et al., 2015) and aspects pertaining to nature-based learning as presented in the introduction (e.g., sensory, open-ended, and direct experiences) that contributed to the development of an overall coding framework. Human–nature relations were central to this study, hence the first consideration related to the implicit connections that participants make between self and nature. The form of these relationships could be analyzed as between child(ren) with nature or between child(ren), their adult carer with nature. Features of nature play involved four main categories (behavioral and emotional, cognitive, affective, ecological) and involved specific considerations to support and recognize what such play and interaction may involve. The third consideration related to the impact on the garden and referred to conservational impact. An overview is provided in **Figure 1**.

Given that the coding process was flexible, we were open to new codes emerging during the analysis. The second author in conjunction with two other research team members reviewed and compared coding to ensure consistency and reliability and this supported methodological integrity that there was adequacy of the data as well as ensuring that findings are grounded in the evidence. Thus, a detailed picture of the nature play site and the types of activity that were experienced by adults and children were collected within the study and examined in the analysis. Further detail is provided in the **Supplementary Material**.

Findings

An insight into the engagement and play experienced by children and families is considered in the following section. Excerpts are presented to capture the role of nature and illustrate practice within both an established and a newly developed play area. Across these examples, behavior and interaction with the surrounding area were recorded on a naturalistic basis meaning that the observer adopted a non-participant background role.

Visitors and Involvement With Play Spaces

Community engagement was a feature evident across both sites. In Melbourne, the established basis of the play space facilitated observation as it is a feature accessed by the community (the area is regularly promoted locally and to wider audiences). Fewer demographics were collected regarding Melbourne visitors as the intention for such data (parent and child response and engagement with the play space) is to a form of baseline or benchmark to support evaluation of the Edinburgh project. There was clear appreciation among visitors of the availability of such spaces and that there were a range of groups to observe across the 2 days is particularly noteworthy as the data collection occurred in winter (late June). Children engaged as they wished without coercion from the adults accompanying them. The naturalistic observation approach in Melbourne suggests that accessing the children's area was part of a wider garden visit. It is plausible for some visitors that the garden was a target of their experience and for others a welcome surprise. Nature play areas promote and encourage interaction of all kinds, stimulating activity and less active play. Running jumping and splashing in water were likely as was sitting in the areas enjoying looking at the plants/resources around them. The combination of open and semi-sheltered areas created visual interest and play/experimentation. Modeling/demonstration was noted more often when infant/very young children visited, whereas older children instigated and led play and adults almost always showing clear trust in their child.

In Edinburgh designated times (morning 10–12pm and afternoon 2–4pm) were established to support evaluation of interventions and capture engagement of communities invited to experience the nature play area. Most families planned their visit signaling their intention in advance (171 families) with the remainder joining on the day (31 families). In Edinburgh, a total of 371 participants[5] visited at least one intervention and repeated visits did take place. Two families attended three sessions, two families attended four and one mother and her two girls attended five of the possible six interventions. Overall, greater numbers visited in the morning. Practical considerations may help offer an explanation: the age-group of the child participants who routinely take afternoon naps or perhaps other family commitments such as collecting siblings from school (with the exception of the Meadow intervention where attendance was more equal, when 27 participants were recorded during morning and afternoon sessions[6]). However, the goal to encourage visits from previously identified harder to reach groups (Roe, 2013) was less successful. Dissemination of project aims and opportunities was problematic; making evaluation of support such as transport challenging (transport was a difficulty previously identified; Roe, 2013). Offers to share project news across ten community groups were not accepted and awareness relied on leaflets and posters being displayed or shared by email. Word of mouth and snowball sampling did have some success among the local community. For example, the Community Liaison Officer a family recruited from a local Library event attended in July who then encouraged two further families to attend. The project was greeted with

[5]A participant includes both adults and children. Three hundred and seventy-one participants involved 149 adults, 118 girls, and 104 boys.

[6]This intervention was available in the summer holidays and the lack of school may explain this change in pattern.

