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Review article

How many ways are there to measure a tree? – An experiment in cross-disciplinarity

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Peer review

This article has been peer-reviewed through the journal's standard double-anonymous peer-review process, where both the reviewers and authors are anonymised during review.

Abstract

This article takes a transdisciplinary approach to a relatively simple-sounding task – tree measuring. It asks the question, 'How many ways are there to measure a tree?', in order to provoke a discussion of our different ways of knowing. It attempts to engage a reader in thinking about disciplines and what they do. It does so by sharing insights from a project in which diverse scholars, practitioners and children came together for the common purpose of producing engaged knowledge. The experience of reading the article should prompt questions about whose knowledge counts and why, and the value of university research that is engaged and grounded. We conclude with a question of what kinds of measurements matter and why. The article takes the reader through different disciplinary perspectives, from science to social science to poetry, and, in that process, engages with the 'how' of disciplines in terms of real-world problems.

Keywords trees; science; social science; engaged research; climate change; co-production; children and young people; art practice; geography; philosophy; science

Key messages

- University disciplines distinguish empirical, sensory and affective ways of measuring a tree without recognising how bringing them together might produce a more complex account of a tree from different perspectives.
- A cross-disciplinary practice of allowing different forms of knowledge, insight and understanding to grow in dialogue with each other, can contribute to this richer notion of measurement.
- This could then enhance an understanding of the value of trees, providing a reconceptualisation of the concept of 'ecosystem services'.

Introduction

> Measure twice, cut once. (Traditional advice from carpentry and needlework)

This article asks fundamental questions about whose knowledge counts and why. It tries to co-create, through diverse voices from a multidisciplinary team, the tangible as well as intangible experience of measuring a tree. By intangible, we mean recognising the aspects of a tree that resist conventional forms of measurement. We reflect on our experiences of working in a transdisciplinary project: a collaboration between scientists, philosophers, social scientists, literary scholars, artists, anthropologists, educators and childhood studies researchers. We are concerned with the importance of urban trees in multiple ways and from different perspectives. This ranges from speculations on forest literacies to the potential of below-ground urban tree roots to store carbon. We are exploring how children relate to trees, and how that understanding can inform adult scientific and wider cultural understandings of trees.

As part of our project, we have focused on tree measuring on a fundamental level to estimate the size, volume and density of specific trees in order to find out how much carbon they have sequestered from the atmosphere and stored. Nothing is straightforward if you work across disciplines, and we quickly learned not to take anything for granted. For example, each member of our team had a different perspective on what a measurement was and why having accurate measurements was (or was not) important. We decided that our work together was not concerned with finding a common ground or shared understanding, and the most interesting ideas emerged when we worked through our differences, what we paid attention to, where we invested our time, and when we hid within the groove of our respective disciplines.

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To try to capture a flavour of this process, each member of our research team responded to the provocation 'How many ways are there to measure a tree?' in around five hundred words. The response could be technical, a personal reflection on our activities together or a piece of creative writing. This resulted in a series of vignettes of tree measuring and what it means. Some are written by scientists, some by social scientists and some by artists, and sometimes in collaboration. Some are written as field notes, others as explanations. Our mode of responding differed; we also differed in what and how we measured things.

The team wrote their contributions independently, without seeing what others had produced. From the fragments of writing, we developed three propositions. Finally, the team invited the philosopher-in-residence, Johan Siebers, to provide a short commentary on the article. The whole article is an experiment in a team learning to write together and make sense together. Kate Pahl, lead author, and Steve Pool, artist, who have a long-standing writing partnership, discussed the contributions, and wrote comments after each piece. At the end of the article, we sum up what this work contributes to the field of collaborative research and citizen science.

Proposition 1

Measuring trees is a way to explore how we value them within disciplines.

This requires paying attention to conversation and dialogue, rather than favouring fixed disciplinary methods.

Proposition 2

For citizen science to engage with more people, it has to consider their histories, interests and concerns.

There are many ways to get the measure of a tree.

Proposition 3

There is no agreement on how to measure the whole of a tree.

We all learnt from each other through our differences.

We draw on Facer and Enright's (2016) idea of 'living knowledge' to build a growing and expanding understanding of our ideas and concepts.

Background to the project

The Voices of the Future project was funded through the cross-council Future of UK Treescapes programme of UK Research and Innovation (UKRI) (NE/V021370/1). One of six large grants, this project aimed to develop a relational understanding of how children and young people related to trees, and how their knowledge of trees and treescapes could be translated into a new language of description for how children and young people experience treescapes. In the programme, a treescape is a landscape where trees and/or woods and forests play a significant role.

Our funders asked specifically for an interdisciplinary approach to understanding the benefits and possibly dis-benefits of treescapes. We therefore collected a large team together from nine universities involving many disciplines, including ecology, education, childhood studies, anthropology, linguistics, English, arts practice, philosophy, youth studies, geography and landscape architecture. We worked in partnership with schools and organisations across Greater Manchester, Aberdeen and beyond in partnership with tree-planting organisations Manchester City of Trees and The Mersey Forest.

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Our project was informed by the premise that children and young people, being the ones to inherit a rapidly changing planet, have a lot to teach us about what trees mean. We recognised the imbalances of power between children and adults. Many of us are committed to creating new methodological structures that enable children to fully engage in doing research. This stance informed our fieldwork. Our methods ranged from tree measuring using terrestrial laser-scanning and below-ground imaging of roots to quantify carbon storage, to using tape measures to infer key tree allometric properties, through to using our bodies to measure the trees, hugging a tree and climbing a tree, poetry and photography.

