Low-stakes, high-interest learning: a hermeneutic phenomenological study of children learning mathematics outdoors

Author Accepted Manuscript

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This is an Accepted Manuscript of an article published by Taylor & Francis in *Journal of Adventure Education and Outdoor Learning* on 20 January 2026, available online: https://doi.org/10.1080/14729679.2026.2618235

ABSTRACT

This hermeneutic phenomenological study explores the lived experiences of primary-aged children engaging in regular outdoor mathematics learning at school. Drawing on van Manen's interpretive framework, the research illustrates how children experience mathematics in natural environments. Findings reveal that children perceive outdoor mathematics learning as safe, inclusive, peaceful, and liberating, fostering belonging, reducing anxiety, and enabling engagement through creativity, self-direction, and collaboration. Participants highlighted the importance of space, sound, natural materials, and peer relationships in shaping their learning experiences. The study introduces the concept of low-stakes, high-interest mathematics learning where the absence of fear and the presence of curiosity enhance engagement and confidence. These insights offer important implications for educational practice and policy, challenging traditional mathematics pedagogy. By exploring the lived experiences of children learning mathematics outdoors, this research demonstrates how the outdoors provides a transformative space for mathematical engagement.

KEYWORDS: Mathematics education; outdoor learning; hermeneutic phenomenology; practitioner research

Introduction

The National Curriculum in England highlights the importance of creativity, beauty, enjoyment and curiosity in effective mathematics learning (Department for Education, 2014). However, studies have shown that children often experience mathematics lessons as difficult (Carey et al., 2019), dull (Sneck et al., 2022) and even scary (Musa & Maat, 2021). These findings suggest a disconnect between the National Curriculum's intent and the realities of how mathematics is taught. This disjunction raises important questions about how and where mathematics learning occurs, and whether alternative pedagogical spaces might better align with the curriculum's aspirations.

In recent years outdoor learning has become an increasingly popular pedagogy for delivering school-based curriculum learning (Harris, 2017). Studies have shown that regular outdoor learning can improve: (1) behaviour (Kiviranta et al., 2024), (2) emotional wellbeing (Beames et al., 2012), (3) academic outcomes (Khan et al., 2020) and (4) social development (Fiennes et al., 2015). However, currently there is a lack of understanding of how children themselves experience outdoor learning in the moment. Furthermore, the focus of outdoor learning research is restricted to what effect the pedagogy has on learning, emotions and wellbeing rather than seeking to understand how children experience outdoor learning and what impact this may have on children's experiences of mathematics. Therefore, this study (Barrett-Rodger, 2023) aimed to address a gap in the existing literature by exploring how children experience learning mathematics outdoors, rather than simply measuring its outcomes. While research has highlighted the benefits of outdoor learning in terms of behaviour, well-being, and academic achievement, little is known about the moment-to-moment, lived experience of children engaging in mathematical thinking outside the classroom. Current understandings are shaped largely by adult perspectives or outcome-based data, overlooking the nuanced, affective, and embodied dimensions of learning as it unfolds in natural environments. This study responds to that gap by examining how primary-aged children live through and make sense of mathematics learning outdoors and is in line with other contemporary phenomenological research in mathematics education (e.g. Cañeda et al., 2024) demonstrates the continuing value of exploring lived experience beyond outcome-based metrics.

Gaining sight of the lived experience

Aim

This study aimed to illustrate and interpret children's experiences of learning mathematics outdoors, seeking to uncover insights that have implications for practice and pedagogy. The research question was as follows:

What is the lived experience of children learning mathematics outdoors?

In aiming to centre children's lived experiences, this study moves beyond evaluating outcomes to explore the felt sense of learning—what it is like to do mathematics outdoors. This study was completed in partial fulfilment of the degree of Doctor of Education between 2017 and 2023.

Methodology

This study adopted a hermeneutic phenomenological approach underpinned by the philosophy of Martin Heidegger. The phenomenological approach is an established qualitative methodology that aims to uncover embodied, experiential meanings of experiences (Finlay, 2009). Whilst Heidegger's concepts were not originally aimed at

providing a means of applied qualitative research, academics have drawn on his ideas to give researchers a platform to interpret and understand the lived experience of phenomena (Dibley et al., 2020).

Specifically, the methodology used draws from Max van Manen's Hermeneutic Phenomenological approach as described in his 2016 book, *Phenomenology of Practice*. Phenomenology of Practice was developed to enable professionals to engage in phenomenological research within the context of their workplaces (Errasti-Ibarrondo et al., 2018). van Manen's pedagogical focus makes his approach particularly suitable for educational research.

In recent years, there has been growing interest in research that captures students' voices—studies that focus on their opinions, attitudes, and views to help improve education. Some of this research has looked specifically at what children think about learning outdoors as part of the curriculum (Marchant et al., 2019). However, this study takes a different approach. Rather than focusing on what children think about outdoor mathematics lessons, it explores how they actually experience them. Drawing on phenomenology, which is concerned with how people experience the world before they put those experiences into words (van Manen, 2016), this study aims to get closer to what it feels like to learn mathematics outdoors. This focus requires a methodological attentiveness not only to what children say but to how they say it, the metaphors they use, and the settings in which their memories are anchored. While it's not possible to fully capture an unfiltered, 'prereflective' experience—because talking about it always involves some reflection—the focus here is on describing the experience of outdoor mathematics learning as it is lived, rather than as it is later interpreted or explained.

