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# Pedagogy with a heartbeat: The transformative potential of citizen science in education

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**Abstract**

*Over the past few years, we have worked together in a citizen science project called Diamonds on the Soles of our Feet (see also Goldin et al. 2021, Goldin et al., 2023). In this project we engaged with 420 young learners in the Limpopo Province of South Africa. We came to see participating schools as collaborative ecosystems where young citizens become entangled with water through experiential encounters that make science alive and relevant. Through our engagement with citizen science, we experienced the transformative power of affect and the relevance of emotions in education as a social and political project. In our pedagogy we depart from the idea that human beings are separate from the biosphere, thus recognising the interdependency of all life forms on earth. We believe that keeping science education in laboratories and libraries affirms what Bozalek and Zembylas (2023) call “privileged irresponsibility”. We propose that citizen science and its transformative potential can be one way to redress such irresponsibility. Through impactful encounters with human – non-human entanglement and the emotions which are evoked in this process, citizen science can create opportunities for response-ability (Bozalek & Zembylas, 2023), through teaching and learning with the heart. Such entanglement also resonates with relationality as the currency of care theorists. In the context of our citizen science work, caring for unfamiliar others is a form of non-human-centred care with unfamiliar water bodies in which the binary of inside-outside learning becomes porous as the geographies of water penetrate the classroom walls. In Diamonds on the Soles of our Feet, we noted how watery spaces and images move back and forth caring-with and through human bodies – waterbodies to school, school to waterbodies. The entanglement with the non-human resonates with Massumi’s (2015) notion of becoming where there is an unrolling of an event that is a becoming of two together.*

**Keywords:** *caring-with, citizen science, pedagogy, entanglement, response-ability, water bodies, schools, collaborative ecosystems*

## 1. Introduction: The Citizen Science project Diamonds on the Soles of our Feet (DSF)

Before we dive into the main objective of this article, which is to reflect on the transformative power of affect and the relevance of emotions in education as a social and political project, we will briefly introduce the citizen science project

*Diamonds on the Soles of our Feet* (DSF) to which we will refer when we discuss practice-based experiences to illustrate our points of view. Wehn *et al.* (2021: 1) define citizen science as a multi-stakeholder process that aims at increasing democratisation of science and policy, scientific citizenship, public engagement, transparency, equity, inclusiveness and justice. Aware of the flurry of definitions and contested meanings of citizen science, Goldin *et al.* (2022) have defined it quite succinctly as taking science out of libraries and laboratories and into life.

DSF took place in the Hout Catchment area, in the province of Limpopo in South Africa (see Goldin *et al.* 2021; Goldin *et al.* 2022). This is an arid to semi-arid region where climate and socio-economic concerns affect the everyday lives of communities. Repercussions of South Africa's apartheid and colonial history resonate – still today showing marked inequalities. While living conditions vary significantly, those living in the Hout Catchment experience water scarcity and water stress because of the shrinking availability of water. In the early phases of DSF, we ran a local project on measuring groundwater levels. After completion, local residents shared their deep concern about water quality and expressed the need for follow up activities that would involve local schools. And so, DSF came about, driven by the communities' quest to know more about water quality and in so doing to connect young learners with their local environment. Young learners undertook a number of activities which included taking samples of river water and analysing them to assess the status of the health of the river.<sup>1</sup> The DSF was purposively driven from the bottom up. The community sought cooperation with the Southern Africa Association of Youth Clubs (SAAYC) who in turn identified a local youth club, called the Boys and Girls Education Foundation. The motivation to work with a youth club was to firmly embed the project within recognisable and accredited community structures. This was an important objective, given the disconnect between communities and river health, scarcity of water, the constantly looming threat of drought and a lack of access to clean water. DSF was co-designed by academics, water professionals and a team of citizen scientists who were all involved in determining the activities from the onset. Local communities played a significant role in selecting citizen scientists, identifying the schools and setting the agenda. This created space for the transformative potential of citizen science and its propensity for not only enhancing water literacy but also building trust, hope, dignity, pride – intangible goods that we discussed in depth elsewhere (Goldin 2003, 2015; Goldin *et al.* 2021, 2022, 2023).