The Principal Investigator, Kate Pahl, was intrigued by how her team conceptualised measuring, and how these conceptions both engaged and alienated the young people with whom we were working. Measurement is treated as a necessity for understanding, a part of scientific method, a way to hold business to account, and a way to mitigate the effects of climate change. The idea of measurement seems initially straightforward in relation to quantifying the size of something; yet, for most participants, the process of measuring became more speculative. The results of this request were very different. In these examples, the tension between the process of measuring and the process of experiencing a tree comes to the fore.

Below, we provide our accounts of the tree measuring as they emerged from the space of the project. At the end of each piece, we include a short commentary on the process, with a few final thoughts at the end of the article.

Where does a tree start?

Jennifer Rowntree and Khawla Badwan
An applied linguist and a plant ecologist

Where does a tree start? Where does it end? How to determine the main stem? What to do with leaning trees? How accurate should tree measuring be? We grappled with these questions and many more as we designed tree-measuring activities with children in a primary school setting.

There are at least two sides to the argument we would like to present here. On the one hand, it is commonly argued that one of the challenges of undertaking scientific activities, such as tree measurement, where data are collected with individuals without a formal scientific training, of any age, is the quality of the data (Aceves-Bueno et al., 2017). The term 'scientific' implies some agreed principles of objectivity and rigour, and the scientific methodology has been developed to try to reduce bias in individual measurements. However, there are inherent challenges in this, and it is widely recognised that experiments undertaken in one setting may not be replicable in another (National Academies of Sciences, Engineering and Medicine, 2019). Hence, the drive within science towards developing consistent methodology and the collation and systematic review of results from similar bodies of work, such as the Cochrane Reviews (www.cochranelibrary.com).

The other side of the argument calls for creating room for new ways that speak to children's experiences of what measuring might mean while trying to adhere to simple protocols agreed by foresters and ecologists that could be easily repeated to measure tree growth. The new room is a space for improvisation, and it does not aim to produce reliable or accurate scientific data. Rather, it aims to nurture new connections and imaginings that encourage children to think that measuring trees matters and can tell us something important about the world. In the following two examples, we demonstrate how we navigated our position with these two arguments in mind.

In the first, we followed a standard protocol using tape measures to determine diameter at breast height (DBH), and clinometers to measure the height of mature trees in a park. Year 3 children took three of each measurement for all trees, and they uploaded the average values to the tree measuring app Treezilla (www.treezilla.org). This provided a permanent and accessible record of the children's work, and it contributed to a wider database of UK trees. While engaging the children in this activity, we noticed how

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they developed new ways for measuring the tree diameter. Some children hugged trees and used arm's length as an indicator. With larger trees, three or four children formed a hugging circle around the tree and talked about how many arm's lengths covered the diameter. While we did not record these improvised ways as data, we were able to witness the development of a new lexicon around tree measuring. What this lexicon might mean remains up for debate in the scientific community, we argue.

In the second activity, the children measured the height of the trees they had planted the previous year with tape measures. Again, we took three measurements, so that we could estimate the average. We wanted the children's data to be valuable to organisations that had facilitated the tree planting, and to provide a method that the school could use for longer-term monitoring, perhaps with different students. While many children followed the instructions, some children held the tapes loosely, did not follow the main tree stem, stopped at the last leaf, tried to straighten a leaning tree, and the list goes on.

Measuring a tree is hard work. While we tried to ensure that the measurement data are useable and reliable, we also attended to the mattering of the event. Trees matter. Their growth matters. Children's ability to monitor trees' growth matters. All of this matters as much as (if not more than) the accuracy of tree-measurement data matters.

Comment: Two disciplines came together with Year 3 students in the event of tree measuring. They explore citizen science with the Treezilla app, and they think about what it can measure and what it cannot measure. The discussion is concerned with accuracy, what matters and what needs attention. Measuring becomes a means to a conversation where learning can take place.

A scientist wonders about trees

Emily Lines
A forest ecologist

Before deciding *how* to measure a tree, the first question a scientist would ask would be *why* they want to measure a tree. In the documented modern scientific literature, the first measurements of trees come from silviculture, where measurements were taken over many years to determine how much timber would be harvested from a stand of trees. The standard measurement, the diameter of a trunk at breast height (DBH, standardised to 1.3 m) has been used for well over a hundred years, and it is still the base unit of measurement to understand tree structure. It is very easy for even the non-specialist to measure, and nowadays we use DBH to estimate all sorts of properties of a tree. In the last few years, a huge amount of research has gone into generating good estimates of the amount of carbon within a tree in order to estimate its value for tackling climate change. And while DBH is also used for this purpose, scaling from a single one-dimensional measurement to a whole-tree property such as biomass or carbon content requires many assumptions about the shape of the tree, and so introduces significant error. In this project, modern remote sensing methods have been used to directly measure the entire structure of a tree, creating not only full 3D reconstructions of a tree, but also direct measurements of the volume the tree fills, so producing much better estimates of the carbon content of the wood. But carbon is just one property of a tree that a scientist, and society, values. The carbon within a tree is a measure of its *state*, but we could also measure its *processes*, which are important aspects of how trees contribute to climate change mitigation. For example, we could use a tree corer to measure tree rings, and therefore tree growth – how fast it converts CO_2 to timber – or a gas analyser to measure gas fluxes of leaves – the rate at which they draw CO_2 out of the atmosphere through photosynthesis and return it through respiration.

