Global Science Opera: Enacting Posthumanising Creativity

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Abstract
This article is a theory/practice positioning paper which applies posthumanising creativity as a conceptual framework for Global Science Opera (GSO) practice, in the context of global education/citizenship and STEAM education. Through this positioning we demonstrate how GSO has potential to help students to globally attend to wicked problems from within education, and how posthumanising creativity might prove a productive way to understand creativity more generally within education. The Global Science Opera (GSO) emerged as a practice in 2014, at the intersection of developing agendas in STEAM (Science, Technology, Engineering, Arts and Maths) education, and global education and citizenship. Since this time GSO has been implemented on a global scale with a remit to explore the interweaving of arts, sciences and technology within a creative and democratic inquiry process which necessarily crosses geographical and other boundaries. The article considers the intersections of posthuman understandings of creativity, STEAM and global education and goes on to articulate GSO in relation to these. This includes discussion of how GSO creative process might be shaped through this positioning and how GSO creative pedagogies might manifest. The article concludes by offering insights into how GSO and posthumanising creativity might symbiotically productively move forward.

Keywords: *posthumanising creativity; STEAM; global education; Global Science Opera; symbiosis*

Introduction

This article is a theory/practice positioning paper which applies posthumanising creativity as a conceptual framework for Global Science Opera (GSO) practice, in the context of global education/citizenship and STEAM education. Posthumanising creativity (PHC) takes the posthuman turn in conceptualising creativity by decentring the human and offering an intra-active explanation of impactful novelty as generated

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by humans and other-than-humans (Chappell, 2018). Through this positioning we demonstrate how GSO conceptualised through PHC has the potential to help students to globally attend to wicked problems, and, how PHC might contribute to understandings of creativity more generally within education. Within this introduction, GSO, wicked problems and transdisciplinarity are explained, as are their relationships with the STEAM and global education agendas. The wider posthuman turn, which is beginning to have influence, but is not yet dominant in these areas, is also explained as foundational for the theoretical positioning via PHC that follows in subsequent sections. The article goes on to define and consider posthuman understandings of creativity and how these shape GSO, and GSO's creative process and creative pedagogy. It concludes by looking forward to how a more symbiotic approach might be beneficial and impactful to GSO and beyond.

The Global Science Opera (GSO) was the first opera initiative to produce operas as a global community (www.globalscienceopera.com); these are realized through a creative method which has its roots in the Write a Science Opera educational approach (Ben-Horin, 2014; Ben-Horin et al., 2017).[1] Educational operas are written, designed and performed by the global community, consisting of school students and their teachers, artists and scientists. During each annual production, a storyline created by one of the country-specific GSO teams, is divided into scenes and dispersed thereafter throughout the global network. Each location (e.g. school) is then responsible for writing and performing their opera scene as part of the complete opera. GSO emerged as a practice in 2014, at the intersection of developing agendas in STEAM (Science, Technology, Engineering, Arts and Maths) education, and global education and citizenship. GSO has since been implemented globally with a remit to explore the interweaving of arts, sciences and technology within a creative and democratic inquiry process which crosses geographical and other boundaries.

Since 2015, annual productions have been inspired by a variety of scientific themes and their associated wicked problems, for example light pollution, particle physics and ecosystem restoration (Global Science Opera, 2016). GSO shares control of the learning process and content with pupils and their teachers in numerous countries, thus continuously generating research questions with relevance for the local and international practice fields, and for teaching and research professionals (Urbaniak et al., 2021).

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[1] The Global Science Opera educational practice was set in motion in May 2014 as a collaboration between the European Commission's CREAT-IT project "Implementing Creative Strategies Into Science Teaching" (Craft et al., 2016) and representatives of the following initiatives: Write a Science Opera (WASO), a creative approach to science and art inquiry in schools, developed at Western Norway University of Applied Sciences; the science education networks Galileo Teacher Training Program (GTTP) and Global Hands on Universe (GHOU); ICT-based distance learning amongst rural schools, led by the educational organization Ellinogermaniki Agogi. Author 2 coordinates the Global Science Opera. See www.globalscienceopera.com for further details regarding organization of the opera productions.