Hermeneutic phenomenological research requires an inventive approach to study design (van Manen, 2016). Whilst scholars such as van Manen provide various options and suggestions, there is no step-by-step guide to completing a phenomenological study. Instead, researchers need to demonstrate 'methodologically informed inventiveness' to explore the experiences of its participants (van Manen, 2016, p. 227). Therefore, the methods used within the research design must be supported by the traditions of the phenomenological philosophy and maintain methodological congruence throughout the study.

Positioning the researcher

In hermeneutic phenomenological research, the researcher is not a detached observer but an active interpreter whose own experiences, beliefs, and assumptions inevitably shape the research process (Crowther & Thomson, 2020). Recognising this, the researcher —who is also the deputy headteacher of a primary school recognised for its exemplary outdoor learning provision—acknowledges the dual position of being both an insider and advocate within the field under investigation. His professional commitment

to outdoor learning and his role as a speaker at related conferences foreground a passionate orientation toward the topic, which, while offering rich contextual insight, also introduces the potential for interpretive bias.

In addition to his leadership role, the researcher is a primary mathematics subject lead for an initial teacher training provider, with a strong interest in fostering a love of mathematics. These overlapping identities provided a valuable lens for engaging with participants' narratives but also required ongoing reflexive scrutiny to ensure that interpretations were grounded in participants' lived experiences rather than the researcher's aspirations or ideals.

To mitigate potential bias and enhance the trustworthiness of the findings, the researcher engaged in a pre-suppositions interview prior to participant recruitment, helping to surface and critically examine assumptions that might influence the study (Barrett-Rodger et al., 2022). Reflexive diaries were maintained throughout the research process, capturing not only decisions and interpretive moves but also the researcher's emotional and intellectual responses to emerging data. These diaries served as a means of 'bracketing in' —not to eliminate subjectivity, which is neither possible nor desirable in hermeneutic inquiry, but to make its influence visible and open to interrogation.

Importantly, interpretive decisions were regularly discussed with the supervisory team (co-authors of this paper), offering a dialogic space where the researcher's perspectives could be challenged and refined. Revisions were made when it was judged that personal experiences may have overshadowed participants' voices. This iterative process of reflection, articulation, and review formed a key part of the study's commitment to reflexivity and ethical responsibility.

Participants and recruitment

The participants of this study were 10-year-old children who had several years of experience of learning mathematics outdoors. As this study aimed to understand children's experiences of regular outdoor mathematics learning, it was decided that the children would be recruited from the school where the researcher worked. Outdoor learning had been a well-established common practice in the school for many years, and this helped ensure that students' experiences were developed over time, rather than shaped by novelty.

A gatekeeper (the headteacher of the school) managed the recruitment of the participants, ensuring that all of them and their parents or guardians were fully informed. Participation in the study was voluntary, and no incentives or compensations were offered. All children took part in outdoor mathematics lessons as part of their regular school routine. Those recruited to take part in the study, then had interviews to find out more about their experiences in those lessons. Participants remained

anonymous, and each was assigned a gender-neutral pseudonym to help maintain confidentiality.

A concern for the researcher was the influence their position may have on the responses from the participants. Siipi and Uusitalo (2024) highlights the ethical tensions inherent in teacher-led research, particularly the ways in which the dual role of teacher and researcher can subtly shape participant responses. Participants may feel obliged to respond in ways that align with perceived teacher expectations, especially when power dynamics and existing relational trust influence what feels 'safe' to disclose. Recognising these challenges, the British Educational Research Association (2024) case study on Classroom observation for 'insider' teacher-researchers offers practical guidance for mitigating such influences, particularly relevant when working with younger children. It emphasises strategies such as creating informal and play-based research contexts and engaging in reflexive journaling to continually examine one's positionality. For these reasons, as will be explored further in the next section of this paper, the researcher engaged in creative methods for interviews. Whilst acknowledging that a power-dynamic is still present, the researcher's intention was to minimise this through taking children beyond a formal classroom environment, allowing them to lead the interview and capturing their experiences through stories and artwork.

The position of the researcher concerning the participants was also carefully considered. As the researcher was familiar with the participants (as their teacher and deputy headteacher), the researcher was required to account for his biases and preconceptions regarding each participant reflexively. To achieve this, the researcher crafted penned illustrations of each participant, detailing the researcher's presuppositions and expectations, as detailed in Barrett-Rodger et al. (2023).

Data collection

The purpose of data collection in hermeneutic phenomenological studies is to gather experience material that can be used to develop an understanding of human experiences (van Manen, 2016). A one-to-one phenomenological interview was conducted with each participant. Whilst each interview was largely unstructured so to follow the participants' descriptions of their lived experience, a prompt sheet was used by the researcher to support them in their questioning. Phenomenological studies often rely on participants to describe their experiences during interviews with clarity of language (Punch, 2002). Therefore, consideration was given to what strategies could be provided during interviews to support children in describing experiential accounts. Four strategies were implemented to provide a platform for accessing the lived experience. These methods were not just tools for data extraction but carefully considered practices that honoured the phenomenological goal of accessing rich, embodied meaning.

Catalyst lessons

Catalyst lessons took place in the two weeks leading up to each interview. These were regular mathematics curriculum-based lessons that took place wholly or partly outdoors. The purpose of these lessons was to act as specific examples that could be referred to. During interviews, the catalyst lessons offered real-life examples for participants to draw on. Equally, when children began making generalisations, the researcher asked the participants to describe their experience of specific instances, which then provided more detailed experiential descriptions. This proved to be a useful technique for gathering experiential material, as demonstrated by Sydney's response.