Comment: This piece tells us of the conventions of tree measurement – the first measurements were taken at breast height, which was then standardised or averaged to 1.3 metres. The original DBH method

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measurement, which is still in use, sets the tree against the body. In science, for a measurement to be useful, there is a need for standardisation and repeatability. Human differences are extracted to give a consistency that can be applied universally. The distinction between the *state* and *processes* of a tree introduces the dimension of time.

A ruler has limitations

Steve Pool
An artist

Measuring the height of trees with Year 3/4 students (age 7/8) was a challenge. Estimates were not incremental. The guess would be anything between 10 and 100 metres. I told the students that I was nearly 2 metres tall and asked them to imagine how many times I would have to stand on my shoulders to be the same height as the tree. I became a nonstandard unit of measurement that helped us guesstimate 14 Steves to the oak, 10 for the ash. The nature of measurement is about having something to measure something else against. The standard tape measure or ruler works well at a certain scale. It's harder to use when you are trying to estimate the height of a large oak tree. We have many images of children offering themselves up to trees to make a measure. These measurements are usually about scale and size, but more critically they are about relation. This is not something I have observed, theorised or invented, it is something the children have taught me. For children to measure something they need to find a scale of relation to set one thing against another. I remember when I was small, it was hard to develop abstract thoughts, touch, taste and feelings that shape a shifting world. I knew my reach by what I could touch, not in millimetres. We can learn a lot about measurement when we understand that a ruler has limitations.

Poem

Let me count the ways I measure you.
My arm against your branch
My head against your trunk
The rising of your sap against my blood pressure.

Let me put a price next to your carbon
What you will lock away until you burn
Let me imagine you as logs, tables, chairs
As rolls of toilet paper, zines
And disposable forks
To eat canapés

Let me count the routes to climb you
Assess the risk you pose to
Buildings, footpaths, drains and public order
Let me scan your roots and find a number
That accounts for what we cannot see
Your unknowns that stretch
Beyond your canopies

To be measured is not to be known
To be measured is to be accounted for.

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Comment. Steve is annoyed about over-objectifying things. He riffs off Elizabeth Barrett Browning's 'Sonnet 43' to bring love into the equation. He is saying that there is a problem in measuring something, as it links it to capital. His poem of love is difficult to measure.

Measuring a tree

Simon Carr and Ian Davenport
A geographer and an environmental scientist

Measuring a tree could be many different things. Even asking the question 'How big is a tree?' is challenging to answer, as 'big' could mean the total mass of the tree in kilograms, but this might be partitioned into the above- or below-ground biomass (the total carbon store), or the mass of the trunk (the bit of most interest to production forestry). However, the size of the tree may be a reflection of the height of the tree, the shape and spread of the canopy, or the overall volume of the tree. However, as our stated aim is to quantify carbon in our trees, we focus here on measuring tree mass.

Within Voices of the Future, we have evaluated standard tree mensuration methods (for example, Jenkins et al., 2018) to see whether they are applicable to trees in urban settings. The reason for doing this is that within the forestry industry, most of the 'measurement' of a tree is based on application of a simple measure, diameter at breast height (DBH, typically at 1.3m above ground level), from which standard allometric relationships derived from the forestry industry are used to infer the mass of a tree of known species.

This still misses the assessment of the below-ground biomass and carbon. At present, we have deployed terrestrial laser scanning (TLS) (above ground), plus ground-penetrating radar (GPR) and 3D X-Ray CT (below ground) to generate volumetric models of urban trees. Such imaging techniques are labour-intensive, and we have only been able to derive very limited data on the below-ground tree, but these are the first non-destructive examples of estimating whole-tree biomass and carbon for any trees worldwide.

What we have found is that DBH-based allometric masses offer poor comparison with our volumetric mapping using TLS, GPR and 3D X-Ray CT. Our urban trees are very different in shape and form from the 'standards', and we are still working out what this means in term of carbon storage.

Of course, measuring a tree is about more than mass of wood or carbon. A big part of the work we have been doing with children and young people across the project is about considering those aspects of trees and treescapes that they value. Within urban planning, ecosystem service or natural capital evaluation are terms that are thrown around with abandon by developers, planners and policymakers (Thompson et al., 2019), often missing more abstract, harder to define ways of valuing a particular green space.

Consequently, an emerging theme of our work measuring trees is about developing a child-focused typology of trees, seeking to identify what children value about particular treescapes: whether it is a tree that welcomes climbing and exploration, an aged, hollowed-out tree that offers a sanctuary or hiding place, or the discomfort at seeing a tree that is being choked to death by ivy and other parasitic creepers. Science may demand observations and estimations based on objective, quantifiable measures, such as DBH, tree height or mass, but these reductionist approaches fail to capture other ways of measuring a tree or treescape that offer insight into different ways of valuing that tree. The tree may not care about how we measure or value it, but these more nuanced, emotive measures perhaps offer the best potential to enhance the valuing of our treescapes in the coming decades.

Comment: Simon and Ian work across two states and registers as they say, 'Science demands observations and estimations based on objective, quantifiable measures.' There is no middle ground from a disciplinary perspective: this is a fact. Without consistency and repeatability, science cannot do its work.