The term 'wicked problem' describes issues, such as climate change and educational inequalities, that at first appear too complex to address, but that through transdisciplinary analysis and navigation can be tackled (Thomassen & Stentoft, 2020). Transdisciplinarity is defined through Benatar's work (2000) as "an integrated approach to complex problems using the methodology and insights from a range of disciplines with differing perspectives on the problem under consideration (p. 171)."

By 2014 when GSO began to emerge, STEAM had established itself as a significant phenomenon in Europe. In 2019, Perignat and Katz-Buonincontro were able to show that there were a variety of definitions of the inter-relationship between the five disciplines including transdisciplinary, interdisciplinary, multi-disciplinary and cross-disciplinary. Within this developing articulation of the field, GSO can be positioned as transdisciplinary STEAM practice as the science, arts and technology involved merge together rooted in an authentic inquiry (Glass & Wilson, 2016; Liao, 2016; Quigley et al., 2017), supported by a creative, democratic process. In a recent research commission Colucci-Gray et al. (2017) argue that STEAM enables connectedness; learners link knowledge and environment, becoming more creatively engaged and responsive to their communities; and teachers make connections with peers and external partners. Ben-Horin (2015) argues that science opera is able to demonstrate these processes in action when long-term pedagogical transformation transcends short-term partnership practice.

Alongside its development of and within STEAM education, GSO has also developed in the context of changing global education agendas. The Global Education First Initiative (GEFI) was launched in 2012 by the United Nations Secretary-General identifying fostering global citizenship as a priority. As Akkari and Maleq (2020) note, "this marked a paradigm shift: framing education in a global perspective and aiming to enable learners to understand global issues and empower them to take action (p. 4)." A global perspective on issues relevant to learners, addressed through a transdisciplinary approach is at the heart of GSO; alongside the potential of opera as a performative medium which can change minds and spur those engaging with it to take action in relation to the issue under scrutiny. GSO staff and participants are very aware that global education must be responsive to changes in conceptions of citizenship in order to address global issues (Akkari & Maleq, 2020).

In recent years, within both the STEAM and global education arenas there have also been marked shifts questioning human exceptionalism within posthuman and new materialist research (e.g. Braidotti, 2013) and critiquing Western onto-epistemologies via the decolonisation agenda. GSO has been influenced by these movements as they include arguments that it is only by decentring the human and acknowledging multiple onto-epistemologies that there is hope to address wicked global issues like climate change and democratic corruption (Chappell, 2021). Burnard and Colucci-Gray (2021) argue that in order to move STEAM beyond human exceptionalism, we need to work with alternative epistemologies that decentralize the human as knowledge producer, and acknowledge transdisciplinary intersections across scientific and

artistic ways of knowing and being in the natural world. Researchers such as McGinty and Bang (2015) are developing Indigenous STEAM education in collaboration with communities. They recognise that dominant Western epistemologies ignore the fact that the idea of decentring human influence has long been core to Indigenous thinking and practices. To avoid continuing the colonial legacy, those working posthumanly therefore must acknowledge the prior practices of these Indigenous thinkers and practitioners (e.g. Todd, 2016), especially when developing global practice such as GSO. Similarly within global citizenship education Reynolds (2015) articulates the influence of post colonial ideas which work to decolonise education that claims global reach and to disentangle it from its Euro-centric frame. Hacking and Taylor (2018) spotlight the key tension to argue that educators need to go beyond anthropocentric notions of education and consider 'international mindedness' within a posthuman frame. This means affirming nonhuman-human assemblages, enabling distributed agency and rethinking ethics. They draw on the posthuman turn to argue that within global education, the nonhuman or other-than-human should be part of the educational conversation too.