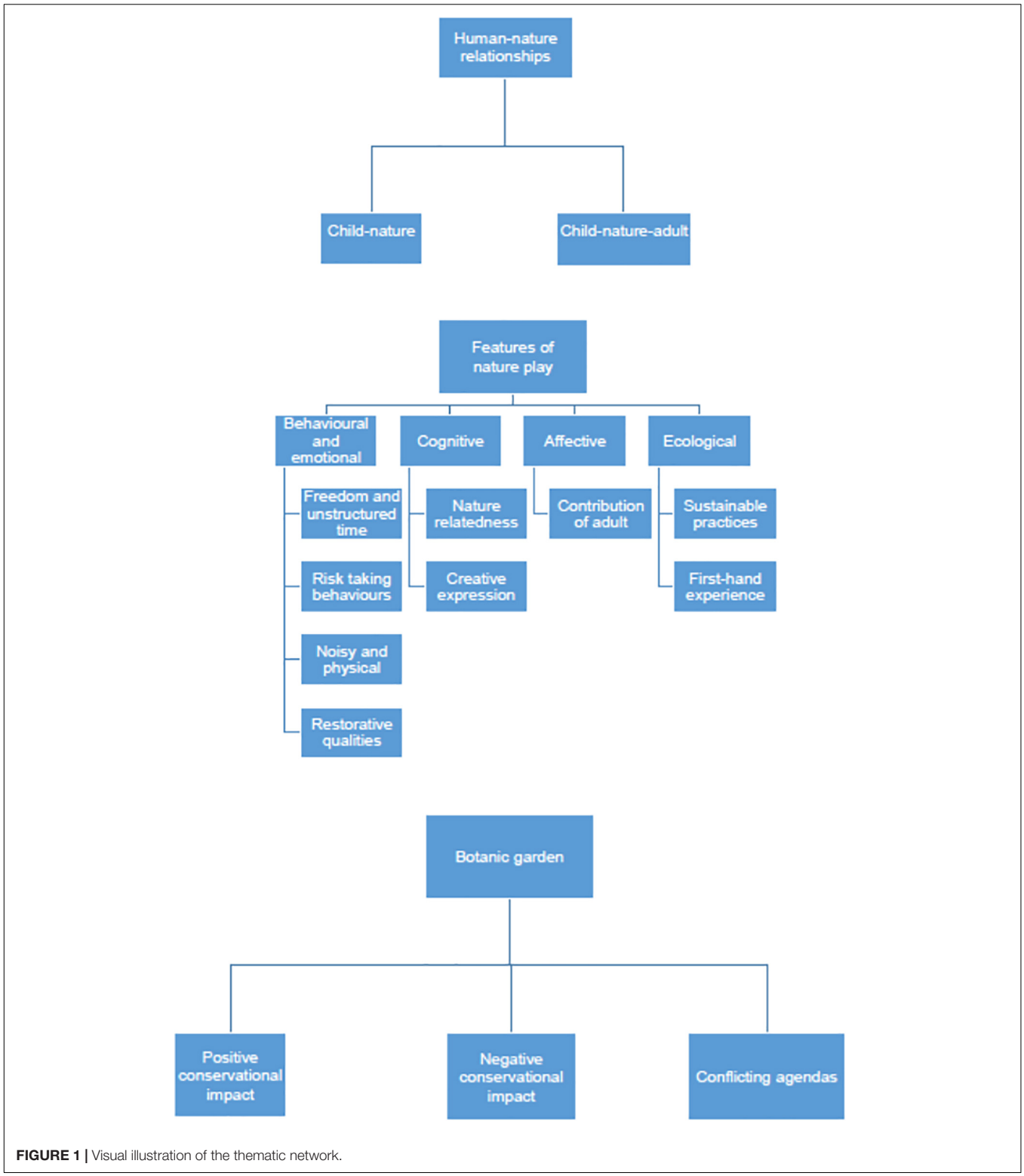

FIGURE 1 | Visual illustration of the thematic network.

enthusiasm by parents who showed genuine interest in being a part of the lifecycle of their local resource. The majority of participants reported being familiar with the Edinburgh garden and valued the revised play space, indicating they were hopeful it would feature within a longer-term strategy to support families within the gardens:

a regular pre-school session would be great addition to the gardens [. . .] and we would certainly come and do this all year round
Adult feedback on map, Water intervention. Edinburgh.

In Edinburgh, maps were shared to visitors to communicate the special features of interventions, including where different aspects were located in the botanic garden. In turn, visitors completed their own maps during visits to capture reflections and suggestions, this included young children who expressed their views for adults to transcribe and added their own sketches. Having completed maps participants appeared to have little additional commentary as the supplementary feedback form sent after each intervention yielded only eight responses (0.05%). Across observation and map completion a wealth of data were obtained that evidenced nature play and interaction with interventions. Visitor enjoyment of the area was also clearly articulated during a conversation with a father at the Meadow intervention who described having time to engage in conversation was a feature of experience:

these sessions are really relaxing [. . .] the children are playing and there's no urgency to rush onto the next thing. We've time to relax and talk to you about things!
Adult feedback, Meadow intervention. Edinburgh.

Creative and Fantasy Play

Make believe was a pervading aspect of human–nature interaction. Children sought out fairies and other characters originating from their own imagination and others (for example the Gruffalo). Such play was encouraged by adults and also initiated by children. The blend of reality and fantasy was noted when children enjoyed imitating bird song and audible features of the environment (e.g., grass swishing). The role of experience and repeated access to play spaces is noted as a valued feature contributing to childhood and opening up conversations in a family.

now the project has been running for a while and we've been here again and again, we're enjoying talking about the seasonal changes. There's hazelnuts appearing on the trees this week and the water level in the pond is lower. The children notice these things and I like that [. . .] it fixes stories about nature in their memories
Adult feedback on map, Meadow. Edinburgh.