In this article we will present the theoretical background around affect considering Tim Ingold (2017) on entanglement and Brian Massumi (2015) on becoming and Joan Tronto (2013) on caring-with. We then turn to the work of Vivienne Bozalek and Bob Pease (2020), which is helpful when considering the potential of citizen science to reverse 'privileged irresponsibility' and promote 'response-ability.' Our goal is to address the persistence of ecological damage and the transformative power of affect as a social and political project and as such we identify schools as collaborative eco-systems where socio-ecological learning is enhanced as young learners are connected to water bodies through water literacy inside and outside the classroom. Our lens is also on the science/art field (poems, posters, dance, stories, song) which serves as a powerful transdisciplinary tool for bringing science out of libraries and laboratories and making it accessible to all. We introduce an image of pedagogy with a heartbeat to reflect on the idea of caring-with and caring about the environment. In

1 MiniSASS was obtained from an NGO, Groundtruth in KwaZulu-Natal. We used Freshwater Quality Monitoring Kits donated by Earthwatch Europe to measure nitrates, phosphates and turbidity and miniSASS, a uniquely South African scoring system, to identify macro-vertebrates. Together these instruments enabled us to classify the water quality in the different sites of investigation

our conclusion we propose that citizen science offers an opportunity to care-with, to reverse privileged irresponsibility and promote response-ability, opening the heart to science through human-nature encounters.

## 2. 'Caring-with' and the role of emotions and affect in education

Lanas and Zembylas (2014) define care as an emotional and practical concern for the other. Caring-with<sup>2</sup> is an emotional and practical concern with the other and it is a relational act conceptually linked to inclusion (Joorst, 2021). With her concept of 'caring-with', Tronto (2013) expands the ethical considerations of care to include not only the immediate relationships between caregivers and care receivers, but also the broader social and political context in which care takes place. 'Caring-with' thus underscores the necessity of creating political and social systems that support equitable care practices. The idea of education as generating critical awareness about the global reality and providing tools for social participation and transformation is at the core of an ethics of care as transformative learning (De Arriba *et al.*, 2023). Our DSF project emphasises the way learners are entangled with water bodies, both inside and outside the classroom. Inspired by Joorst (2021) who wrote about Tronto's 'caring-with' through an engaged pedagogy, we set out to explore what 'learning-by-doing' could mean for the experiences of children involved in the project. Although Joorst mainly refers to experiences of educators rather than students, his emphasis is on real-life learning situations which are supportive and caring. He categorises several elements of care: caring about, noticing the need to care in the first place; taking care of, assuming responsibility for care; care-giving, the actual work of care that needs to be done; and care-receiving, the response of that which is cared for to the carer. From these elements of care arise four ethical dimensions of care, namely: attentiveness, responsibility, competence, and responsiveness. We decided that 'caring-with' would drive the idea of transformative learning processes in DSF in which learning experiences are given a "moral character through caring, where caring is also a form of attachment" (Joorst 2021: 7). Such learning experiences do not only strengthen the propensity for enhancing water literacy but also enhance trust, hope, self-esteem, dignity and pride as intangible goods, developed through emotional involvement.

There are traditional tensions between science (masculine) and emotion (feminine), which are much more acute in branches of learning that are positivist and technical, emotions are plonked to the side and they are not considered as 'proper' topics for scientific inquiry. Defined as private, they are not usually socially articulated. Dating at least from Darwin's classic study (1872) *The expression of the emotion in man and animals*, the study of emotions has focussed on behaviour and manifestations of emotions that are to do with conduct around communication – studies of verbal communication of emotion began to emerge in the 80's.<sup>3</sup> For rationalists, emotions are 'if not symptoms of the animal in the human at least disordering and problematic; they are vague and irrational' (Lutz & White, 1986: 409, in Goldin, 2015). Immordino-Yang and Damasio's (2007) image of a toddler in a China shop causing havoc amongst delicate chinaware is pertinent.

For anthropologists who examine emotions, the norms and values of a society are shaped by culture – and it is these norms that define what experiences are permissible or appropriate. "When we have emotions, we are engaged in an attempt to make sense or meaning out of

2 Tronto refers to caring with. The hyphen – caring-with is our addition

3 For instance, J.T. Irvine's *Language and affect: some cross-cultural issues* in Lutz and White (1982: 423, in Goldin's, 2015 article on Hope as a Critical Resource for Small-Scale Farmers in Mpumalanga).

that intersection of possibilities ... in such a way we 'read' situations and those readings lead us to subsequent thoughts, feelings and actions" (Henricks, 2012:109). It is helpful to make a distinction between emotions that might be individual and private – but all in all emotions impact on social action.