> Um, the one from yesterday. I like it when we went in the forest and had to like complete different like, like long question and all stuck on the trees. I just like enjoyed that because like my partner really like helped because like if he couldn't do it and then like I couldn't do, he tried. We both gave ideas to see are we doing this bit right or are we doing this bit wrong? (Sydney)

Sydney recalled one of the catalyst lessons to provide specific details about their experiences. This reference point acted as a platform from which they drew concrete examples that supported the researcher's interpretation of their lived experience.

Place-based techniques

Interviews were conducted in the forest on the school's grounds which is where most of their recent outdoor mathematics lessons took place. This means that participants could 'show' the researcher their experiences in the exact location of the phenomenon. Doing the interviews in the location of the mathematics learning experience enabled participants to recall specific details, show where it happened and to re-enact their experiences, providing greater richness to their verbal accounts.

Participants were given ownership over where they wanted to be interviewed and could move around the outdoor environment to help illustrate their experiences. This technique meant the participants were in a familiar environment, reducing the power dynamic between the researcher and the participant (Clark, 2010). Additionally, some participants moved around continuously, turning the process into a walking interview (Kinney, 2017).

Art elicitation

During the interview, participants were invited to draw on their experiences of learning mathematics outdoors. To do this, they were provided with a range of different art resources and materials. Following the creation of their artwork, the participants were asked to describe what they had drawn. This strategy was used as a springboard for more detailed conversation. The researcher was also able to ask further questions about different aspects of the drawings.

> And then there's going to be, wait, this isn't going to be the apparatus, this is actually going to be the door into the side of the, into the classroom. And then we're going to have a tree over here to define that it's outdoors. (Casey)

Casey uses their artwork to describe their experience. They change their drawings and reveal the meanings behind what they have drawn and what this signifies as part of their experience.

The artwork created during the interviews was not considered research data. The drawings were not subject to the researcher's interpretations but were used to provide a platform from which data in spoken words could be elicited.

Vocative exercises

Vocative language (e.g. metaphors or poetry) is commonly used in phenomenological research to represent or interpret meaning (van Manen, 2016). These literary devices embody meaning that enables access to the essence of experience.

As the participants' teacher, the researcher knew that the participants understood some literary devices well. Therefore, during the interviews, participants were asked to give an example of a simile or metaphor to help the researcher understand the experience. While some of the responses were cliched or overly simplistic, others provided more sophisticated responses that acted as rich examples of the participants' experiences.

Data analysis

Data analysis in hermeneutic phenomenology aims to reveal the meaning of a lived experience through the researcher's interpretation of participants' descriptions (Adams & van Manen, 2017). As with the data collection methods employed, researchers must choose a series of analysis techniques that best fit the study's aim and the collected data. In this study, there were three stages of data analysis: (1) Cultivation, (2) Thematization, and (3) Development.

Cultivation

First, the data needed to be prepared for phenomenological analysis. The researcher transcribed each of the interview audio recordings, and an initial reflexive commentary was created to record the researcher's immediate interpretations. Secondly, each transcript was developed into a crafted story (Crowther et al., 2017). Through crafting stories, participants' narratives were brought into first-person present tense and extraneous detail was removed. This process provided one crafted story for each participant containing their own words and retaining the rich experiential material while removing the interviewer's voice, off-topic content and postreflective noise.

Thematization

Each crafted story was subject to phenomenological thematization to reveal the essential qualities of the experience. The term thematization distinguishes this approach from thematic analysis, which is common in other forms of qualitative research (van Manen, 2016). Rather than producing themes through coding or grouping words with similar meanings, thematization involves creative insight on the researcher's part to uncover meanings within the lived experience.

Thematization was achieved through a process of moving between reflection, holistic, selective, detailed reading, and descriptive writing. In hermeneutic phenomenological research, rich insights into the lived experience are produced at the intersection of the text and the researcher's reflexivity.

To support detailed reading, this study drew on van Manen's lifeworld existentials as lenses through which to describe and interpret the participants' experiences. The lifeworld existentials (spatiality, corporeality, temporality, relationality and materiality) are fundamental aspects of all human experiences and can be used to examine human experiences from different vantage points.

Development

Through a series of writing and reflection, this study produced descriptions of the essential essences of the studied phenomena, illustrating the study's findings. The development of these descriptions was supported through the use of three phenomenological techniques: (1) insight cultivators, (2) philosophical notions, and (3) vocative methods.

van Manen describes insight cultivators as sources that 'stimulate further creative insights and understandings concerning the phenomenon under investigation' (2002, p.126). This means that external material, such as poetry or philosophical writings, can support a researcher in developing alternative insights which may not have occurred to them previously, enhancing the meaning of words used by participants. To develop the researcher's understandings of the phenomena being studied, this study drew on poetry as well as being the first recorded study to use AI-generated imagery as an insight cultivator. To achieve this, the researcher took extracts from the participants' stories and used an online AI image creator to generate an image. This image was then used as an insight cultivator to prompt further interpretive reflection.

Philosophical notions are often utilised by hermeneutic phenomenological studies as a frame of reference to illuminate meaning in interpretations (Finlay, 2013). In this study the researcher drew heavily on Heidegger's concepts of *leaping-ahead* and *leaping-in* when interpreting the roles that peers played in an individual's experience. Philosophical notions are not to be used to limit the researcher's thinking, but as a way to explore interpretations beyond the obvious.