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Tree height and sensing place, by geometry

Elizabeth Curtis, Ed Schofield and Jo Vergunst
An anthropologist, a geographer and an educationalist

Learning to measure the height of a tree brought together a series of relationships among us, the children, the trees and the landscapes we sited ourselves in. Ed Schofield had been aware of this particular technique for a long time, but we checked it using instructions on the Woodland Trust website. In this project, we tried it first with primary school children aged 10–11 during a visit to the conifer forests of Bennachie in rural Aberdeenshire. Elizabeth Curtis and Jo Vergunst used it later in a wooded area in suburban Aberdeen with another primary school. The method is as follows:

- Divide the children into groups of three or four.
- Fold a piece of A4 paper into a square and then fold (or cut) along the diagonal to create a large right-angled triangle.
- One child sights the triangle so that the hypotenuse (longest side) lines up at 45 degrees from their eye to the top of the selected tree. This entails walking back from the tree until the correct point is reached.
- Other children use a tape measure to measure the distance from the tree to the child. They then measure the height of the child from the ground to their eye line, and add this measurement to the distance, giving the height of the tree.

We found that it was possible, with some patience, to explain to the children the geometry that underlies this process. Perhaps of more significance, however, are the ways that the participants, the tree and landscape relate to each other. Children found their own trees to measure based on aesthetics – did they like it? – and affordances, such as whether they thought it would be easy to measure, whether it could be climbed, or had a big canopy. Watching the children, we saw how measuring involves the whole body, stepping backwards from the tree, with others pulling tape measures along the ground.

Once selected, the tree provides the grounding and cardinal point for the landscape. Rather than asking 'Where are the trees?' from an objective geographical perspective, the exercise raised different questions: Where are we in relation to this tree? How should we position ourselves in relation to it? Children had to arrange themselves according to the dimensions of their tree and work as a team to collect the necessary data. Thinking philosophically, this is Maurice Merleau-Ponty's (1962: 115) 'spatiality of one's own body', of bodies that are situated in the face of their tasks. Participants have to follow the tree's dimensions and be subject to its qualities, orienting themselves to it as best they can. They learned about their own capacities – their own spatiality – for sensing the place and working together. In other words, measuring a tree involves taking the measure of ourselves as well.

Comment: Our bodies come into the equation, and we have a reoccurring theme: the 1.3 metres of the waist of the average forester, the movement of a child as they orient themselves to measure their favourite tree; the 14 Steves stood on his multiple shoulders. Setting ourselves against the tree: how many flights, tea bags or boilings of the kettle as carbon-generating activities? Perhaps this is the middle ground emerging from our bodies, our movements and our geographies. The basic measurement unit is not our footprints, it is our bodies.

How to measure a tree with the youngest children

Abigail Hackett
An early childhood educationalist

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As well as working in schools, our project worked with families who had children aged under 3 years, in collaboration with two local authority-run playgroups. While committed to the view that very young children also have something to teach us about trees, we knew that this lesson would likely arrive in a different mode, which might not involve language. From both this project and from our previous work with young children, we had learnt that 2- and 3-year-old children often show, rather than tell in words, what is meaningful to them (Hackett, 2014).

This may seem inconvenient, or potentially a reason to exclude such young children from the category of 'those with something to teach us about trees'. But being open and willing to learn new knowledge in whatever form it is offered (even when it falls outside of the adult/academic mode of words) is important for genuinely encountering ways of knowing that are radical or unsettling, or a departure from what we have already assumed. From this perspective, we organised a number of loosely structured walks, treasure hunts, art activities and play sessions for young children and their families in parks and green spaces, open to what the children would choose to show us in whatever mode they preferred.

Young children shared lessons with us about what trees meant to them via movement, gesture, gaze and play. One thing we wondered during these encounters was what it would mean to consider the children as measuring the trees with their moving bodies. The snippets from our fieldnotes below begin to paint a picture of some of the moments that helped us to think about tree measuring as full bodied, in the moment, a relational entanglement:

> A bigger boy grabs a stick and flings it violently into the undergrowth. A small boy tries to lift a too big log, which is partly submerged in fallen leaves – he experimentally yet unsuccessfully pulls it by one branch upwards.
>
> M. sees the others playing hide and seek and wants to play too – so we run together. We run to a tree and hide behind it. I hug the tree, is it so wide? We look at its width together and stare up into the branches and admire the bark. We pat it. We run to another and another. It starts to rain, but it is dry under the tree. M. balances on the tree root, and steps carefully from one to another, moving around the tree.
>
> L. and his grandma walk to some nearby sycamore trees; she holds him high in her arms under the branches, and he stares up at the movement, lifts his arms towards them.

Comment: Very young children may have the most to teach us, yet to learn we have to listen differently. Perhaps very young children measure the world all the time through encounter. Perhaps this should be our touchstone, our first step.

Measuring a tree activity

Samyia Ambreen
An educationalist

Fieldnotes: In small groups, children accompanied by an adult, were asked to measure a tree's diameter. At the beginning, our colleague (Simon) explained how to measure the diameter of a tree with a special kind of measuring tape. The tape given to the children became an exploring material during the activity. Children liked to touch the big measuring tapes and started reading scales/measurements written on these. Children started measuring the tree diameter by measuring their height against the tree bark and measuring the circumference of the same tree, and also by noting these measurements on the sheet given to each group at the beginning of the tree-measuring activity.