Let us now briefly consider the idea of affect and how it differs from emotion. Affects are links between the body and the brain that begin when the brain senses a situation that demands an emotional response (Damasio, 1999). The affect turn in education addresses the relationship between emotions and what happens in education. The affect turn is more than just inserting emotion into pedagogy (Zemblyas, 2021). According to Haberl (2021), learning is a lasting modification of behaviour that happens through moving experiences, referring to affect as being 'sticky' with shimmers, expectations, daydreams, encounters in something that feels like *something*. As such they are sensorial, experiences. For Haberl, the affective turn in education draws attention to the entanglement of affect and emotions. Zemblyas (2005, 2021) sees affect as a much broader term than emotion, denoting modes of movement, intensity, movement and change, allowing for transformative interventions in educational spaces. Zemblyas (2011) describes emotions that 'stick' to the body and move from one public (or private) space to another, they circulate between bodies and are located in movement – they are actions and practices. This is relevant when referring to learning in – and out – the classroom where sensorial experiences inform action and inform the encounters of learners and their entanglements with the environment.

Scientists might shirk away from these shimmerings or embodied engagement, thinking of experiences in our bodies as being the bull (or toddler) in the China shop, but not so philosophers, who across the ages gave attention to the non-material. For instance, Hegel's story is a quest for attaining a state of freedom and a society that is full of hope and the Greek god Prometheus, the god of fire, was seen as a symbol of hope. The Greek word for hope – Elpis conjures up Pandora, who ties together the themes of hope and suffering where torments and miseries escape into the world - but hope (in Pandora's jar) remains intact. Earlier work on hope (Goldin, 2015) emphasised that development processes can be enriched through a deeper analysis of emotional life and that emotions, as drivers of social action, are at the core of what we do and how we act with ourselves and the world that surrounds us. Goldin's (2003) focus on shame claimed that there was only an uncertain place for human affect in a quintessentially industrial world, where development or aid is often limited simply to technological mediation. Emotions help to direct our reasoning into the sector of knowledge that is relevant to the current situation or problem (Immordino-Yang & Damasio, 2007).

And so, for centuries, Western modern thought has been dominated by cognitive approaches that emphasise rationality, logic, and objective knowledge. However, in recent decades, there is growing recognition of the importance of what is called the 'affective turn'. This change is part of broader transdisciplinary trends, which include research in psychology, neuroscience and cultural studies that acknowledge that human experience is deeply intertwined with emotions. The 'affective turn' refers to a shift towards understanding and integrating emotions, feelings, and affective experiences. Prominent authors from diverse academic fields, such as Noddings (1984), Damasio (1994), Boler (1999), Ahmed (2004) and Zemblyas (2005; 2008) have laid a solid foundation for the idea that emotions indeed play a critical role in interactive (learning) processes, influencing motivation, engagement, memory, and overall outcomes.

Other work on emotions includes that of feminist philosophers, such as Fraser's (2009) *Scales of Justice*, and Iris Marion-Young (1990) on justice and politics of difference; the work of human geographers such as Nigel Thrift (2004) writing about intensities of feeling; feminist geographers such as Bondi (2003; 2005), care ethicists such as Tronto (2013), Wetherell (2015) on trends in the turn to affect, Van Wijnendaele (2011; 2014), and Bozalek *et al.* (2014) on social justice and the politics of emotions. In our own work too, we have stressed the important role of emotions in meaning-making processes (Suransky & Alma, 2018; Goldin *et al.*, 2023). Together, these insights have significantly shaped our understanding of the affective dimensions of our citizen science work in which we try to develop a more holistic approach that recognises the central role of emotions in learning processes.

The work of Bozalek and Pease (2020) on *Post-Anthropocentric Social Work*, and bell hooks (2000) *All About Love and Teaching to Transgress (1994)*, *Critical Posthuman and New Material Perspectives* were all helpful when we considered whether and how human bodies could engage with nature. What brings these authors together is a common attention to care. In the preface to their tome, Bozalek and Pease (2020) state the obvious, but no less critical observation that, as humans, we need to understand how we are part of the biosphere rather than separate from it, and, if humanity is to survive, we must understand our interdependency with all of life on the planet. We cannot disentangle human morality from environmental morality (Flower & Hamington, 2022). This is where the focus that Bozalek and Zemblyas (2023) have on responsibility, privileged irresponsibility and response-ability is most helpful. Although their context is higher education, their attention to responsibility, privileged irresponsibility and response-ability is relevant to citizen science work and the potential of projects such as DSF for transformative justice through a pedagogy of the heart.