Vocative methods, such as symbolism and anecdotes, were used in this study's writing to allow the findings to 'speak' to the reader. The product of a phenomenological study is writing rich with experiential material that allows the reader to understand the essences of the phenomena without prior knowledge or personal experience of the context (van Manen, 2016).

Rigour and trustworthiness

Rigour refers to how research shows quality in how it is conducted and presented (Dibley et al., 2020). On the other hand, trustworthiness can be described as the 'confidence readers have in the results' (Cypress, 2017, p.254). This study is based on a single school with a homogeneous group of participants, therefore reducing transferability. However, phenomenological studies do not seek to instil trust due to generalisability or repeatability. This study did not attempt to claim that the insights of the research are 'right' or 'truth' in the empirical sense. Instead, the findings and recommendations represent the fusion of horizons between the participants and the researcher's interpretations at a moment in time. Whilst they are not generalisable, their value is in how they contribute to outdoor mathematics learning discussions and provide a glimpse into the previously unseen lived realities of children learning mathematics outdoors. The depth of lived experience captured in a familiar setting offers insights transferable through resonance rather than replication.

The effectiveness of phenomenological research needs to be evaluated on its terms. van Manen (2016) suggests a series of criteria that can be used when considering the rigour and trustworthiness of a hermeneutic phenomenological study. These criteria include evaluating the extent to which a study contains descriptive richness in its data, self-critical questioning in its interpretations and demonstrating a move beyond what is expected.

Throughout this study, there was a determined focus on attending to the prereflective experiences of the participants. The researcher engaged in a series of reflexive activities to foreground their assumptions, and the results of the study demonstrated rich experiential material with implications for pedagogy and practice.

Ethics approval

Ethics approval for this study was obtained by the Health, Education, Medicine and Social Care Faculty Research Ethics Panel at Anglia Ruskin University on 24 September 2019 (project number: 18/19/039). Further ethical approval was granted on 12 November 2020 to resume face-to-face research during COVID-19. The headteacher gave permission to conduct research with children at Kendall Church of England Primary School and fully informed consent was obtained by all participants and their parents or carers. The ethics panel and school also agreed that the school could be named in any future publications.

Grasping meaning

This study produced three key areas of insight into children's experiences of learning mathematics outdoors: connection, enthrallment and serenity. These represent the essence of participants' experiences, each providing insight into the nature of learning mathematics outdoors. Whilst this section of an academic paper refers to a study's findings, this term *findings* is not methodologically congruent. Hermeneutic phenomenological studies do not report facts which have been found. Instead, they present the fusion of participants' descriptions and the researchers' interpretations, illustrating possible experiences. Therefore, the term *poises* (from the Greek word ποίησις meaning to bring something into existence) is used. P*oiesis* is used to denote interpretive creations that evoke rather than report experience.

Each poiesis is accompanied by an online audio recording containing extracts from the study's crafted stories. Volunteer children have voiced these audio recordings with permission from parents or carers and are not the participants' voices to preserve anonymity. The purpose of the audio recordings is to allow each poiesis to be delivered directly to the listener through the participants' words. Through these, the researcher welcomes listeners to make their own interpretations of the children's words and lean on their own experiences to make new meaning in the continuing conversation around the pedagogy of outdoor learning. What emerged from the data were not merely categories or codes, but richly textured descriptions that revealed the heart of children's experiences. These are presented as three interwoven 'poieses' – ways of bringing experience into form and language—which illustrate the participants' lived experiences as expressed through their own words and the researcher's interpretive writing

Poiesis 1: connection (https://youtu.be/ClROEezY9GY)

Throughout their descriptions, all participants illustrated the importance of connections with peers when learning mathematics outdoors. This is particularly important in several opening lines which establish the togetherness of the learners at the beginning of lessons.

> We leave the playground. (Paris)
>
> Everybody is trying to get the worksheets down from the trees. (Alex)
>
> . . . we're working outside! (Casey)
>
> As we go outside . . . (Robin)
>
> We're in the forest for maths . . . (Sydney)

Participants' continuous use of second-person pronouns throughout their descriptions indicates that this is an experience shared with others and not one experienced in

isolation. Even when children work independently, they have the sense that others are around them.

> Because there are people near, if I ever do need help, they can always come and help me. You always need people to help you. You can never work completely alone. (Alex)

While it can be imagined that this would be the case inside the classroom, participants reveal that the outdoor location supports learners in connecting with each other throughout their learning. The space afforded to learners outdoors allows them to move around, seeking out support from others or to move away from distractions that would otherwise impede their learning. How the outdoors provides a platform for support is described in Alex's account of their experience:

> As the questions get harder in the lesson, I feel like a bee when they get sugar and water. They drink the syrup and then they go really fast and crazy. It feels almost like that. When I get a question wrong, I am the bee trying to rest, waiting for somebody to come and help. The person gives me the syrup and then I'm back in action. (Alex)

Alex's energy is drained as they progress through the lesson, and they require the support of others to feed them the power they need. Rather than being carried, Alex's description of being re-filled by someone points to the phenomenological concept of *leaping-ahead*. *Leaping-ahead* is a term used by Heidegger to describe how someone can provide the necessary tools to another so that they may continue with their own success (Glover & Philbin, 2017). Rather than Alex receiving the answers from a peer (which would be considered phenomenologically as *leaping-in*), Alex receives support so they can come up with the answer themselves. This concept is echoed in several other participant accounts. For example, Sydney describes how they receive motivation from others when they get stuck.