Freedoms, Nature Play Spaces, and Restorative Experiences

A common ingredient across each play space was open areas that children could enjoy. Such areas support running, jumping skipping, and walking as well as more relaxed engagement. Play can be formalized and guided to ensure that activity targets set objectives as well as being open-ended. In each botanic garden, the play spaces facilitated open-ended play where children's responses were a reaction and engagement was encouraged but not directly facilitated by features such as signs or markers. For example in the meadow intervention, long grasses were retained and a subtle path created to encourage discovery in the meadow area. Children were keen to follow the path but also create their own by navigating through the long grasses. In Melbourne, children enjoyed moving around the space as well as taking moments to sit and relax.

In Edinburgh, intervention-specific resources including hammocks and a dripping hosepipe were used to resource each intervention. Such additions to the designated site, however, were not overt and did not establish prescriptive forms of play, engagement, or activities. Through their engagement children valued the autonomy offered to them in the play space. The lack of signs, activity sheets and other instructions was commented upon:

we like the freedom of not being told what to do and what not to so
Adult – written on map during Earth intervention. Edinburgh.

at first she asked if it was "OK mummy to move the stones?" but didn't need much more confirmation than "go for it!"
Conversation between mother and daughter at Earth intervention. Edinburgh.

The lack of structure and the goal of enhancing restorative opportunities was recognizable in each space. Different features attracted children and adults at different times. Few patterns of movement between features or areas within each intervention session were identifiable. In Edinburgh the "free," "unstructured" "calm" genre of play that was experienced was emphasized in visitor accounts. During the Listen, Earth and Meadow interventions adults were comfortable to be seated away from their children who were playing elsewhere. Such trust between adults and children can offered create tension or be challenging when experiences are occurring in a public space; thus such observations speak to visitor engagement and comfort in the space.:

it's good to see things different things, like the hammocks here today. Normally we keep going or sit on the grass if it's dry. The hammocks are a novelty and we like that.
Adult – conversation with researcher during Listen intervention. Edinburgh.

Similarly, restorative experiences were enriching for adults and children and mutually beneficial. Children were observed to relax and enjoy their environment, gazing at features of the garden, remaining still to capture every movement of an insect crawl on the ground. That botanic gardens offer a restorative niche for both adults and young children is worth emphasis as such dwell time is often overlooked as a characteristic contributing to nature play:

Good to have sit mats and blindfolds to focus on being still and listening.
Adult – feedback form response from Listen intervention. Edinburgh.

Examining Nature Play Across Edinburgh and Melbourne

Nature play involving directed and spontaneous interaction was evident across each location. Children appeared confident and relished making use of their environment, pursuing activities and creative experiences where there was time for

movement (running, jumping, splashing) and relaxed (less physical movement) engagement and exploration.

A commonality is the unpredictable nature of such play. Interventions were shaped to offer stimulation and enjoyment and by invoking children's creativity and imagination what may appear to be similar opportunities and experiences for children were realized in different ways by each child. Opportunities for free play with purposeful stimuli were valued, creating interest in nature and offering a connection to gardens. Children were content to sit and observe their surroundings as well as move around and handle objects, including tracing patterns in water and mud. These descriptions of nature play suggest that engagement is not necessarily derived solely from physical interaction and may also support qualities such as children's wellbeing. Thus, the shape and scope of interventions welcome a range of interaction possibilities and opportunities, including the water-themed space. The interventions applied in Edinburgh were designed in accordance with features available in the garden space as well as affordances tied to the season. An inherent property of the interventions is that they involve transient features. Given the data collection, there was a clear start date (set out in **Table 1**); however, an end date is harder to specify. For example, health and safety considerations meant that provision of hammocks was restricted and provided at key times and days. Whereas in the meadow intervention, creation of pathways in the long grasses was clearly visible at the start and varied as the grass grew over the next few weeks. Thus, the exact form and shape of the interventions employed in this project may need to be tailored in other gardens seeking to consider nature play spaces in accordance with their environment and characteristics.

An area rich for additional consideration is the duration of visits. In Melbourne visits approximated 45 min whereas in Edinburgh the duration was more varied (and often longer). In both settings the wider garden experience has not been captured, thus this estimate refers to the use of the nature play area. Parents self-assessed the duration of their visit to suit their needs. A longitudinal approach that captured more precise data across seasons is warranted to grasp a better understanding of nature play within gardens, Edinburgh appears to have longer, more relaxed visits and this could be linked to the different seasons (and weather) at each site.