Lanas and Zemblyas (2014) focus on the emotion of love in the context of formal education in which these authors assert that discussions of love have been notably absent, and that formal education has failed to recognise the transformative power of love as a social and political project. Choosing to speak about love makes love especially significant for transformation, needing much more attention in educational theorising. Lanás and Zemblyas examine ways in which teachers and students experience love as a powerful transformative force, developing a transformational political concept of love in critical education. Their observation is that love isn't something that just exists but rather it is embodied and performative. Embodied practices emphasise the role of the body in how we understand, engage with, and navigate the world. They shape and are shaped by cultural, social and individual contexts. By realising that human experiences are embodied, we acknowledge that cognition, perception and action are not only mental processes, but are deeply intertwined with bodily experiences. Here we learn from Sheets-Johnstone (2011), a philosopher and dancer, who challenges Cartesian dualism that separates body and mind. Based on phenomenological research, she argues that cognition cannot be fully understood without the bodily basis of experience. Following on from this, performative practices emphasise the active role of individuals and communities in creating meaning. They do not merely reflect pre-existing realities, but rather create and shape them and thus bring about new conditions.

In line with our previous arguments about hope being a driver of social action, love, and this is also how bell hooks (aka Gloria Jean Watkins) (1994; 2000) sees it, is an action rather than a feeling. For Lanás and Zemblyas this means seeing education as a way of asking what progress means in different contexts and how it relates to the values by which we wish to lead

our lives. Just one example they give is the need to develop patience with learners where we let go of our obsession with immediate results or/and personal gratification but rather give more focus on developing loving ties. In line with our previous arguments we see love as an action rather than a feeling, as a disruptor that allows for new moments of becoming and caring with.

Today, we are convinced of the relevance of emotions to education, and as Immordino-Yang and Damasio (2007) puts it, “we feel therefore we learn” and we don’t see a bull<sup>4</sup> or a toddler breaking valuable things, but rather as breaking down walls between science and society, between science and art, between science and the heart. Many educational researchers are trying to understand how cognition and emotion work together in transformative learning. Some make more general claims on how cognitive and emotional learning inform one another (Walker, 2018). Both individual and group processes are important and as Walker (2018) stresses, there is much we have learned from the ‘emotional turn’ in the literature in transformative learning: emotions are central to understanding transformative learning processes: various learning, reflective, pedagogical activities can activate embodied and emotional learning. Emotions can both enhance and interfere with learning depending on which ones are driving or colouring the experience. Emotions can also be contagious, with strong positive or negative emotional states infecting others in the learning environment. Whether in a face-to-face or online environment, the emotional states of learners – and teachers – can influence one another (Osika *et al.*, 2023).

For Immordino-Yang and Damasio (2007), it is literally neurobiologically impossible to think deeply about things that you don’t care about.<sup>5</sup> Advances in neuroscience highlight the connections between emotion and have the potential to revolutionise our understanding of the role of affect in education. This brings us to the next part of our paper where we make these connections between education and emotions more explicit.

### 3. Water spaces, education and emotions

In our DSF project, we pay specific attention to relationships, emotions and empathy in the context of human-non-human transformative learning. Here, we see schools as collaborative ecosystems where, through moments of learning about water inside and outside the classroom, young citizens become entangled with water.<sup>6</sup> Relatedness to nature in general – and water in particular – can be kindled through watery encounters making science alive and relevant. In the words of a teacher in DSF: “Oooh, the kids can’t wait to go back to the river, they are so excited. They are asking to learn about nitrates and other things.”

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4 Maybe it needs just that – a bull, because bulls are strong and in the Chinese culture they have perseverance and diligence (Zeus became a white bull when he needed to win the heart of Europa).