Children taking turns, each child having a go with measurements and with writing on the sheet. Children reading out loud all the measurements from the sheet and talking about the differences. Each time, children measuring diameter of the same tree and coming up with a difference of 0.5 and 1 or 2

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cm in calculations. Children also keen to note and record what else is happening as part of the group activity. Some of them started audio recording their talks and random voices, including their loud laughs, shouting and screaming.

The groups were reunited by Simon, who introduced children to the laser scanner, another tool to measure tree diameter to find out carbon that a tree has absorbed from the atmosphere. Children were very excited, trying to measure diameter through the scanner, pointing it to the top and at the bottom of the trees.

Amid the activity, there was more than using tapes and scanners to measure a tree diameter. A pair of children hugged the tree by stretching their arms around the tree bark. On finding their arms too small to cover the full circle of the tree bark, children inviting another child to join the tree hug. Children calling this measurement 'two children and a tree, no, no … three children and a tree' (27 April 2023). Two girls putting their palms on the tree bark, guessing how tall the tree is.

Children's eyes also moving from the measuring tree height to finding holes and different patterns on the tree bark, finding all alive and dead bugs, finding bugs (i.e. ants and tree lice) living as a family, living in colonies, and spider webs in the tree bark. This also includes touching the bark and finding it smooth, sometimes hard, rocky and bumpy.

The activity of tree measuring appears as a mixed example of adult- and child-led encounters with trees. However, the tree encounters with different groups of children during the measuring activity embodied much more than only measuring. The encounters offered a move away from human voice by developing care/attention to all other available voices. This involves centring around more-than-human voices such as trees, ants and tree lice etc. Human as well as non-human being active players, producing a non-coherent depiction (Günther-Hanssen, 2020) of what could it mean by 'measuring a tree'. Children, along with other human and more-than-human teammates/counterparts practising the scientific concepts of tree diameter and carbon emissions as creative, emergent and embodied explorations (Rautio et al., 2022).

Comment: Here the fieldnotes open the attention – watching children's eyes finding bugs and bark and lice becomes a practice of observation that creates a new sense of a tree, as a living being, hosting other living beings, with a smooth and striated surface with lots of bumps.

Ways to measure a tree: on (not) caring and (not) getting the measure of things

Peter Kraftl
A children's geographer

Notes from observations: As we undertook our various tree-measuring activities, I found myself becoming very protective of the trees we had planted. I couldn't quite work out what the children's different relationships were with the newly planted trees – and especially those that their class had not planted. In any case, despite my best instincts, I found myself rather forcefully and directly telling children to avoid the saplings, to the extent that I tried to show them the best path through the trees as we neared the edge of the school playing field where we were doing our activities.

About 45 minutes later, when our group was still doing an activity, the Year 6s were having their break on the small tarmac playground next to the area where we had planted a new hedge with one of the classes in March. They were playing football. I became fascinated with, and distracted by, their game. I was drawn to the ways in which the ball and the children interacted with the newly planted hedgerow that bordered their game. In a very different way – quite distant from the tree-measuring activities – this brought me back to wondering about the extent to which children 'cared' about the new trees. These children had not planted the hedgerow, nor really been part of our activities. Did this mean they cared

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less? They were also engrossed with their game – the ball frequently hit the new saplings, and on at least two occasions children trod on them when retrieving the ball. Perhaps they didn't care for those trees in and of that moment, even if they would in other contexts?

Reflections and (initial) analysis: This prompted reflections about *care*, and the different ways in which this might (or might not) be expressed. How many of the children really cared about their trees? Did they care less if they accidentally trod on one, or rolled over one as they were messing about on the ground, pretending to do CPR on each other? Perhaps some of the children did not care hugely about the trees – taken up with their games, or with the technologies we were using to measure them. Indeed, does one need to care about something to measure it, and to measure it well? For, as Ravaisson (2008) argues, habituated expressions and practices that require skill (such as measuring) require a kind of distancing, of emotional detachment. In other words, we can care *for* trees even if we live with, act with or interact with trees in highly variegated ways, and in ways that could potentially damage them (not that any trees were damaged during the day). Or, perhaps, some of the children *just didn't care about trees, or about measuring them* – and that is something that we must also recognise as important when working with groups of children to measure trees.

Comment: Peter suggests that we may only be able to measure the things we are interested in. He expands the idea of what it is to get the measure of something. The children are playful; they play along with an adult-oriented agenda, and the good children are good at playing along. We all go along with the slight feeling of chaos. Is this part of the intangible measurements of a tree?

Measuring as metaphor

David Cooper
A literary critic

I (David) was supposed to be working with the tree scientists – we were supposed to be *properly* measuring trees with equipment I'd only recently learnt about and technical language I'd only just picked up. Unfortunately, though, the difficulty of synchronising schedules meant that the scientific experts were unable to make it, and we had to lead the field trip on our own.

We'd taken the students from Bolton College out of town and into the curiously named Jumbles: a country park just outside the town and on the southern edge of the West Pennine Moors. All of the students were working towards an Early Years qualification, and the vast majority were aged between 16 and 18. As a result, it was perhaps to be expected that they would collectively roll their eyes when invited to put their phones away in their bags at the start of our circular walk around the reservoir. I also knew that I was probably pushing my luck when I asked them if they'd like to find a tree to embrace.

Looking back, however, one visual memory has stayed with me. A group of four girls had been particularly keen to express the sheer boredom of finding themselves in green space. As I chatted to another group of students, however, I spotted them all, down by the edge of the reservoir, surreptitiously taking photos on their phones. What interested me was the fact that they were taking close-up photos of the bark of trees the species of which I can't recall; they were zooming in to see and to frame the knotty texturality of the tree.