In this complex context GSO continues to develop and work to make a difference to how learning happens, to consider who is learning and with what, and how all elements approach learning together. Whilst acknowledging the decolonisation agenda's importance, the GSO team has developed a growing curiosity with how creativity works within the initiative, as a driver for this more dispersed kind of learning and also as a driver for change within GSO and for creative actions that ensue in relation to global education. In this article, we therefore focus on our journey into posthumanising creativity, continually raising questions about what this framing means for developing GSO's entangled artistic, pedagogic and research strands. We will use this platform to conceptualise creativity in GSO and raise questions for future consideration and development of practice.

Creativity as a central tenet – but what kind?

The notion of everyday or little c creativity (Craft, 2005) has been key to how GSO staff and participants have understood that everyone can be creative and that the originality and value of creative process should be judged for that person and/or their peer group rather than the world at large. Indeed, Chappell et al.'s (2011) notion of wise humanising creativity (WHC) was influential at GSO's inception as it refers to creativity as collaborative and communal, both of which are central to GSO's practices. WHC (Chappell et al., 2012, 2016) entails a welcoming of, and interaction with, opinions and values of others as the very way to realize the creative process. Ben-Horin et al. (2017) detailed ways in which this occurs in an educational environment characterized by inquiry across disciplinary boundaries of science and the arts. In this context, WHC theory allows an understanding of creativity which forefronts dialogue as the key driver for generating

new ideas, which also contributes to identity development of those engaged in a process of becoming.

Similarly to the way in which paradigms are shifting in STEAM and global education, GSO staff and participants have recently become engaged in arguments around decentring humans and Western onto-epistemologies within creativity in education and arts education research. Chappell has argued that it is imperative that we move beyond conceptions of creativity which position human needs as central; her 2018 and 2021 publications develop WHC theory into new territory which decentres the human by conceptualising posthumanising creativity. She encourages educators to consider how we might step outside of ourselves or 'de-centre' in order to address challenges of the Anthropocene (Malhi, 2017), which have been brought about by dominant Western blindness to our impact on the earth. Such challenges include climate-based problems (Leichenko & O'Brien, 2020), technological threats to democracy (Piccone, 2018), and political violence (Khalili, 2013) and extremism brought about by, amongst other issues, land competition and emigration. More recently those connected with GSO (e.g. Chappell, in press) have also started to incorporate decolonising and anti-racist theorising and practice into their pedagogy and research with this avenue a possible further development area for the GSO project as a whole. This will hopefully create space for what Sundberg (2013) refers to as multi-epistemic literacies: diverse epistemic perspectives – whether embodied, Indigenous or posthuman – to enact pluriversal understanding.[2]

Joining together these turns in STEAM, global education and creativity/arts in education research, we rely on Chappell's (2018) arguments to set out next how posthumanising creativity can be applied to understand and develop learning and change across GSO practices and to fuel students' and others' contributions to respond to wicked problems.

Posthumanising creativity as a framework for GSO

Posthumanising creativity (PHC) takes the posthuman turn in conceptualising creativity by decentring the human and offering an intra-active explanation of impactful novelty as generated by humans and other-than-humans (Chappell, 2018). As the initiator of posthumanising creativity, Chappell builds on long-standing arguments from Craft (2005, 2011), Preiss et al. (2016), Banaji et al. (2010), and Robinson and Aronica (2015) who contend that creativity should be at the core of education. All argue that, as educators, we need to prepare students for 21st century citizenship. Creative skills are crucial to this. Whilst organisations like the OECD (2018) position creativity in education as fuelling the workforce of tomorrow and related financial growth, others have countered this line (e.g. Craft et al., 2008). Craft et al., and in turn Chappell (e.g. Chappell et al., 2012), raise questions about how ethics and

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[2] For further insight into these elements which are beyond this article's scope, we point readers to Chappell et al., in press.

trusteeship might be better embedded within our understanding and teaching for creativity in education, what its value and impact might be and what the implications are of this line of thinking. Chappell's theorisation of creativity takes this question about ethicality and, in line with the wider posthuman turn (Taylor, 2020), goes further, to ask how we may incorporate both human and other-than-human ethics within creativity.