5 Article by Jessica Lahey titled, ‘To help students learn, engage the emotions’ (*New York Times*, 4 May 2016).

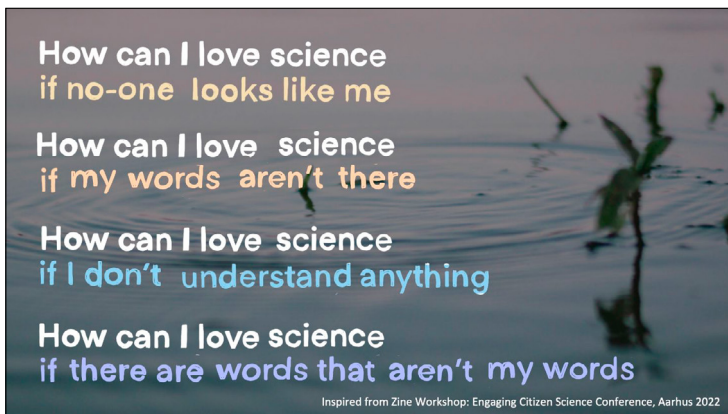
6 The fourth phase pivots around a youth development programme involving 420 learners, 28 teachers and seven principals. It has been funded through a ‘Science Shop’ grant from the South African Department of Science and Innovation administered by the South African Agency for Science and Technology Advancement (SAASTA), which is a business unit of the National Research Foundation. This particular Science Shop is implemented by the University of the Western Cape (UWC) in South Africa in collaboration with local citizen scientists and other national and international partners.



**Figure 1:** Encounters with watery spaces

Photo by courtesy of Ashraf Hendricks, Groundup (May 2023)

We believe that citizen science can bring the realms of science and ‘the heart’ together. These realms generally stand apart, because as Ballard (2021) posits, the way people and communities engage – or do not as the case might be – is not well understood by scientists who often know very little about the needs, interests and expertise of people and communities. Furthermore, in traditional scientific research, scientists are neither educated nor encouraged to support community engagement as part of their scientific efforts. The image below ‘how can I love science’ resonates in this context.<sup>7</sup>



**Figure 2:** How can I love science?

In the case of DSF’s youth development programme, through encounters with watery spaces entangled moments with water bodies help chisel away walls of privileged irresponsibility and foster spaces for response-ability.

<sup>7</sup> Zine Workshop during the Engaging Citizen Science Conference 2022 (Aarhus University).

Seven schools were selected – one of the criteria was that they are close to a river so that it could be practical for learners to ‘encounter’ watery spaces outside the classroom in walking distance from their school.



**Figure 3:** Learners from Boetse Secondary School singing on their way to a river  
Photo by courtesy of The Dollie House (May 2023)

A balance between inside/outside learning is a powerful way of bringing nature closer to the classroom and the classroom closer to nature.<sup>8</sup> Response-ability here is to a river, or other water bodies (wetlands, springs) where touch, smell, laughter, dance, joy, curiosity create shimmering moments for entanglements of human-non-human bodies. In the words of a teacher from one of the schools “you have made the children love science, and they want to know everything now about water, they want to be with the river”.



**Figure 4:** The kids are loving science  
Photo by courtesy of The Dollie House (May 2023)

<sup>8</sup> Education outside the classroom (EOtC) is a school-based learning in outdoor environments, characterised as inquiry-based and place-based teaching as a supplement to indoor lessons in the classroom (Bolling *et al.*, 2018).



These encounters are impactful and “the response not only foments the flourishing of the other, but the one caring is no longer the same being as prior to the encounter” (Flower & Hamington, 2022: 3):

I was scared of words like nitrates that confuse my head, but now, I am next to the water ... I see the little bit of paper goes pink. I know what a nitrate is and I know that the water can have things inside it that can make me sick. I can also make a river sick because I throw plastic bottles into the water.<sup>9</sup>

An ethics of care is a relational approach to morality and in its focus on context, on emotions and on empathy it is different from more traditional approaches. DSF is a disruptor, disrupting ‘learning as usual’ – and it is also a connector: human-human and human-nonhuman, seeing the river, feeling the river, relatedness to a/the river, not any river but ‘my’ river that is near to ‘my’ school.

It is this proximity to the water body that invites closeness and a feeling of relatedness and encounter with ‘their’ water body. Classroom and field are enmeshed – lessons about rivers and water inside the classroom resonate with the learners and kindle curiosity as new wor(l)ds, images, worries, interests, about water and the human-water-knot of emotions unravel.



**Figure 5:** Encountering water  
 Drawing by learner Magwareng Primary School, Limpopo

<sup>9</sup> Learner from Mara School, Buysdorp, Limpopo.