Balancing Nature Conservation and Nature Play

An anticipated tension in the study was the endorsement of respect for nature while encouraging play. Among other aims, botanic gardens at their core are focused on nature conservation. Melbourne garden had tried and tested means to support typical nature play behaviors and nature conservation side by side, providing an 8 week year period each year for conservation. Confining nature play to a designated area in Edinburgh was a deliberate strategy to encourage engagement providing a clear message to visitors it was appropriate to play and touch plants. Such an approach addresses anticipated tensions (held by staff and visitors) regarding what is safe and appropriate in the garden. At the Edinburgh site, while being newly designated, showed minimal physical impact upon the site. Children that did 'roam' tended to keep to pathways and other play space. With guidance (maps, planned mowing etc.) visitors could be directed away from potentially vulnerable areas (in conservation terms). Given the form and provision achieved across interventions the potential of nature play was not reduced or inadvertently made safe and is supported through joint evaluation achieved with the Melbourne data. Risk-rich play was achieved (for example, water in the pond, logs for balancing and rolling) that is characteristic of learning with nature.

The environmental impact linked to the use of a designated area was also evaluated. A visual inspection and photographic log were undertaken before and after each intervention session (leading to 24 entries) to look for signs of impact. Overall (and somewhat surprisingly) there was a lack of disturbance with minimal impact from visitors. In most instances, disturbance was evident across a small area of two meters nearby an introduced resource (for example, in the water intervention this was the dipping platform and adjacent area). Beyond this immediate area, disturbance was recognized as bent or crushed grass, displaced stones, and moss removed from long-standing stones. Within the meadow intervention, a number of new paths had been created through grass and flattened grass areas reflected time taken to enjoy the surroundings by visitors. Two weeks later the grass was mown with strimmers and there was no evidence of the temporary pathways after grass cutting. The most ecological sensitive area in the study site was the woodland. During the woods intervention, visitors appear to have followed established paths and used the existing bare ground as no disturbance was recorded among the herbaceous plants (some mosses were dislodged from low limestone walls). As some of the children were dragging or carrying quite large branches through the site it is interesting to note what little impact was made. The overall environmental impact of the Nature Play activities was minimal. Further research is warranted to consider whether more regular opportunities and sustained nature play would have a similar minimal environmental impact and requires particular, local consideration in relation to the resources and materials adjacent to play spaces.

DISCUSSION

This paper reports on a project that targeted a play space identified as being underused and aimed to support a range of parents to embrace a nature play area within a city botanic garden. Nature play is a relatively new role for botanic gardens. This study has shown that within the context of a diverse, semi-natural or naturalistic landscape, containing a variety of native trees, shrubs and herbs, nature play involving close contact with plants, bark-chip and mown paths, stones, soil, water and small creatures can have a benign effect on the plants and landscapes. Regular interactions of relatively short duration with high intensity appear to have no lasting impact on the habitat and has the potential to have a lasting impact on visitors. Botanic gardens can offer a useful route to examine conservation, environmental understanding and stewardship with the youngest

members of society as nature play experiences are first-hand and locally relevant. The involvement of a multi-disciplinary team supported project design and implementation. Both designated spaces and temporary "pop-up" spaces have value as do areas such as the fixed nature play space in Melbourne. The variation across interventions for play that involved editing the location and provision of play resources was appreciated by visitors. Such low-cost and environmental friendly alterations indicate that minimal input is required to facilitate play sessions that could extend for an hour or more that involve few goals with the exception of nature play.

Opportunities for Nature Play and Children's Engagement

Children used their imagination and inspiration to stimulate play. Simple resources enticed children, supported imagination, and contributed to creative play. Spaces were managed by carefully selecting and introducing resources (when required) that were naturally occurring (e.g., such as leaves, twigs that feature because of the established gardens). Organization and layout of the nature play space did not involve demarcation of designated seating areas or play areas and built on the value of semi-wild spaces evidenced in other countries (Laaksoharju et al., 2012). Fixed opportunities such as provision of games or worksheets were avoided; while such approaches have been deemed valuable (Tampoukou et al., 2015) the research being reported acknowledges a range of interaction and engagement facilitated by a relaxed environment that did not require specific completion of activities.