Participants also describe how connections are formed with others who have previously used the shared outdoor learning space.

> I start my first question at what looks like one of the oldest trees. It's surrounded by quite a few dens made by last year's Year 6. (Paris)

Paris understands that they are in a shared learning environment, pointing to the phenomenological concept of *historicity*. People are embedded within a world which existed before them. When humans engage with that world, the moment is informed by the individual's past and the previous events of the location. Paris' description of artefacts left by those who have previously learnt in the location demonstrates that learning in a shared outdoor environment spills out of the time constraints of a single lesson and is experienced by those who come after.

The crafted stories in this study demonstrate that returning together at the end of lessons is an important way for them to experience learning mathematics outdoors.

> After we have finished, we join up at the fire circle. I feel happy here. This is my happy place in the forest. It's nice to meet up again after we finish. (Paris)

Those who have worked alone, completed different work, or collaborated within a team reunite as one. This brings the experience full circle from a beginning of togetherness to an ending of unity, solidifying the idea that lived connections with others are at the heart of learning mathematics outdoors.

Poiesis 2: enthrallment (https://youtu.be/X1uSuwcn3eU)

The participants in this study reveal that when learning mathematics outdoors, they are absorbed and engrossed within the environment and this state of enthrallment provides a sense of safety. The wonder that participants experience begins as they physically transition between locations.

> We leave the playground – it's really loud and there's not much space. There aren't as many leaves or trees than in the forest where we're headed. The moving from playground to forest makes me change how I feel. (Paris)

> As the questions get harder in the lesson, I feel like a bee when they get sugar and water. They drink the syrup and then they go really fast and crazy. It feels almost like that. When I get a question wrong, I am the bee trying to rest, waiting for somebody to come and help. The person gives me the syrup and then I'm back in action. (Alex)

For Paris, the forest is the antidote to the 'loud' and 'crowded' playground and profoundly impacts how they feel. Similarly, the beginning of Casey's crafted story directs us to the excitement and anticipation of the move to the outdoors.

> Today's lesson is maths, but with a twist; we're working outside! It's something more exciting – a very immersive experience; more immersive than ever imaginable at school. Going outside is like you're almost in the wilderness already. (Casey)

As previously mentioned, learning outdoors is common for the participants. However, Casey's nod to this lesson as 'with a twist' demonstrates that this is a very different experience compared to mathematics in the classroom. Casey goes on to explain that immersion provides a 'better way of learning,' and this is established as they prepare to go outside. Casey also highlights the creativity they are afforded by learning mathematics outdoors, which is echoed by other participants, such as Robin.

> I like moving around and I like space. It makes it feel like it's not a maths lesson – it's like a fun game, whereas it really is a mathematics lesson. (Robin)

Robin reinforces that learning mathematics outdoors is a different experience than learning in a classroom. The outdoor environment induces a sense of creativity and freedom, holding the learner and allowing them to create an environment suited to their learning needs. The outdoors is not just a location for learning but a factor in how that learning is experienced. This is demonstrated particularly well through how the participants engage with the natural resources outdoors.

> We use sticks and things, like leaves, to help with timesing. You can just count what you need. With all of the stuff surrounding us, we can use that for quite a lot of maths – it can really help. (Paris)
>
> Pretending it has numbers. (Robin)
>
> You have to explore to find the things you want to use. (Sydney)

Throughout their descriptions, participants talk about how the 'equipment' they find helps them to learn and solve problems or questions. The participants engage creatively with natural objects and project meaning onto these objects to serve a specific purpose. By assigning a number to a stick, the stick is no longer a stick but a representation of that number. When used by the participant, any physical aspect of the stick is suspended and replaced by an understanding that it represents a number for calculation. This illustrates the self-directedness possible when learning mathematics outdoors. Rather than being prescribed resources by a teacher in a classroom, participants use natural resources they find and experience a sense of creative autonomy in their learning.

The creativity the participants engage in illustrates children's sense of safety when learning mathematics outdoors and the subsequent freedom this results in. As a result, participants describe the sense of pleasure and happiness this instils, which is linked to the calm and peaceful nature of the outdoors.

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Poiesis 3: serenity (https://youtu.be/b2ijYANmll0)

Throughout all of the participants' accounts, there is a central theme of peace, calm, and freedom. Participants describe moving from 'normal' lessons to a learning environment that removes anxiety and suspends worries about the outside world. This results in children being able to focus on their learning rather than worrying about external influences.

One way in which serenity is achieved is through how the participants describe their experience of time. Alex's account begins with children rushing around. However, the outdoors impacts their understanding of time as it begins to slow down.

> Where I am, in the middle, is calm and I can hear the screams in the background and leaves getting crunched. I can hear the sound of leaves; leaves crunching and the birds singing. I feel the stress fall away from me and I am calm. The world slows down and the breeze in the air makes it feel like I have all the time in the world. The air hits me, and I calm down. (Alex)

In this quiet space, the sounds of nature (leaves, birds) can be heard whilst the screams of children are relegated to the background. The natural sounds slow time for Alex. They are still aware they are moving towards an endpoint, but the new noises allow them time and space to concentrate on their work. The term active can refer to being physically energetic. However, Alex appears unable to engage in learning when it is noisy and busy, but the serenity that the outdoors brings clears the way for Alex to slow down and refocus on their work. Therefore, active learning, in this sense, is active engagement in learning.

Other participants also describe how the peacefulness of the outdoors supports their focus. For example, Robin compares how they can concentrate on their work more outdoors than in the classroom.