Chappell (2018) posits that, when we are being creative, we should acknowledge our active dialogue with other living beings, objects and environments; we are all embodied and agentic, and together we are enmeshed. Embodiment is perhaps easier to understand in relation to humans when we think about the theorizing of Merleau-Ponty (1964) who encouraged us not to see body and mind as split, but as a combined, 'embodied' entity. Posthumanists go further to argue that not only humans but also objects, art works, environments and technologies are embodied through the material which constitutes them, and how this material interacts with others around them. So, there is active focus on how material bodies, objects, spaces and environments, combined with human bodies, contribute to emergence of subjectivities, and their related ideas (e.g. Jusslin et al., 2022). In GSO, this means asking how do artworks, technologies, natural environments, sounds, teachers, movements, sciences, children, studios, instruments all enmesh together in the creative process to produce a Global Science Opera, and its related outcomes, ideas, subjectivities, learnings and impacts? For example, how and to what extent does this global approach to education provide space for individuals and wider society, to inter-relate with that which is beyond our own planet in a new way, and thus understand/experience ourselves differently? In what ways may a global educational environment contribute to inviting pedagogical humility on the part of human participants in the educational context? Can the GSO classroom's global dimension provide a stepping-stone to new points of view from which we may research with, and better understand on their own terms, other-than-human participants in the creative process? Will the global perspective help us teach, learn and research like or with a tree? A libretto? A galaxy? What would that mean? Which pedagogical approaches would that unleash?

The importance of intra-action and dialogue

Posthuman theorists have coined a new term for this more intensely enmeshed form of interaction – 'intra-action' (Barad, 2003). Barad sees humans and others engaging in a process of becoming through their intra-action. Each is changed and emerges differently through intra-action – each is being made through the intra-action and is expressing agency. Barad (2003) argues that "things do not have inherently determinant boundaries" (pp. 812–813), and that, whilst potentially different, the boundaries between 'people and people' or 'people and objects' are not clear cut. Humans are "phenomena…beings in their differential becoming, particular material re-configurings of the world with shifting boundaries and properties that stabilise and destabilise along with specific material changes in what it means to be

human" (Barad, 2003, pp. 818). By applying this notion of intra-action to creativity and arts in education to GSO, we are arguing that children are 'becoming' through their engagement with everything around them, globally. They do not develop in isolation but are co-dependent on the environment, technologies, artworks and all kinds of others to shape these becomings which are defined by their dispersed nature. Creative outcomes in their multi-various forms are becoming too. This is a different way of theorizing creativity compared to individualized, cognitive theories which root creative process in critical, convergent and divergent thinking, as the domain of human beings (Vincent-Lancrin et al., 2019). For GSO, this means that we would benefit from 'de-centring' the site of creativity from the human, and theorise/practice it as dispersed and enmeshed across this broad range of intra-actants. With GSO focusing on themes such as the ocean, gravity, energy and ecosystem restoration (www.globalscienceopera.com) it is already engaging with wicked problems that have potential for 'de-centring.' As outcomes, such as operas, learnings and other intra-actions between children-environments-technologies,[3] emerge from each GSO process, they have the capacity to impact, and have agency, in dispersed ways; to contribute to arts, activist and environmental initiatives, and to make change in relation to the Anthropocene challenges discussed earlier (Robberstad, 2017). It is from here that we may ask whether and to what extent learning together in a global context allows intra-action with that which exists beyond our planet as a more concrete element in the creative process.

GSO has inquiry at its creative heart; and this can be conceptualized using posthumanising creativity which has dialogue at the heart of the above-detailed intra-actions. Posthumanising creativity is driven by curiosity, where question leads to answer leads to question in dialogues (Bakhtin, 1986) between different kinds of 'others.' New knowledge is created through dialogic interactions between 'voices' embodied not just in humans but in 'others' – texts, movements, artworks, artefacts, experiments, thus resonating with the posthuman notion of intra-action (Bakhtin, 1986). In Chappell et al. (2019) we acknowledge this pre-posthuman theorizing of the 'other' and couple it with Barad (2007) who understands agency as a relational performance entangled within an assemblage of material and embodied humans and other-than-humans. Matter and materiality are thus not inert objects but dynamic phenomena.