Children were enthusiastic and eager and appeared to lead interaction for the most part. Experiencing the sensory qualities of objects held a special fascination for children where they were recorded pulling, lifting, stroking, or splashing. The support provided to manage spaces to ensure the availability of suitable resources in play spaces was important to prompt and encourage exploration. The use of specific interventions was helpful to adequately resource data collection as it required observers to be on site. Innovative strategies could be adopted to document children's exploration of the environment and play space. Earlier studies involving naturalistic recording (video and audio) during play will be valuable within future work seeking such data. Building on the study being reported such approaches could consider help-seeking and help-seeking within interactions to appreciate such nuances within nature play experiences; including how children seek input from others, what help is requested as well as the breadth of such talks (Hoyte et al., 2015). Playing freely around plants and natural features of different types may be familiar or less familiar for some children and challenge expectations they have about what is permissible behavior. Potential concerns that encouraging first-hand contact may encourage children to keep tokens – recognized as a feature of childhood experienced tied to nature (Beery and Lekies, 2019) – were not observed at either site. Future work would do well to allow for considering the child's voice to allow for variance across experiences and perspectives to be recognized (Sanderud, 2020). Similarly, video data could support subtleties in behavior where children seek or do not seek reassurances, feeding into the wider literature regarding risk-taking and outdoor experiences. Such knowledge would be supported by a wider consideration targeting parent and caregiver perspectives in addition to observation as caregivers are a recognized influence on the opportunities provided to children alongside the expectations of behavior emerging during play (Laird et al., 2014; McFarland and Laird, 2020).

The form of nature interventions reported in this study took careful planning and implementation. Assessments were undertaken by botanic garden staff across the intervention (before and after sessions) and these considerations varied in line with seasonal changes and the specifics of each intervention. This was normal practice within such staff roles and featured as a condition to support the use of the botanic garden space for nature play. However, the support of such interventions could be further evaluated. A more developed form of technical assessment may be valuable to ensure that features of the garden and seasonable changes are accounted for when nature play is established as a common feature of botanic garden provision. Ensuring such provision and nature play is accessible for all is also an additional area for evaluation to support inclusive engagement. For example, paths were created that were flush to the ground and mostly even, making such areas accessible. However, the lack of seating or designated rest areas may cause concern for individuals where rest is needed, and exertion or seated on the ground would be problematic. Thus, there are broader tensions and opportunities to consider in future work to foster inclusive nature play designs and ensure participation and engagement are suitable for all (Prellwitz and Skär, 2016; Fernelius and Christensen, 2017).

This small project focused on one nature play area across 6 months and acquired additional data from a comparison garden involving an established nature play area. While this duration is admirable, longer term projects are warranted to provide deeper insight into engagement and the implications across different seasonal conditions, particularly in adjacent habitats to the nature play space. Poor weather was identified as a risk to the research being reported, however, the weather was consistently fair. Future work could consider seasonal perspectives including opportunities provided by diverse weather. Challenges (both new and unforeseen) may come across any project, those involving families and children that visit gardens need to consider issues such as clothing, toileting, and family support (e.g., private spaces for breast-feeding/changing located nearby to play spaces). Weather is unpredictable and is a potential barrier to any work, knowledge gained from early years settings suggest that a supportive approach (e.g., offering supplies of appropriate clothing) may be a helpful strategy to foster engagement and could help families feel welcome in such spaces (Nugent, 2015).

The role of staff in such gardens could also be considered. This project aimed to consider play as it was inspired by the environments where adults and children chose to access. This required staff on site to hold back and avoid any attempts at encouraging or suggestion of helpful behaviors that may be commonplace for their role. It would be valuable to look at

the longer-term value attached to such areas, including when staff on site were part of the community engagement and their knowledge was an aspect of the relationship. For example, there is an expectation that engagement with nature invites curiosity and over a longer term fuels environmental awareness encouraging a reflection of behavior and understanding (Bonnett, 2007). As our conceptions and knowledge regarding nature are arguable different during childhood and adulthood there is a strong basis to consider multiple perspectives regarding individually and jointly constructed knowledge tied to nature (Adams and Savahl, 2017).

Longitudinal work could invest in a closer understanding of play, going beyond initial contact with play areas. The research being reported focused on reaction to the play space within a botanic garden and the changes observed from nature-based learning opportunities. Duration was used in the research being reported as an estimate of engagement and it would be valuable to further such evaluation in future work. For example, when/how interaction with the play area features within access and engagement with the garden more generally would be valuable. Technology such as GPS devices/drones would add to the qualitative observations captured in the project. While complications are noted in the use of such devices (Waite and Waters, 2020), advancements in technology (such as wrist-based GPS) could provide an additional lens. Thus, a longer-term approach would do well to consider parent–child play both at and away from nature play spaces and could extend to considering additional patterns in play. Measuring play experiences in children will be important to understand the potential impact on such play spaces and develop their use more broadly. As noted in this study observation is a common approach to capture play activity and while parents' self-report is noted as forming a crucial part of the wider understanding (Ahmadzadeh et al., 2020) the location of play as well as its features ought to be recognized in such accounts.