> Outside it's nice and quiet – it's quiet out here. When it's quiet, it's easier for me to concentrate. It's like the opposite of the classroom. It's not as warm outside – you're not near everybody. (Robin)

For Robin, the sense of peace has a calming impact on learning mathematics outdoors. Their body is keenly aware of the importance of sound and identifies others (including natural objects) that create those sounds. Quiet does not refer to silence but a state where an individual can focus and concentrate more easily than in a noisy environment. There is a sense that peace belongs to the natural environment and that by visiting it, Robin can acquire comfort and concentrate more fully without disruption.

Sydney's description also demonstrates how the outdoors can provide a calming effect.

> The noise calms me down. I can hear the birds and the wind. The leaves rattle together. I feel happy and calm as I listen to the birds. It relaxes me. In the quiet I can hear a squirrel climbing up a tree. The mathematics gets hard again, and I like the noise because it calms me down a bit. It's like listening to an outside version of a lullaby. It makes you feel a little bit sleepy. (Sydney)

Sydney describes how the environment's sound alleviates an individual's frustration when things get more challenging. Sydney's body senses the environment's calmness through the sounds that can be heard. By instilling a calm attitude, the individual can refocus on the learning and drive their full attention towards this.

The participants indicated how learning mathematics outdoors removes stresses, worries, and concerns from children.

> I get a breath of fresh air. It feels like you're getting a lot of fresh air and it's just really calm. It's a relieving feeling, breathing in slowly and breathing out. Just like yoga and calming down. [. . .]. It's like you don't have much weight on your shoulders – everything's pretty laid back. I sit down and just forget about everything going wrong and just do mathematics. Being outside lifts a weight off my shoulders and the bad thoughts are lost in nature. (Casey)

Analysis shows that concerns are lost in nature—absorbed by the natural environment. The air supports the refreshing nature of the outdoors, allowing the mind to start thinking anew and providing a space for thoughts to be released and weight to be taken off the shoulders of the individual.

The increased affordability of outdoor space also contributes to providing participants with a sense of peace and freedom.

> Sometimes when you have no space, you feel trapped, and you don't feel like you're doing well in your maths. You feel when you're in a tight space and you're working like there's a lot of pressure on you, and you need to get it done. But when there's a lot of space, you can just sit back and feel no pressures on you in the world and just float free in the air of the outside. Floating free. (Casey)

For Casey, the space allows them to feel at ease and, as they put it, 'float free.' Freedom relates to the pressure of the task and the learning. It is not that Casey is no longer attempting to reach the same endpoint, but the sense of freedom within the lived space allows the pressure to be lifted.

Several of the participants discuss the frustration they feel within their mathematics lessons. However, they also describe how being outside helps them to manage this frustration and persist with their learning until they are successful.

> Being outside helps the frustration, and then suddenly, I get it. I'm really surprised; I want to scream. (Sydney)

For Sydney, being outside supports them in having another go and not giving up. This links back to other parts of Sydney's story, which explain how the environment provides them with calm and peace. This serenity resolves their frustration and allows them to continue.

Synthesis of poieses

Taken together, the poieses offer a multi-dimensional view of how outdoor environments shape the emotional, cognitive, and relational aspects of mathematics learning. Combining the points drawn from the poieses, this study asserts that outdoor mathematics is experienced as low-stakes, high-interest learning.

The outer circle of Figure 1 represents the children's connections with the outdoors which is experienced as a creative and engaging learning environment. Children make connections with: (1) natural objects, (2) sounds, (3) peer learners, and (4) the space around them. Natural objects are used creatively by participants to support them to the achieve goals and develop their mathematical understanding. The sounds heard outdoors help immerse participants within the environment, often providing them peace and comfort. Children engage with peers through collaborative relationships while managing their autonomy and self-directness. The increase in space provides learners with opportunities to move more freely, support others, avoid distraction, and add to their sense of freedom and calm.

The inner circle of Figure 1 illustrates the qualities of the experience which result from being outdoors: (1) safety, (2) belonging, (3) peace, and (4) freedom. Children feel safe as the environment's security allows them to make errors, reducing the threat of failure. This is influenced by the peace around them, eliminating stress and external worries. The fear of getting things wrong is disrupted by attending to learning without the burden of external concerns. The outdoors is a learning environment which provides a sense of belonging and unity. They are afforded the freedom to be self-directed in their learning. Rather than being given knowledge, they are given opportunities to learn.

The child is at the centre of Figure 1. As a result of the connections of the outer circle and the subsequent essences of the inner circle, children experience low-stakes, high-interest mathematics learning outdoors. Low-stakes refers not to trivial or low-effort learning, but to experiences free from fear and performance pressure, allowing curiosity to drive engagement. Learning is driven by wanting to do well and having the barriers of fear and anxiety removed. The outdoors and its objects remove the distractions of everydayness and permit the learner to inhabit an internally constructed world suited to their own learning needs. High-interest refers to the active engagement of the participants in their learning, inviting their curiosity and creativity.

Figure 1. Outdoor mathematics experiences.

Fusing horizons

From the above perspectives, this research has arrived at four key insights, each with implications for practice, policy, and pedagogy. The following insights draw together the threads of children's lived experiences with existing pedagogical literature, suggesting ways outdoor mathematics learning might reshape educational thinking and practice.