One of the many poems written inside the classroom reflects a being-with water.

*Water should never be taken for granted  
It is the liquid of life, you know  
Through the cycle it goes  
When it stops  
Nobody knows  
I goes it goes  
Through precipitation, accumulation,  
Evaporation and condensation  
And there it is  
The water cycle isn't showbiz<sup>10</sup>*

Watery spaces and images move back and forth through human bodies – river to school and school to river, carried in the heart and heads of young learners. Encounters with 'my' river/waterbody is about bodies enmeshing with water. Massumi's (2015:3) notion of affect as a connector, "being right there where you are – more intensely" is more about affecting or being deeply affected rather than simply an emotion. Perhaps too, as Haberl suggests, it is art that offers a kind of metaphor for this complexity and these tensions of non-linguistic, indescribable, abstract, changing, in-tension affective intensities, expressed in poetry, drawings, storytelling, movement and dance. Relatedness to the water means taking in the water in its totality – its smell, colour, sounds it makes or does not make.

The kids are super excited about the project it helps them in terms of science. I think we made a mark with regards to their future. They are so interested in the quality of water ever since we introduced our project. Even the principal said she sees a change in the kids.<sup>11</sup>

And again:

The kids are so happy about the project. The teachings are eye opening for them. They see water in a different way as they did before. They were surprised that all the hard and big words such as 'nitrates', 'turbidity', 'phosphates' were very simple practically. When they saw the *YouTube* video they were even happier as they see that we notice their songs and their dancing.<sup>12</sup>

#### 4. Discussion

For Mbembe (2020, in Bozalek and Pease, 2020), humans are but one species in a multi species, interconnected, relational world where we are bound together. The poems, extracts and images above reflect the love, curiosity and caring-with experienced by young learners. Human-non-human encounters come about through entanglement and being-with or what Barad (2007) would call "practices of knowing".

The boundaries between inside-outside learning are porous when geographies of water penetrate the classroom walls. Tim Ingold's idea of meshwork is relevant here, suggesting that in 'joining with one another, these lives of lines comprise a meshwork, in which every node is a knot, and in answering to one another, lifelines co-respond' (Ingold, 2017: 4). An idea of meshwork explains more the knotting and entanglement of individuals who are full of loose ends and always on the move, thus 'becoming' rather than being fixed in time (Grove *et al.*, 2021). Entanglement with the non-human other, resonates with Massumi's (2015:48)

<sup>10</sup> Poem by Mohlo Refilwe, Boetse Secondary School, Limpopo.

<sup>11</sup> Interview Catherine Basson, April 2024.

<sup>12</sup> Feedback from Catherine Basson, citizen scientist.

notion of becoming where one is “thinking of self on the one hand and the (water)body on the other, in the unrolling of an event that is a becoming of the two together”. Encounters with water – through singing, dancing, walking, laughing, looking – are e-motional and fluid, and do not correspond to a fixed point.

These attunements or encountering moments (human-to-human and human-to-nature) are in stark contrast to what Bozalek and Pease (2020) frame as privileged irresponsibility which is about power and constructing silos and walls between humans and their environment with dire consequences being ecological damage and damage to people who feel disconnected, alienated, fearful and hopeless. If you can't touch, you can't feel or know – then the path that we have so dangerously made for ourselves as humans continues. It is privileged irresponsibility to keep ourselves in a position of power over rather than with nature and it is also privileged irresponsibility to deny our younger generation the opportunity to connect, to learn and to be empowered by understanding and feeling the human-nature relatedness.

This concern for attunement builds on an intellectual legacy in highlighting the associational and heterogenous as part of the nature of networks (Flower & Hamington, 2022). Relationality is the currency of care theorists who emphasise the personal and particular and the caring for unfamiliar others – in this instance water bodies. It is the Anthropocene that forces us to consider how we care for the non-human material world and we can better understand and analyse the Anthropocene by reframing or de-centring the human and making prominent a non-human centred care. Emotional engagement fits well with an ethics of care and an expansive notion of relatedness, so applicable to encounters between young learners and non-human others.

Rather than causing havoc, emotions can also help to direct our reasoning into sectors of knowledge that are relevant to the current situation or problem (Immordino-Yang & Damasio, 2007). In earlier work, Goldin (2003; 2010) argues that development processes can be enriched through a deeper analysis of emotional life and that emotions, are at the core of what we do and how we act within ourselves and with the world that surrounds us.