In my discipline of English, the *Oxford English Dictionary* is always an obvious starting-off point. According to one of the dictionary definitions, the verb 'measure' can be – but is not always – a transitive verb: 'Of a person: to ascertain or determine the magnitude or quantity of (something); (of a thing) to be the means of ascertaining or determining the magnitude or quantity of (something).' The practice of photographing the near-at-hand was an act of defamiliarisation. At the same time, though, it can be said to have been a form of measuring; as the students transgressively played around with their phones they

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were, in their own way, trying to understand the 'magnitude' of the more-than-human. At this particular moment, down by the reservoir, the act of looking was a qualitative rather than quantitative process. The noun 'measuring', then, can be metaphorical as well as literal.

A few weeks later, we were back on the college campus where Marion – a Lecturer in Education and Early Years – invited the students to collaborate on the painting of a mural where the built environment of Bolton town centre and the treescapes of Jumbles were to be presented on the same representational space. The intention was to then ask the learners to write poems responding to the mural and their memories of visiting the country park. As with the field trip, the session didn't quite go according to plan: it was the last week of the academic year and, as a result, the learners were finding it difficult to concentrate on anything that felt too much like 'work'. My hope, though, is that at least some of those students will still have their own close-up photos – their personal tree measurements – saved on their phones.

Comment: The students are 'measuring' the trees with their phones – deciding which one to choose and taking a close-up of the bark – they were using their own methods, but they were measuring all the same with technology. This is an aesthetic measuring that might have slipped off the edge, but that is here presented as part of their typology of trees.

It can only be known through being there together

Caitlin Nunn, Peter Lawrence, David Cường Nguyễn
A sociologist, physical geographer and artist

We came together with a team of global youth for a sensory ethnographic encounter with trees in a local park that included tree surveys, rubbings and conversations (Figure 1).

Figure 1. Global youth measuring urban trees in Manchester

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Below are excerpts from a transcribed discussion reflecting on the encounter, which we have woven together to share the experience:

> I initially felt uncomfortable.
> I felt like a gatekeeper to the trees.
> But the activities provided the youth team a gateway and they charged through and made the park their own.
> As we all became comfortable with the physical measuring, the encounter became a bigger thing.
> It became a conversation.
> They saw the trees as equals,
> As things that they are as well,
> As living beings they can connect with.
>
> Science pretends to objectivity: abstracting nature from us, rather than us being part of nature.
> And yet, the words scientists use to describe trees can break those boundaries down.
> Heartwood. Limb. Wound. Bleed.
> It became a relational experience.
> The youth team understand the care they need to have for each other, but then to understand the care needed for the tree as well – that language provided the bridge.
> Caring for the tree, getting an accurate measurement, and ensuring that nobody missed out on the experience became entwined.
> And then, they were measuring each other.
> There was something so lovely about the technology moving between humans and trees.
> They were putting themselves in the same position. They were literally putting it to scale.
>
> Trees are not mystical, but they are hard to know.
> The science brought us to the trees in a different way; in a way that you wouldn't normally when walking through a park.
> The close attention that science demands of us has a relational value for our connection with trees.
> Looking up and taking in the whole tree to view its canopy,
> Hugging the tree to measure its circumference.
> And if you mentioned a wound or blood
> We would all feel compelled to go and actually touch that thing.
> There's something visceral, a knowing through touch,
> That also occurred with the rubbings.
> What the rubbings do to bring out the detail of nature in a different way –
> Veins and the finer components
> There was something important in the failure too; the inability to fully capture the bark.
> That it can only be known through being there together.

Comment. Here the tree-measuring process becomes a recognition that it is hard to know trees. Measuring is a much more complex activity than we ever bargained for. The how – the way of writing they have chosen – conveys the way that interdisciplinary understanding can be developed.

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Below is a reflection on the project by our Philosopher in Residence, Johan Siebers.

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Est modus in rebus

Johan Siebers
A philosopher

The interdisciplinary experience of sharing what measurement might mean in different contexts of encountering and relating to trees, different epistemologies, knowledge practices and different ways of being with trees, as adults, children, academics, artists, thinkers and designers, helps us to overcome a narrow view of measure as an external comparison that we, as knowing subjects, apply to the contents of our experience. We compare one thing with another and apply a number to the ratio. In the project, we experienced that measurement means something very different. It is a name for a creative aspect of the encounter between one being and another. The everyday notion of measurement is part of these encounters, but measurement is by no means exhausted by it.

We turned to Martin Buber's reflection on the dialogic encounter with a tree at various points in the project. Buber (1970), in *I and Thou* (first published in German in 1923), distinguishes between a mode of relating in which we treat the entity we encounter as an object ('it'), and one in which we treat the entity we encounter as this particular individual existent ('thou'). The first one remains partial and fragmentary, a form of classification; the second is whole, individual, without comparison and in that sense without measurement. I can see the birch or I can be with you, this tree, which I encounter every day as I walk by. Buber (1970) is quick to point out that these modes do not exclude each other. I don't have to give up measurement or anything I know by way of it for the sake of encounter, but the I–thou encounter is not a measurement, not taking the measure of anything or anyone. In a way, Buber (1970) says, the encounter is even beyond knowledge: I don't know, don't need to know, anything about this tree in order to encounter it. But what I know can go into the encounter, just as I can measure without encountering.