Regarding addressing Anthropocentric challenges through education, posthumanism therefore asks us to dialogue differently with artworks-environment-technology, etc. It requires us to attend to new and different ways of being and becoming. GSO structures and processes already exist which promote de-centring. One example of this is that digital technologies are integral to GSO productions, thus necessarily

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[3] Whilst we are currently restricted by English language use that provides humanist signifiers such as 'children,' 'operas,' 'oceans,' one convention increasingly adopted in posthuman writing is to use hyphens to indicate the intra-acting nature of actants into new phenomena.

including technologies' possibilities, challenges, and the ways in which GSO participants are intra-acting with them, as central elements in the creative process. Another example is the scientific theme which provides the inquiry's focus during each annual production. That theme (e.g. ecosystem restoration) guides much of the creative process. Perhaps a next step in practice is to consider how humans and other-than-humans within GSO can attend and listen to each others' ways of being and becoming, to gain even more creative potential from these intra-relationships. So, for example, GSO's global dimension means that when a global community joins hands, that joining, in itself, provides potential to explore both human to human intra-action (seeking greater justice for all ways of knowing) and to explore beyond the globe (e.g. solar system-moon-universe) in a previously impossible way. So creative intra-action might happen on a planetary level and/or stretch to include elements outside of our planet, but either way each participant, human, or other-than-human is equally important within the process.

It feels timely to ask, How can GSO creatively make space for the varied cultural ways of knowing that such a global initiative brings? In particular, what does this mean for opera as the central art form, which is Western by heritage and brings with it a colonial tradition? A partial response is that GSO is designed to build upon the richness of all cultural expressions and traditions, whilst ensuring everyone is free from harm. Indeed, one of the challenges involved in each GSO production is creating artistic statements which honour differences while keeping doors open for all cultural (e.g. musical) expressions. Previous productions have included music contributions inspired by e.g. bossa nova, African percussion rhythms, pop, hip-hop, traditional European music, and electronic music. This is, however, an area in which GSO is actively critiquing and developing its practice for the future.

The role of ethics

We have therefore established why and how we might theorise other-than-humans as part of the creative process, as well as beginning thinking around inclusion of multiple ways of knowing and being. We will now consider what this means for ethics in a creative GSO context. Taylor (2018), Chappell (2018) and Lissovoy (2010) argue that we can expand how we think about ethics and responsibility. Making the 'posthuman turn' and aiming to decolonise practice implies moving beyond limitations of Western, humanist ethics. These pay little attention to the other-than-human, rather they often impose Western human moral judgement frames on humans and other entities, such as the environment and technology. If we are to take steps towards addressing the challenges of the Anthropocene, we would benefit from 'decentring' our approach to ethics too so that we take responsibility, care and empathise in a more just and dispersed way. Hacking and Taylor (2020) remind us that the posthuman turn is very practically grounded, and is an "ethico political orientation requiring us to live in the knowledge that 'the Earth we inhabit is not an optional element' (Braidotti, 2020, pp. 27)". So, if GSO is working to centre appropriate

ethics for socially just intra-actions between all humans and with, for example, the ocean, gravity, energy and ecosystem restoration (all GSO opera themes), the GSO creative process must allow for responsibility to emerge as a conversation between human-and-human and human and other-than-human in order to respond to today's 'wicked' problems. As Braidotti (2013) argues, this way of enacting ethics combines human self-interest with the wellbeing of other-than-humans which creates a more even playing field. Concerns of all actants are therefore part of the ethics, rather than one group of actants dictating ethics for the collective. For example, the ethical concerns of a tree that has been alive for over 4,800 years (Bauza, 2022) will be very different to a particular cultural group of human beings who at best will survive 90 years; these ethics need attending to through different ways of knowing without humans taking control. But it is more risky – there is no moral checklist to follow here. Indeed, it would require humans to take steps in the opposite direction to where our basic instincts might otherwise lead us. We have, since the dawn of our existence, honed our abilities to acquire resources of food, water and shelter in order to survive and thrive (Epstein, 2009; Nicholson, 1998). Would extending other-than-human ethics into our physical, emotional lives, imply our willingness to sacrifice our power as humans (Pavid, 2022) for the better of other-than-humans?