We explore ways in which citizen science activities go against a tendency for privileged irresponsibility, reversing elite notions of science. We do not promote citizen science as a one stop shop that can reverse such damage but propose that it potentially forges new pathways towards response-ability, and through attunement to specific contexts, rendering those who are involved as being capable of response. In our article entitled *Decolonisation of Education through Citizen Science: slow science not slow violence* (Goldin & Suransky 2024), we give a vivid portrait of privileged irresponsibility – in this case manifest in authoritative systems of control and management. We refer to the predominantly colonial architecture that permeates administrative and management systems, with a Western notion of privilege and power that, as Mbembe (2016) stresses, permeates all aspects of the higher education space, infused as a result with privileged irresponsibility. Bozalek and Zemblyas (2023) see coloniality and ecological damage as being intertwined with each other. We share their concern about what might be done about living on a damaged planet and about the continuing effects of coloniality on the planet (Bozalek & Zemblyas, 2023:22).

We discussed the importance of emotions in learning processes and tried to show that love has everything to do with science. In fact, without love, the uptake of science, particularly with the younger generation, might be fleeting, fragile, forgettable. Science in and with the heart is more likely to be anchored and accepted. The 'affecting' is ongoing – "it goes up and down gently like a tide, or maybe storms and crests like a wave" (Massumi 2014: 4) and cannot be reduced to a single emotion for no one emotional state can encompass all the depth and breadth of our experiencing. We argued that the transformative potential of citizen science requires the heart and the context specific connecting to, connecting with and caring for and with the other. Artists are often so much better than scientists at capturing in image, form and colour, nuances that the written word just cannot do and the practice of art itself is embodied and performative. Many artists seem to be so much better at communicating with, rather than to – their audience and that is a great rationale for having a pedagogy that talks to the heart and not just the head and for a pedagogy that kindles cognitive curiosity.<sup>13</sup> If science makes you laugh, makes you weep or/and moves you, so that you are caring with human-non-human bodies, then the chances are it will make you think.

In a 2007 paper titled, "Non-persuasive communication about matters of greatest urgency,"<sup>53</sup> Baruch Fischhoff ends with a paragraph that is right on point,

Scientists who avoid science advocacy can still engage in value advocacy by speaking about the things that they cherish. As seen in the success of science films and science centers, the passions of scientists often matter to non-scientists. Like artists, scientists have a special sense for the uniquely meaningful features of the world around them, enabling them to speak with an authenticity that goes beyond technical estimates of the costs and benefits of climate-related decisions.

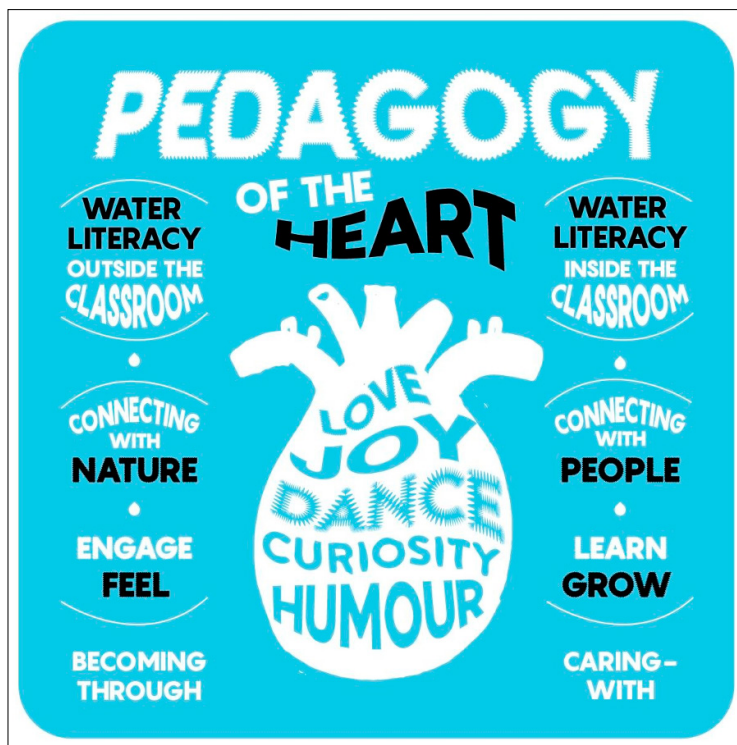
Fischhoff is right. And today, the roles and opportunities of academics can enmesh far better with those of artists. Artists know how to open up doors to the heart and to solicit emotional responses that science is less skilled at recognising or lighting up. It is the fire that burns inside, the smouldering coals – this communicates science:

[...] we cannot compare working in research with, for instance, working in a call centre. Academic labour is not a regular job. It is not a job at all ! It is no coincidence that we keep on working even after dinner. If we were employed in a call centre, we would not do that; we would stop after our working hours. We cannot explain our work through economy, nor can we assimilate it to 'standard jobs' because research is about love (GA, man, mailing-list excerpt, Jan 2013).<sup>14</sup>

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13 We have a small Youth Education and Life Skills (YELS) grant where we are strengthening this dialogue between art and science and aim to foster a community of practice within the context of the Dynamics of Youth, University of Utrecht, Netherlands

14 Busso and Rivetti (2014: 20).



**Figure 6:** Pedagogy of the heart model

In designing DSF and recognising ways in which citizen science addresses difference, justice, and concerns around care we build on the important role of emotions in the field of education. Here our attention is on relationships, emotions and empathy in the context of human-non-human transformative learning. From this we develop a model with at the centre the idea that learners feel, engage, learn and grow through embodied and performative experiences. These experiences are on the one hand shaped by cultural, social and individual contexts and on the hand, through love, joy, dance, curiosity and humour, cultural, social and individual contexts take on new forms and meaning. Science enters the heart through song, dance, poetry, story-telling, laughter - reflecting the entanglements with nature and people and a becoming through caring-with.

In their article, also titled, 'What's love got to do with it' Busso and Rivetti (2014: 12), through their work<sup>15</sup> at Italian universities on passion as a way of pursuing excellence, remind us how this echoes the Aristotelian notion of pleasure as a 'stairway to heaven'. There is also the passion that arises from the social dimension of it, which gives researchers the opportunity of being 'public intellectuals'. This type of 'social' passion is motivated by the fact that research may have a positive impact on society, physically and spiritually enhancing the quality of life

<sup>15</sup> Precarious academic labour forces and the role of passion in Italian universities.

of many people. This kind of passion is often central to the representation (and stereotype) of the passionate researcher (Fusulier & del Rio Carral, 2012), driven by an ardent desire to defeat cancer or eradicate poverty. Although strictly related to creative passion, this model does not necessarily equate with love for the everyday practice of research. On the contrary, it has more to do with the idea of sharing knowledge with the whole society rather than producing it.

## 5. Conclusion

We recognise the transformative power of affect as a social and political project and the relevance of emotions to education appreciating that it is neurobiologically impossible to take in science if you don't care about it. As we have shown, affects are links between the body and the brain that begin when the brain senses a situation that demands an emotional response. The affective turn in education addresses the relationship between emotions and what happens in teacher education for learning as a lasting modification of behaviour that happens through moving experiences, through shimmerings, expectations, excitements, enthused utterations – encounters and entanglements with the environment. Understanding that we are not separate from the biosphere and recognising the interdependency with all life on our planet we cannot disentangle human-nature encounters. We recognise citizen science as a vehicle for transformative justice with its potential to disrupt and redress privileged irresponsibility and to create, through impactful encounters, response-ability. Keeping science in laboratories and libraries confirms privileged irresponsibility. Human-non-human entanglement inside and outside classroom, learning and attunement to specific contexts, offers ways of learning that reverse elite notions of science. Relationality is the currency of care theorist who emphasise the personal and particular and the caring for unfamiliar others – in our context this is unfamiliar water bodies, a non-human centred care, emphasising a relational approach to morality. We see how the boundaries of inside-outside learning are porous as the geographies of water penetrate the classroom walls. This entanglement with the non-human resonates with Massumi's notion of becoming where there is an unrolling of an event that is a becoming of two together. We have seen how watery spaces and images move back and forth caring-with - through human bodies – river to school, school to river with schools as collaborative ecosystems well suited to reach audiences and have lasting effects through e-motional encounters that are fluid and becoming – with. Citizen science presents us with an opportunity to care-with, to promote response-ability and to open the heart to science.

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