Societal Engagement and Botanic Gardens

Spaces primed for play are a good starting point indicating that promotion of nature play can co-exist and be facilitated within public spaces like botanic gardens that have a vital role to play in human–nature relations and this includes supporting the development of environmental awareness and behaviors (Williams et al., 2015). Botanic gardens can play a much broader role in unpicking and encouraging environmental education in young children and future work targeting such goals would be valuable. Botanic Gardens, as part of their social role, can serve as a community's meeting place and are a familial link between people and their local, natural spaces (Konijnendijk, 2008; Morgan et al., 2009). Attempts to foster contact with a broader range of community groups had limited success and encountered difficulties engaging with specific communities. A new starting point may be called for, where relationships are developed within these communities over time to create contact and engagement over a longer term. The hesitancy of such hard to access groups is difficult to pin-point and contributing factors may involve unconscious biases within settings (Vergou and Willison, 2016). Well-designed participatory research is recognized for the value it can offer to address tensions held by potential participants who are aware they are being researched (Bradbury-Jones et al., 2018) and has been fostered with particular groups in Botanic gardens (Vergou and Willison, 2016). Gaining children's and adults perspectives could meaningfully help broaden societal engagement within future studies and ensure that marginalized communities feel supported to establish and build a connection to the garden. Appreciation of restorative effects from time in nature could be a feature of such work, particularly as "being away" or relishing visiting a space that is not our own is a recognized feature within adults and adolescents interpretation of their experiences (Herzog et al., 2003; Roe and Aspinall, 2012).

There are in excess of 3,500 botanic gardens identifiable worldwide, positioning them as an ideal location to consider nature play[7]. Enabling nature play and learning within a designated area provided a positive experience for families and visitors without posing a serious risk to either the plants or disrupting the experience of other garden-users. Botanic gardens and other sites of high biodiversity can develop opportunities for safe and rewarding self-directed nature play without impacting negatively on their wider resource and environment. Supporting nature play is feasible and could be facilitated by designating an area of semi-natural vegetation encouraging the provision of nature-based learning opportunities that facilitate multiple gains for families as well as endorse the role of botanic gardens for wider audiences.

DATA AVAILABILITY STATEMENT

The datasets presented in this article are not readily available because participants of this study did not agree for their data to be shared publicly, so supporting data are not available.

ETHICS STATEMENT

Ethical review and approval were not required for the study on human participants in accordance with the local legislation and institutional requirements. Written informed consent from the participants' legal guardian/next of kin was not required to participate in this study in accordance with the national legislation and the institutional requirements.

AUTHOR CONTRIBUTIONS

Both authors listed have made a substantial, direct, and intellectual contribution to the work, and approved it for publication.

[7]There are potentially many more gardens as inclusion/exclusion criteria are hard to pinpoint and not all gardens will be registered within the available Botanic garden database: https://www.bgci.org/garden_search.php.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2022.778151/full#supplementary-material

REFERENCES

Adams, S., and Savahl, S. (2017). Nature as children's space: a systematic review. *J. Environ. Educ.* 48, 291–321. doi: 10.1080/00958964.2017.1366160

Ahmadzadeh, Y. I., Lester, K. J., Oliver, B. R., and McAdams, T. A. (2020). The parent play questionnaire: development of a parent questionnaire to assess parent–child play and digital media use. *Soc. Dev.* 29, 945–963. doi: 10.1111/sode.12450

Beames, S., Higgins, P., and Nicol, R. (2012). *Learning Outside the Classroom: Theory and Guidelines for Practice*. Abingdon: Routledge.

Beery, T. H., and Lekies, K. S. (2019). Childhood collecting in nature: quality experience in important places. *Childrens Geogr.* 17, 118–131. doi: 10.1080/14733285.2018.1463431

Bonnett, M. (2007). Environmental education and the issue of nature. *J. Curric. Stud.* 39, 707–721. doi: 10.1080/00220270701447149

Bradbury-Jones, C., Isham, L., and Taylor, J. (2018). The complexities and contradictions in participatory research with vulnerable children and young people: a qualitative systematic review. *Soc. Sci. Med.* 215, 80–91. doi: 10.1016/j.socscimed.2018.08.038

Carver, A., Timperio, A., and Crawford, D. (2008). Playing it safe: the influence of neighbourhood safety on children's physical activity—A review. *Health Place* 14, 217–227. doi: 10.1016/j.healthplace.2007.06.004

Chawla, L. (1998). Significant life experiences revisited: a review of research on sources of environmental sensitivity. *J. Environ. Educ.* 29, 11–21. doi: 10.1186/s13054-016-1208-6

Cutter-Mackenzie, A., Edwards, S., Moore, D., and Boyd, W. (2014). *Young Children's Play and Environmental Education in Early Childhood Education*. Cham: Springer Science & Business Media.

Edwards, I. (2006). Social integration for all. *Roots* 3, 13–16.

Fernelius, C. L., and Christensen, K. M. (2017). Systematic review of evidence-based practices for inclusive playground design. *Child. Youth Environ.* 27, 78–102. doi: 10.7721/chilyoutenvi.27.3.0078

Fjørtoft, I. (2001). The natural environment as a playground for children: the impact of outdoor play activities in pre-primary school children. *Early Child. Educ. J.* 29, 111–117.