For GSO, as a process enabled by digital technologies, there are important technological implications around ethics of creativity. Here we return to the idea of becoming. Through their intra-action with each other, differently embodied or materially configured entities (e.g. artworks, virtual realities, children, software, visiting scientists) are changed and emerge differently. Each has their own ethical offerings. Through these intra-actions, we need to pose questions such as what it may mean for a libretto to stay true to its intention, indeed for a virtual reality environment to show ethical responsibility, all in intra-action with each other? Osberg (2018) draws on Jonas (1984) to suggest that we might think of ethics within technological situations as those of long-range responsibility. Within virtual worlds and digital spaces, it is hard to see the ethical upshot of our actions and to apply a moral code to the results; for example a post on social media can quickly have impacts beyond your awareness, and can shift out of your control in terms of how it is used practically and ethically. Hence the need for a new notion of long-range responsibility. Osberg argues that this process is never under our control. If we allow ethics, responsibility and care to emerge from the intra-action (e.g. of the libretto, the visiting scientist, the child, the software and virtual environment), we are engaged in lively, activist and responsive conversations and actions about ethics, working relationally to enact care between human-and-human and other-than-human and human. This does not mean ignoring or letting go of responsibility but listening and attending for it in different ways – acknowledging the different ways of being and becoming that generate it. In GSO, when listening for that responsibility, participants' local culture, arts practice and experience may not suffice. Perhaps access to, and active involvement with the digital technologies which shape and enable GSO productions is a way to stretch this

ethical understanding and practice beyond the local to a larger collective consisting of all sorts of others, with differing ethical workings.

To summarise the posthumanising creativity framing then, we are creating a way of understanding GSO which articulates emergent creativity through embodied dialogue and intra-actions of humans and other-than-humans (anything from the natural environment, to technology, to the school-built environment, to the objects of opera and science, even beyond the planet and the wider solar system). But we are not just interacting with these 'others' as context, our 'intra-action' with them creates our emergent subjectivities and shapes us and them through a process of becoming. We listen, attend and act differently when we are aware that intra-action is at the heart of our relationships. We understand that we are becoming and learning through the intra-active creative process, as are the other-than-humans around us. This shifts us away from trying to impose Western human ethics frames or competencies onto humans and other-than-humans and encourages us to think about the ethics of creativity as generated by relational empathetic subjectivity from embodied and enmeshed actants. This leads to new questions about relations of ethics and technology: are GSO participants better-equipped to apply ethical considerations to the development of technology, or at least to the practice or usage of it? With posthumanising creativity as a frame for thinking about and enacting creativity, GSO therefore has a greater chance of helping children to creatively respond to the changes and challenges of technology, relationships and sustainability, and of 'becoming' in relation to those changes, because it will actively incorporate the changes' sources into its creative activities and the ethics through which they are judged.

Posthumanising creative pedagogies

On the one hand we talk about posthumanising creativity as relevant to conceptualise GSO, but we can also gain from thinking about the related creative pedagogy and how this influences the shape of the creative process. By creative pedagogy, we mean the inter-relationship of teaching for creativity, teaching creatively and creative learning (Jeffrey & Craft, 2004). Page (2018) argues that we can benefit from being more aware that we are teaching and learning *with matter*; she emphasises that material pedagogies are embodied, where bodies are being taught and are learning "with matter and between spaces, where matter teaches us what it can and cannot do" (p. 1). Much like the definition of posthumanising creativity detailed above, she focuses on relationality. She does this in order to become clear about the "ways, materials and spaces of pedagogy" (Page, 2018, p. 1) so that she can recognise and know how to create these places to facilitate materially-grounded emancipatory pedagogy which resists dominant discourses. Here we see the call for equality and justice emphasised. Page becomes conscious of the ruptures and disruptions that a focus on intra-actions with matter can produce, the space for questioning and new potential it creates, and the renegotiations of learner-teacher-material relations. She is seeking

and shaping a conception of pedagogy which is about learning how to be in the world and how this can become a practice of freedom.