Insight 1: learning mathematics outdoors supports the development of a growth mindset

In this study, the outdoor environment reduced the stress of learning mathematics and instilled a sense of peace and freedom in children. The peacefulness and calm of the outdoors are provided through what is seen, felt, and heard. For example, the view of the sky above instils a sense of freedom from the children's external pressures and concerns. This is supported by the increased availability of space seen and felt by the learners.

In addition, the sounds of the outdoor world are important in the participants' experiences. Although the research did not ask directly about what the participants could hear in their lessons, each referred to the soundscape of the outdoors when describing their experience. Previous research has suggested that environmental noise during lessons can negatively impact attainment (Shield & Dockrell, 2008), but this study found that outdoor noises reduced anxiety and proved beneficial for learning.

This study further claims that outdoor learning needs to be explored to counter mathematics anxiety. None of the participants in this study demonstrated any anxiety

during their outdoor experiences, but they often compared the calming effect of the outdoors to the pressures of the classroom.

Participants described overcoming barriers and mistakes in lessons, demonstrating the ability to adopt a growth mindset outdoors. A growth mindset, a term coined by Dweck (2006), refers to a learner who sees opportunities for growth and success in failures. By adopting a growth mindset, learners understand that mistakes are a necessary part of learning and do not stop or give up in the face of adversity. This study finds that the outdoors is experienced as a safe learning environment that allows children the freedom to be wrong and learn from their mistakes. The outdoors reduces the threat of failure and supports learners in persisting.

Insight 2: the outdoors provides an environment for creative mathematics learning

This research reveals that the outdoors is a space where children can engage creatively in their mathematics learning and work in a self-directed manner with greater autonomy and ownership of their learning. As children transition from the classroom's externally constructed adult-centric classroom environment to outdoor spaces, they create their own child-centric, internally built world by suspending everydayness. This is seen through children engaging playfully and imaginatively by using natural resources to support their learning. Whilst the children do not lose touch with reality, the environment holds their learning, so they can temporarily shift to a different mental space. This insight demonstrates how mathematics can be engaged through creativity and play, commonly absent in learners' experiences according to much research literature.

An understanding that children can suspend reality when learning outdoors is a finding shared with research by Adams and Beauchamp (2018). They found that when children participated in outdoor music lessons, many participants 'believed that they entered a "different world" during their music-making' (p.60). This finding concurs with this study as it suggests that imaginative engagement in learning in the outdoors is not restricted to music but is also possible in mathematics, which is not commonly associated with creativity.

Using manipulatives (physical apparatus to help the understanding of abstract mathematical concepts) in the primary classroom is a familiar idea. Concrete-Pictorial-Abstract (CPA) (also referred to in the literature as CRA, Concrete-Representational-Abstract or CVA, Concrete-Visual-Abstract) practice is common in primary classrooms. Learners are often directed to use a specific manipulative or guided to solve particular problems. Alternatively, classrooms may be carefully arranged so children can use the equipment as needed. However, in both situations, the resource has been put there by an adult with a specific usage in mind. This study illustrates that children can select natural outdoor resources to support their learning. They do this creatively rather than

by following a procedure set by an adult. Outdoors, the children can use whatever they find and whatever they find most useful in the way it works for them. They move from an externally constructed world where an adult places everything, into an internally created world where objects have meanings for the individual. Through these internally constructed meanings, children creatively make sense of the mathematical concepts with which they are engaged.

This study suggests that taking children outdoors for their mathematics lessons will help them feel more comfortable answering questions and be creative in their learning. This will give them greater autonomy over their strategies to solve problems and achieve success.

Insight 3: inclusivity is fostered outdoors

Compared to the traditional classroom, the increase of space outdoors provides children with greater opportunities to collaborate as they can more freely move around and interact with others. However, the increase in space also allows children to spread apart and work alone whilst constantly being aware that others are readily available to establish cooperative relationships. Co-operation in this context refers to the individual's choice to work with a peer (or within a team) to accomplish a task. Participants describe how they support each other whilst learning mathematics outdoors, an essential part of the experience for many.

During outdoor mathematics lessons, children connect with their peers and experience the space as a shared environment. This supports the children's experience of inclusivity where, although not all are equal, all are included. Children in this research clearly understood their position within lessons (usually related to their mathematical ability). Despite knowing they are academically stronger or weaker than others in the lesson, this study reveals that learning outdoors instils a stronger sense of unity within the children.

Inclusivity is demonstrated through how participants describe the unity they feel when learning mathematics outdoors. This is linked closely to the experience of connection to others and aligns with the findings of research by Fägerstam and Grothérus (2018), who found that outdoor learning was experienced as a community of learners. Inclusivity or inclusion is used here to mean 'all in it together' and is shown through the participants' sense of belonging to a larger whole. The participants describe working alongside their peers in a shared experience where nobody is excluded or left out. However, inclusivity does not directly relate to equality. Instead, this research demonstrates that the children have an evident sense of their academic standing within a lesson. Whilst the participants reveal their understanding of their academic place within lessons, this grouping is experienced neither as negative nor positive. The participants demonstrated a neutral attitude towards this because the experience of identifying as a greater whole

was more important to them. Rather than a concern for their academic ranking, the participants spoke of the significance of belonging to the class. The sense of belonging is reinforced when participants describe the importance of coming together at the end of a lesson.

Insight 4: learning mathematics outdoors promotes co-operative learning

This research has found that, when learning mathematics outdoors, learning shifts from what the teacher provides to how peers can support each other in achieving their goals. Participants' descriptions of their outdoor mathematics lessons show that the role of the teacher is not given great significance, demonstrated through the lack of reference to the teacher in the participants' stories.