Ghafouri, F. (2014). Close encounters with nature in an urban kindergarten: a study of learners' inquiry and experience. *Education* 42, 54–76. doi: 10.1080/03004279.2011.642400

Gibson, J. L., Cornell, M., and Gill, T. (2017). A systematic review of research into the impact of loose parts play on children's cognitive, social and emotional development. *Sch. Ment. Health* 9, 295–309. doi: 10.1007/s12310-017-9220-9

Heerwagen, J. H., and Orians, G. H. (2002). "The ecological world of children," in *Hildren and Nature: Psychological, Sociocultural, and Evolutionary Investigations*, eds P. H. Kahn Jr. and S. R. C. Kellert (Cambridge, MA: MIT Press).

Herzog, T. R., Maguire, C. P., and Nebel, M. B. (2003). Assessing the restorative components of environments. *J. Environ. Psychol.* 23, 159–170. doi: 10.1016/S0272-4944(02)00113-5

Hoyte, F., Degotardi, S., and Torr, J. (2015). What it is all about: topic choices in young children's play. *Int. J. Play* 4, 136–148. doi: 10.1080/21594937.2015.1060566

Hunt, A., Stewart, D., Richardson, M., Hinds, J., Bragg, R., White, M., et al. (2017). *Monitor of Engagement with the Natural Environment: Developing a Method to Measure Nature Connection Across the English Population (Adults and Children)*. Natural England Commissioned Reports 233. New York, NY: Natural England.

Kellert, S. R. (2002). "Experiencing nature: affective, cognitive, and evaluative development in children," in *Children and Nature: Psychological, Sociocultural, and Evolutionary Investigations*, eds P. H. Kahn Jr. and S. R. Kellert (Cambridge, MA: MIT Press). doi: 10.2196/25504

Knight, S. (2009). *Forest School and Outdoor Learning in the Early Years*. Thousand Oaks, CA: Sage.

Konijnendijk, C. C. (2008). "The forest and the city," in *The Cultural Landscape of urban Woodland*, ed. C. C. Konijnendijk (Berlin: Springer).

Kopczak, C., Kisiel, J. F., and Rowe, S. (2015). Families talking about ecology at touch tanks. *Environ. Educ. Res.* 21, 129–144. doi: 10.1080/13504622.2013.860429

Laaksoharju, T., Rappe, E., and Kaivola, T. (2012). Garden affordances for social learning, play, and for building nature–child relationship. *Urban For. Urban Green.* 11, 195–203. doi: 10.1016/j.ufug.2012.01.003

Laird, S. G., McFarland-Piazza, L., and Allen, S. (2014). Young children's opportunities for unstructured environmental exploration of nature: links to adults' experiences in childhood. *Int. J. Early Child. Environ. Educ.* 2, 58–75.

MacQuarrie, S., Nugent, C., and Warden, C. (2015). Learning with nature and learning from others: nature as setting and resource for early childhood education. *J. Advent. Educ. Outdoor Learn.* 15, 1–23. doi: 10.1080/14729679.2013.841095

Mannion, G., Fenwick, A., Nugent, C., and I'Anson, J. (2011). *Teaching in Nature*. Cham: Springer.

McFarland, L., and Laird, S. G. (2020). ""She's only two": parents and educators as gatekeepers of children's opportunities for nature-based risky play," in *Research Handbook on Childhoodnature: Assemblages of Childhood and Nature Research*, eds A. Cutter-Mackenzie-Knowles, K. Malone, and E. B. Hacking (Cham: Springer), 1075–1098. doi: 10.1007/978-3-319-67286-1_58

McIvor, L. (2001). A changing role for botanical gardens. *Pappus* 27, 27–28.

Miles, M. B., and Huberman, A. M. (1994). *Qualitative Data Analysis: An Expanded Sourcebook*, 2 Edn. Thousand Oaks, CA: SAGE Publications.

Morgan, S. C., Hamilton, S. L., Bentley, M. L., and Myrie, S. (2009). Environmental education in botanic gardens: exploring brooklyn botanic garden's project green reach. *J. Environ. Educ.* 40, 35–52. doi: 10.3200/joee.40.4.35-52

Mullins, P. M. (2013). Conceptualizing skill within a participatory ecological approach to outdoor adventure. *J. Exp. Educ.* 37, 320–334. doi: 10.1177/1053825913498367

Nicholson, S. (1972). The Theory of Loose Parts, An important principle for design methodology. *Stud. Des. Educ. Craft Technol.* 4:1972.