Influenced by Page's provocative call to arms, research into posthumanising creative pedagogies demonstrates how humans can be decentred and other practices and matterings can be brought in from the sidelines (Chappell et al., 2019; Chappell et al., 2021). Posthumanising creative pedagogy is clearly about encouraging embodied dialogue, allowing space for empowerment and agency, and doing ethics and trusteeship differently. Chappell et al. (2019; 2021) have explored posthumanising creativity in school-based STEAM and higher education and show that the detail of this pedagogy includes breaking subject boundaries, re-balancing verbal and written knowledge with embodied, felt, care-ful, slower, material, affective ways of knowing, de-centring human knowledge to more equally include other-than-humans and emergent ethics. Posthumanising creative pedagogy also favours flights of imagination, real life rather than hypothetical experiences and improvisational approaches that might involve confusion (Holdhus et al., 2016). These studies show that it forefronts the role of emotions, feelings and expression (including all actants/materials); those engaged in it are interested in making a real difference; again reiterating the social justice thread above. GSO's pedagogical structure is such that, resonating with these previous studies (Chappell et al., 2019), it already aims to accommodate flights of the imagination, real life scientific challenges and an openness towards improvisation (Ben-Horin et al., 2017). It can achieve this because there is no single human being at the centre of the project. Nor does any single institution constitute GSO's centre. In GSO, participants collaborate with those in other geographical locations in order to be part of the creative process. Thus, GSO provides an important experience of learning to operate with recognition of multiple others and multiple centres. Participants enter a space for empowerment of their ideas on a global stage. And GSO is enacted as a mechanism towards social justice: whilst being alert to digital access inequalities, it is the aim that anyone regardless of financial or other resources is welcome and able to take part.

Turning to how pedagogy then influences the shape of the creative process, both posthumanising creativity and GSO have explored this idea[4] and how this might be relevant to any outcome that might ensue (Ben-Horin et al., 2017; Sotiriou et al., 2021). If we apply this idea of the creative process having an emerging shape, understanding of which aids facilitation, we can further benefit from heeding both the human and the other-than-human intra-action within it. GSO, framed by PHC, already reflects this because it includes the other-than-human as part of the core themes within which the inquiry is happening. For example, the ocean in the *One Ocean* opera, gravity in the *Gravity* opera, particle physics in the *Ghost Particles* opera, and ecosystem restoration in the *Thrive!* opera.[5] Thus, posthumanising creativity as a

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[4] See also Drew (2019) for a discussion of "shape" in a Design Thinking process.
[5] See www. globalscienceopera.com/productions/ for further details about these productions.

way of understanding GSO may be able to contribute to describing distinct, eclectic creative processes' "shapes" emerging from, and as functions and representations of, the topic of each opera production. We are therefore confronted with the following kinds of questions: in what ways does the creative process occurring in a global opera about special relativity differ from the creative process occurring in a global opera about general relativity? Could an opera about quantum physics include within it multiple endings which are unknown to the audience? Could an opera about the nature of light include two parallel stories – one shaped as a wave and the other shaped as a stream of photon particles? Future responses to these questions will move GSO further into posthumanising pedagogic practices.

Symbiotically moving forward

Within this article we have therefore set out to offer a posthumanising creativity framework for GSO, in the context of, and acknowledging a similar posthuman turn in global education/citizenship and STEAM education. This raises questions about how global educational practice can work with other-than-humans and humans with greater equity and acceptance, in the hope of better dealing with wicked problems.