In this research, outdoor learning as a pedagogy for mathematics allows learners to learn through their collaboration with others. Rather than providing education as a transactional arrangement between teacher and student, the outdoors offers a space where learning can occur through interaction, discussion and exploration. Current pedagogies for teaching mathematics situate the teacher as the provider of knowledge where they can control the learning. Alternatively, this research finds that outdoor learning pedagogy can provide teachers with opportunities for learners to learn.

The role of peers is central to the participants' experience of outdoor mathematics learning, demonstrating that outdoor learning provides a pedagogy that promotes collaboration between learners and supports the development of teamwork and communication skills. Participants did not simply give each other answers to questions but were able to provide support and coaching so that learners could arrive at the answers themselves.

Implications

This study offers several key implications for mathematics pedagogy, educational policy, and the broader discourse on outdoor learning.

(1) **Rethinking the Role of the Teacher –** While the participants' narratives in this study foreground peer collaboration, autonomy, and connection to the environment, the relative absence of the teacher in children's accounts is itself revealing. Rather than signifying disengagement or irrelevance, this absence points to a pedagogical shift that outdoor learning enables-one in which the teacher's presence is distributed, relational, and responsive, rather than directive. Outdoors, the teacher becomes a facilitator of conditions rather than a transmitter of content. By intentionally stepping back, teachers allow children to engage with mathematical ideas through exploration, dialogue, and discovery. This repositioning allows meaning to emerge through shared engagement rather than predetermined instruction. For teachers, this presents both a challenge and an opportunity. It requires confidence to release control, trust in learners' agency, and

sensitivity to the relational and material dynamics of the outdoor environment. These implications are particularly relevant for teacher education, where reflective engagement with outdoor pedagogy can transform professional identity and confidence Teacher development programmes might:

(a)Incorporate opportunities for teachers to experience outdoor learning, reflecting on how space, sound, and movement shape pedagogical relationships.

(b)Encourage teachers to reflect on their own practice, examining how their presence—or strategic absence—affects learners' sense of autonomy, belonging and confidence.

(c)Provide structured opportunities for teachers to design and trial outdoor mathematics activities, focusing on facilitating curiosity, resilience, and creative problem-solving rather than delivering content.

(2) **Addressing Mathematics Anxiety Through Environment** – Participants consistently described the outdoor learning environment as calming and freeing. Given that classroom-based mathematics is frequently associated with stress, fear, and disengagement, this study suggests that outdoor learning offers an effective pedagogical alternative. By reducing anxiety and promoting emotional well- being, the outdoors becomes a space where learners are more open to challenge and persistence.

(3) **Promoting Active, Experiential Learning** – The natural environment was experienced not as a passive backdrop but as a dynamic learning space filled with opportunities. Children described engaging actively with their surroundings, using found objects creatively and collaborating spontaneously. This reinforces the value of outdoor spaces in supporting experiential and embodied forms of learning that are often underutilized in traditional classrooms.

(4) **Recognizing Children's Sensitivity to Place** – Children demonstrated a nuanced awareness of their learning environments, suggesting that the physical context of learning significantly shapes their engagement. Participants articulated how sights, sounds, and spatial arrangements influenced their focus, mood, and mathematical thinking. This calls for a more intentional integration of physical and sensory environments into educational design and policy.

(5) **Broader Applications Beyond Mathematics –** While this study focuses specifically on mathematics education, its findings have broader relevance. The insights into safety, inclusion, creativity, and co-operative learning suggest that outdoor pedagogies could enhance learning across other areas of the curriculum. Future research may extend these findings to explore how outdoor learning shapes experiences in literacy, science,

and the arts. This could illuminate whether the qualities of safety, freedom, and engagement described here are unique to outdoor contexts or transferable to other pedagogical environments.

Conclusion

This study reveals the transformative potential of outdoor environments as spaces for meaningful, engaging, and emotionally resonant mathematics learning. By stepping outside the classroom children reframe mathematics as a subject of exploration, connection, and personal meaning. Through rich, first-person accounts, the children in this research have shown us that mathematics need not be confined to rigid classrooms or dominated by anxiety and performance pressure. Instead, they offer a compelling reimagining of what mathematics learning can feel like—creative, collaborative, peaceful, and free.

Far from being a novelty or educational extra, outdoor mathematics learning emerges as a pedagogy capable of dismantling fear, inviting curiosity, and fostering deeper connections between learners, concepts, and place. The children's lived experiences illuminate how natural settings support growth mindsets, emotional safety, and authentic engagement with mathematical thinking. Their words urge us to rethink the conditions under which learning occurs—and to recognise that space, sound, movement, and autonomy are not peripheral to learning but central to it. Outdoor learning does not just call us to consider where learning happens—it draws us to reimagine what learning is.

The teacher's task becomes one of creating the conditions for low-stakes, high-interest learning—spaces where curiosity replaces fear, and where children can dwell in the experience of mathematics rather than perform it. In this way, the teacher's role is not diminished but transformed: from directing learning to *hosting* it, from managing outcomes to *nurturing possibilities*. Ultimately, this study is a call to educators and policy makers alike: to listen to what children are telling us, to value their ways of experiencing the world, and to create more opportunities for them to learn in spaces that reflect their needs. The forest became their classroom—not simply as a backdrop, but as an active participant in the learning process. In doing so, it became a space where mathematics was not just learned but lived.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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