Nugent, C. (2015). "Using the outdoor environment in early childhood pedagogy," in *The Early Years Foundation Stage: Theory and Practice*, ed. I. Palaiologou (Thousand Oaks, CA: SAGE Publications).

Nugent, C., and Beames, S. (2015). Cultural transmission at nature kindergartens: foraging as a key ingredient. *Can. J. Environ. Educ.* 20, 79–83.

Nugent, C., Edwards, I., Hutcheon, S., and MacDonald, J. (2014). *Nature Play: Nature Conservation. Project Report on Behalf of Royal Botanic Gardens.* Edinburgh: Royal Botanic Gardens.

Prellwitz, M., and Skär, L. (2016). Are playgrounds a case of occupational injustice? experiences of parents of children with disabilities. *Child. Youth Environ.* 26, 28–42. doi: 10.7721/chilyoutenvi.26.2.0028

Richardson, M., Hunt, A., Hinds, J., Bragg, R., Fido, D., Petronzi, D., et al. (2019). A measure of nature connectedness for children and adults: validation, performance, and insights. *Sustainability* 11:3250. doi: 10.3390/su11123250

Roe, J. J. (2013). *Increasing Social Inclusion and Access in the Royal Botanic Gardens Edinburgh*. Edinburgh: RBGE.

Roe, J. J., and Aspinall, P. A. (2012). Adolescents' daily activities and the restorative niches that support them. *Int. J. Environ. Res. Public Health* 9, 3227–3244. doi: 10.3390/ijerph9093227

Saldaña, J. (2012). *The Coding Manual for Qualitative Researchers Sage*. London: Sage.

Sanderud, J. R. (2020). Mutual experiences: understanding children's play in nature through sensory ethnography. *J. Advent. Educ. Outdoor Learn.* 20, 111–122. doi: 10.1080/14729679.2018.1557058

Sandseter, E. B. H. (2009). Children's expressions of exhilaration and fear in risky play. *Contemp. Issues Early Child.* 10, 92–106. doi: 10.2304/ciec.2009.10.2.92

Sebba, R. (1991). The landscapes of childhood: the reflection of childhood's environment in adult memories and in children's attitudes. *Environ. Behav.* 23, 395–422. doi: 10.1177/0013916591234001

Skår, M., and Krogh, E. (2009). Changes in children's nature-based experiences near home: from spontaneous play to adult-controlled, planned and organised activities. *Childrens Geogr.* 7, 339–354. doi: 10.1080/14733280903024506

Sobel, D. (2015). *Nature Preschools and Forest Kindergartens: The Handbook for Outdoor Learning*. St Paul, MN: Redleaf Press.

Stephenson, A. (2003). Physical risk-taking: dangerous or endangered? *Early Years* 23, 35–43. doi: 10.1080/0957514032000045573

Tampoukou, A., Papafotiou, M., Koutsouris, A., and Paraskevopoulou, A. T. (2015). Teachers' perceptions on the use of botanic gardens as a means of environmental education in schools and the enhancement of school student benefits from botanic garden visits. *Landsc. Res.* 40, 610–620. doi: 10.1080/01426397.2014.947250

Truscott, J. (2020). "Toward a pedagogy for nature-based play in early childhood educational settings," in *Research Handbook on Childhoodnature: Assemblages of Childhood and Nature Research*, eds A. Cutter-Mackenzie-Knowles, K. Malone, and E. B. Hacking (Cham: Springer), 1521–1548. doi: 10.1007/978-3-319-67286-1_82

Vergou, A., and Willison, J. (2016). Relating social inclusion and environmental issues in botanic gardens. *Environ. Educ. Res.* 22, 21–42. doi: 10.1080/13504622.2014.984161

Waite, S. (2007). 'Memories are made of this': some reflections on outdoor learning and recall. *Education* 35, 333–347. doi: 10.1080/03004270701602459

Waite, S., Goodenough, A., Norris, V., and Puttick, N. (2016). From little acorns.: environmental action as a source of well-being for schoolchildren. *Pastoral Care Educ.* 34, 43–61. doi: 10.1080/02643944.2015.1119879

Waite, S., and Waters, P. (2020). "Mobilising research methods: sensory approaches to outdoor and experiential learning research," in *Routledge Advances in Outdoor Studies. Research Methods in Outdoor Studies*, eds B. Humberstone and H. Prince (Milton Park: Taylor And Francis). doi: 10.1080/14729670802078270

Walker, T. (2016). *Kindergarten, Naturally*. Washington, DC: The Atlantic.

Williams, S. J., Jones, J. P., Gibbons, J. M., and Clubbe, C. (2015). Botanic gardens can positively influence visitors' environmental attitudes. *Biodivers. Conserv.* 24, 1609–1620. doi: 10.1002/ajp.22692

Williams-Siegfredsen, J. (2012). *Understanding the Danish Forest Schools Approach*. London: Routledge.

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