   In responding to this, we have argued that GSO is ripe for further including all humans and other-than-humans within its creative processes and practices, and for capitalising on outcomes, ideas, subjectivities, learnings and impacts which ensue from human/other-than-human intra-actions. We have suggested that GSO could go so far as to creatively de-centre humans in order to allow for PHC's more dispersed kind of agency, to dialogue differently with environment and technology, and therefore educationally contribute to addressing some of the Anthropocene's challenges, which might include the climate crisis, political violence and the unknown ethical implications of artificial intelligence. A posthuman approach is better able to do this because of its inherent intra-active understanding of relationships; dispersed agency might better solve wicked problems grounded in dispersed and complex networks of elements and issues. By framing GSO with PHC, we are also proposing it takes a more emergent approach to ethics and responsibility, that perhaps has a political and even activist element.

   There are also now pedagogical questions to explore by applying current research in posthuman creative pedagogies. Page's (2018) work is shown to be useful here to highlight how we can teach and learn with greater awareness of matter, and that this can lead to emancipatory pedagogy which resists dominant discourses. To some extents this also connects the threads around equality and social justice raised by the decolonisation agenda. It provides a pedagogical means for GSO staff and students to not only understand better their relationship with matter, but also to start to respond to the challenges of decolonisation. This will require a questioning of Western privilege and creation of greater space for cultural expressions of all kinds, including from indigenous practices. This can create tensions and discomfort for some, but

is necessary in order to contribute to what Glaveanu (2020) refers to as creative global citizenship. He sees this as working with issues around democracy, diversity, dialogue, multiplicity, participation and ethnicity. As Andreotti and De Souza (2012) argue we need to face up to the lack of analysis of power and knowledge construction which continues to marginalize particular groups. This can unintentionally maintain patterns of marginalization which we hope initiatives like GSO have the potential to disrupt given a productive engagement with the creative process.

A final emergent point from this article is the importance of understanding that the posthumanising creativity framing means that GSO as an educational initiative will, by default change itself *from within*, and also change the systems within which it exists *from within*. We hope this is clear from the explanation above that the dialogic intra-action of humans of all kinds and other-than-humans changes those intra-actants, which in turn means that, for example, the virtual learning environments, the curricula and the educational systems within which posthumanising creativity occurs are also being changed.

Taking into account Osberg's (2018) work, we have tried not to overly envision but to ask questions to provoke ourselves, hoping that GSO through the frame of PHC emerges through practice, writing and experience. Osberg warns against visioning as part of what she describes as *extrapolatory anticipatory* practice where the future is mapped out through extrapolations of the past and present either through creative or democratic imaginings. These practices maintain humanly driven structures and ethics and, she argues, always fail to take education out of the status quo of trying to achieve the moral criteria of "someone's normative vision of a good future" (Osberg, 2018, p. 14). Osberg (2018) recommends that instead, we work with a *symbiotic anticipatory* practice, to "play with the possibility of what is not-yet needed…togeth- erness in difference: a fusion of mutual inspiration and an experimentation with the unknown other" (p. 14). This then allows for possibilities which we, as humans, could not have envisioned or even have known were possibilities.

So, within GSO, this could be a subtle or more obvious process. For example, being part of the initiative might alter how a teacher from the Global South goes about their pedagogy in conversation within the local natural environment; the ensuing online performance might be viewed by a policymaker in another country, perhaps in the Global North, where there may be leverage to blend across subject boundaries and educational/environmental policy implementations to address Anthropocene chal- lenges; which leads to engagement in GSO in a new country and changes in that curriculum and how environment-children-teachers creatively learn and intra-act within it, and so on. In turn, we may come to see this conversation between GSO and PHC as generating a creative educational endeavor which meshes together various cultures, religions, ethnicities and other-than-humans such as trees, oceans, animals and the moon, enabling them to learn and change together productively. We hope it provides an example of how PHC might prove a productive way to understand crea- tivity more generally within education. And, the more we, as a community including

all 'others' (whether environments, technologies, other living beings or objects), are aware of the possibilities of PHC, the more we can capitalise on them.

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