It struck me, reading the accounts of the project members, that, for them, very often the measurement took place within a context of encounter, and added to the quality of the encounter. Measurement then becomes play within dialogue, in Alan Watts's (1972) sense of work being meaningful only when it is play. A child's lesson.

As a philosopher, my thoughts wandered off to Hegel, a place where they usually turn into nightmares. Hegel's (2010) famous treatment of the concept of measure in the *Logic* revolves around the idea that measurement tells us something real, not because of the subjective comparison we subject things to, but because measurement only works if and because things carry measure within themselves. The articulations of reality prescribe the measurements that will deepen our understanding of reality. In this way, we can understand how there can be misguided, or even distorting, attempts at measurement. The contributions in this article reveal that not all measuring yields knowledge, but all knowledge is a form of measurement insofar as it registers and acknowledges the measure that exists in things. It would be easy to pit these considerations against Buber, suggesting that the thou-encounter dissolves into the it-relation, as long as we get our measures straight. Absolute reality, which after all is without encounter, would then mean, for Hegel (2010), the overcoming of all measure.

Long ago, I wrote an article, 'The measure of the ultimate' (Siebers, 2012), in which I argued that our intimations of an ultimate sense of truth, or being, provide a corrective, as it were a negative measure, to critique those moments where we mistake some partial account for the whole. The dialogic encounter is also the place of mystery, of hope and promise of something-I-know-not-what.

Both Buber (1970) and Hegel (2010) would, on different grounds, suggest that it makes no sense to speak of measure in an ultimate or absolute sense. But my mind goes back even further than those early encounters with Hegelianisms and their aftermath, of which I had to free myself subsequently, to my classics teacher in school, who taught us the saying *est modus in rebus*, there is measure in things. He didn't just instruct us about the translation, but also opened our eyes to what is being articulated

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here, itself an instance of what it expresses. We learn to respond to the measure in things as we learn to relate, creatively, respectfully, aware of boundaries and communications, possibilities and vulnerabilities, in space and time. As we measure, we live.

Conclusion

Drawing together the different approaches surfaces some new insights.

We learn about the difference between using the tree app Treezilla – a citizen science approach – as opposed to learning from children's observations. This surfaces a discussion about the relationship between empirical and experiential knowledge. We learn that the *height of a forester* is a key component in measuring a tree. We consider the relationship between a ruler and a poem. From the 3D laser scanners, we learn that urban trees differ from 'standard trees'. We consider the relationship between bodies and spatial measurement. The concept of the 'encounter' becomes important in tree-measuring processes and practices. We then expand on the encounter in a series of fieldnotes that take account of the relationship between the human and the non-human. Measuring turns into a metaphor, a concept that could be expanded to include the encounter. Measuring is also a conversation between the human and the tree.

What does this knowledge enable? This article has raised the question of whether the outcomes and benefits of tree-measuring are simply 'data' about trees, or if there is much more about trees – and our relationships with them – that a broader view of what tree measuring is might enable? To allow trees to move in and out of focus – whether we care about them or not – is to continue to provoke debate about what it means (and why it matters) to measure trees.

The rise in prominence of citizen science, notably in areas of environmental monitoring, often framed as an engagement mechanism, adds a further contextual dimension to our work. Tregidgo et al. (2013) ask if non-expert citizen scientists can generate 'good science', particularly where methodologies and measurements are simplified to make them accessible to untrained non-specialists. They argue that while citizen scientists may identify broad patterns, for example in using common lichen species as indicators of urban air quality, they will miss more subtle trends, limiting the value of the data. Perhaps Tregidgo et al.'s (2013) observation is more of a reflection on the rather extractive approach of many science-led citizen science projects, often using children and young people in a model that claims participation but is essentially about gathering large volumes of data at low cost. In critiquing this approach, Rautio et al. (2022) advocate more emergent, participant-led approaches that open up a discussion about meaning, particularly in an ecological frame. It is notable that within our project, the perceived more objective 'measures' that we explored, such as DBH, which continues to be the basis for production forestry and tree allometrics, are in themselves rather arbitrary, and lacked meaning for the majority of the young people we worked with. By contrast, the more emergent forms of measurement within our study opened up those conversations about meaning. There is a complementarity to be found in the relationship between citizen science and more expert-led approaches (Hadj-Hammou et al., 2017), but for this to be realised, those different forms of measurement need to be appreciated for what they represent. If the aim of our project was about gaining better relational understanding between young people and treescapes, which measures offered the greater value or insight? Even by using the term 'citizen science', we fall into the heuristic trap of privileging scientific expertise above values and beliefs (Kahan et al., 2012) that bring meaning to our understanding and responses to environmental and ecological challenges.

All of this ushers the potential for further discussion about what constitutes the many ways in which trees can be measured. At some point, we may wish to draw a boundary around what can plausibly be considered to be 'tree measuring'. But doing so too readily, or too tightly, might circumscribe a consideration of what it might mean *to get the measure of things* in a broader sense: of the conversations, games, distractions and multiple material-affective interactions between humans, trees and other bodies that are all part of the art of noticing (Land et al., 2022; Tsing, 2015).

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This brings us to the disciplinary boundaries that we worked within. When we consider the discipline of science, and, in some cases, geography, for a measurement to be useful there is a need for standardisation and repeatability. Within education, childhood studies and sociology, the focus was more on the bodily experience of measuring trees, and on what this brings to the activity. Our co-participants, children and young people, produced different concepts and prompts to consider measurement. In this, we are aided by very young children, who measure the world all the time through encounter; perhaps this should be our touchstone, our first step. When measuring a tree, there might be a slight feeling of chaos – what is there to measure? Is this part of the intangible measurements of a tree? What does it mean to measure a tree on a phone, via an app, with a tape, with a triangle and with a laser scanner, or does a tree just need to be hugged to be understood? We conclude by thinking that maybe it is in the *being together*: the children and young people standing with the plant scientists, the linguists, the philosophers, the geographers, the educationalists, the anthropologists, the literary scholars and the artists, that we can begin to come to measure the trees. This could be understood to be a definition of transdisciplinarity, whereby we genuinely work together and embrace these difficulties, accepting them rather than smoothing them away.

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Declarations and conflict of interests

Research ethics statement

The authors declare that this project has been ethically reviewed by Manchester Metropolitan University, the University of Cumbria, Sheffield Hallam University and the University of Aberdeen.

Consent for publication statement

The authors declare that research participants' informed consent to publication of findings – including photos, videos and any personal or identifiable information – was secured prior to publication.

Conflicts of interest statement

Kate Pahl is an editorial board member for this journal. All efforts to sufficiently anonymise the authors during peer review of this article have been made. The authors declare no further conflicts with this article.

References

Aceves-Bueno, E., Adeleye, A.S., Feraud, M., Huang, Y., Tao, M., Yang, Y. and Anderson, S.E. (2017) 'The accuracy of citizen science data: A quantitative review'. *The Bulletin of the Ecological Society of America*, 98, 278–90. https://doi.org/10.1002/bes2.1336.

Buber, M. (1970) *I and Thou*. Trans. W. Kaufman. New York: Scribner.

Facer, K. and Enright, B. (2016) *Creating Living Knowledge*. Bristol: University of Bristol.

Günther-Hanssen, A. (2020) 'A swing and a child: How scientific phenomena can come to matter for preschool children's emergent science identities'. *Cultural Studies of Science Education*, 15, 885–910. https://doi.org/10.1007/s11422-020-09980-w.

Hackett, A. (2014) 'Zigging and zooming all over the place: Young children's meaning making and movement in the museum'. *Journal of Early Childhood Literacy*, 14 (1), 5–27. http://doi.org/10.1177/1468798412453730.

Hadj-Hammou, J., Loiselle, S., Ophof, D. and Thornhill, I. (2017) 'Getting the full picture: Assessing the complementarity of citizen science and agency monitoring data'. *PLoS One*, 12 (12), e0188507. https://doi.org/10.1371/journal.pone.0188507.

Hegel, G.W.F. (2010) *The Science of Logic*. Trans. G. Di Giovanni. Cambridge: Cambridge University Press.

Jenkins, T.A.R., Mackie, E.D., Matthews, R.W., Miller, G., Randle, T.J. and White, M.E. (2018) *Woodland Carbon Code: Carbon Assessment Protocol v.2.0*. Forest Research Report. Accessed 30 January 2025. https://www.woodlandcarboncode.org.uk/images/PDFs/WCC_CarbonAssessmentProtocol_V2.0_March2018.pdf.

Kahan, D.M., Peters, E., Wittlin, M., Slovic, P., Ouellette, L.L., Braman, D. and Mandel, G. (2012) 'The polarizing impact of science literacy and numeracy on perceived climate change risks'. *Nature Climate Change*, 2 (10), 732–35. https://doi.org/10.1038/nclimate1547.

Land, N., Vintimilla, C.D., Pacini-Ketchabaw, V. and Angus, L. (2022) 'Propositions toward educating pedagogists: Decentering the child'. *Contemporary Issues in Early Childhood*, 23 (2), 109–21. https://doi.org/10.1177/1463949120953522.

Merleau-Ponty, M. (1962) *Phenomenology of Perception*. London: Routledge.

National Academies of Sciences, Engineering, and Medicine (2019) *Reproducibility and Replicability in Science*. Washington, DC: The National Academies Press. https://doi.org/10.17226/25303.

Rautio, P., Tammi, T., Aivelo, T. and Hohti, R. (2022) '"For whom ? By whom ?": Critical perspectives of participation in ecological citizen science'. *Cultural Studies of Science Education*, 17, 765–93. https://doi.org/10.1007/s11422-021-10099-9.

Ravaisson, F. (2008) *Of Habit*. London: Continuum.

Siebers, J. (2012) 'The measure of the ultimate'. In H. Tegtmeyer and S. Herrmann-Sinai (eds), *Metaphysik der Hoffnung: Ernst Bloch als Denker des Humanen*. Leipzig: Leipzig University Press, 27–41.

Thompson, K., Sherren, K. and Duinker, P.N. (2019) 'The use of ecosystem services concepts in Canadian municipal plans'. *Ecosystem Services*, 38, 100950. https://doi.org/10.1016/j.ecoser.2019.100950.

Tregidgo, D.J., West, S.E. and Ashmore, M.R. (2013) 'Can citizen science produce good science? Testing the OPAL Air Survey methodology, using lichens as indicators of nitrogenous pollution'. *Environmental Pollution*, 182, 448–51. https://doi.org/10.1016/j.envpol.2013.03.034.

Tsing, A. (2015) *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins*. Princeton, NJ: Princeton University Press.

Watts, A. (1972) *Work as Play*. YouTube video. Accessed 5 February 2025. https://www.youtube.com/watch?v=jGdaJ2NetYI.