Reflecting on Boundary Crossings between Knowledge and Values: A Place for Multimodal Objects in Biology Didactics?

Abstract
Through a series of practice-based narratives, drawn from specific experiences in a higher-education context in Sweden, the affordances of multimodal objects are reflected upon. In this work, multimodal objects are considered as boundary objects that can facilitate learning conversations, both cognitive and affective. Current work in science education research has highlighted the role that boundary-crossings between knowledge and values offer teaching and learning. The author believes such boundary-crossings to be essential in the current context of prolific species extinction, on a planet in which human-made materials now outweigh the living biomass; a planet in which life, death, self and other are ‘braided vulnerabilities’ across a complex socio-biological landscape. Thus, in these iterative, practice-based reflections on specific teaching moments, this paper offers small steps towards reimagining biology didactics in the ‘post-normal’ conditions of the 21st century. In so doing, possibilities for multimodal objects in contemporary biology didactics are reflected upon and suggested.

INTRODUCTION
Entangled time and space between plant, animal and human are more than an individual lesson; they hold deeper possibilities to be immersed in the complex interconnectedness of ecological life (Nyberg, 2017), but how can these ‘braided vulnerabilities’ (Radomska, Citlalli, Gómez, Pevere & Haapoja, 2021) be present in biology and biology-related teaching in ways that resonate with students beyond subject-content knowledge?

Loughran (2002) has described reflective practice as «a lens into the world of practice” (p. 33). In this paper, the focus of this ‘lens’ is an individual teacher reflecting on selected teaching experiences enacted in a higher education setting in Sweden over nine years (2012-2020). Specifically, using multimodal objects in boundary-crossings (Star & Grisemer, 1989) between knowledge and values in biology education with three student groups following different courses within teacher-education (two courses), and in education for sustainability (one course). In the context of the current planetary global crisis such reflections are deemed to be critical.
The current study takes its point of departure from reflections grounded in individual teaching moments, situated in relevant literature. In making such personal reflections public this work seeks to highlight the role of «private framing and reframing of episodes of teaching» (Harrison, 2012, p.8) in developing self-understanding as a teacher. The current work focuses on building relationships between knowledge and values through specific teaching and learning scenarios. In addition, it seeks to constitute such reflections in relation to the socio-biological challenges presented by current extinction rates (IPBES, 2019) and the tipping point reached by human-made materials (Elhacham, Ben-Uri, Grozovski, Bar-On, & Milo, 2020). Critically, this work highlights the negotiating potential of multimodal artifacts and tools as boundary objects (Lee, 2007; Star & Grisemer, 1989) between knowledge and values in biology education (Alsop, 2016; Alsop & Dillon, 2018; Bird Rose, Dooren Van, & Chrulew, 2017; Reiss, 2020,) and between art and science approaches to knowledge and inquiry (Colucci-Gray & Burnard, 2020; Østergaard, 2020). Multimodal objects in this paper are objects which consist of various forms including three-dimensional and two-dimensional artifacts and images, with affordances for boundary-crossings between knowledge and values, art and science. These boundary-crossings are reflected upon, and the boundary negotiating role of such objects in biology didactics is highlighted.

Kelchtermans (2009, p.261) defines understanding the teaching self as: “The understanding one has of one’s ‘self’ at a certain moment in time (product), as well as to the fact that this product results from an ongoing process of making sense of one’s experiences and their impact on the ‘self’”. The self-reflections presented here have been conducted as part of a repeated cycle of planning, teaching, reflecting, planning, teaching and so forth. In this respect, this narrative-based study (Moen, 2006), as here depicted, can be viewed as the ways in which an individual teacher’s self can develop and be networked into larger discussions concerning studies into the teaching of science. Underpinning this current work is the assertion by Harrison (2012, p.8) that: “Being a reflective practitioner at any stage of teacher development involves a constant, critical look at teaching and learning and at the work of you, the teacher.” This ‘constant, critical look’ has not been an individual act of analysis, but one in which others have participated; either as ‘critical friends’ to the emergent study, or as co-teachers in the courses considered.

BACKGROUND
Current extinction data on both plants and animals is extensive, and growing, for example the International Union for the Conservation of Nature (IUCN) estimates that 35,000 species are threatened with extinction; this, they observe, is 28% of all known species (https://www.iucnredlist.org/). Similarly, reports from IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) affirm the depth of loss across the diverse kingdoms inhabiting Planet Earth. As Bird Rose, Van Dooren and Chrulew (2017, p.1), have noted: “At this very moment, many of Earth’s living kinds are slipping away; sometimes quietly, sometimes in bright bursts of controversy, chaos and pain”. Moreover, Planet Earth has reached a tipping point in which human-made materials now outweigh the biomass of the planet (Elhacham, et al., 2020). In addition, the COVID-19 pandemic can be seen as a prism: “shedding light on the issues of environmental violence; social and environmental injustices; temporal, spatial and material scales at work in the Anthropocene; more-than-human and non/living agentiality; and ethico-political responses that the present situation may mobilise” (Radomska, et al 2021).

Hence, in an era in which human-related activities are rapidly changing planetary constituents, the teaching of biology can be seen to require further incorporation of affective approaches (Alsop, 2016; Alsop & Dillon, 2018) in order to consider the critical question ‘what is science education for?’ (Gilbert, 2015) in such historical contexts. More specifically, in biology didactics, we might ask of ourselves, as teachers - what we require from our courses, following on from Reiss (2020, p.462) who requests: “Do we want biology courses, in addition to the content they include and the skills they
develop, also to shape students’ attitudes and behaviours? Do we want students not only to be able to write about the causes of biodiversity loss but also, passionately, to care about this?”

The current work is a response to such debates. It seeks to establish a boundary-negotiating role for multimodal objects in contemporary biology didactics and present a case for interweaving art/science approaches (Østergaard, 2020) to teaching. The use of multimodal objects, as a means to generate these boundary-crossing moments, is described and reflected upon. A boundary negotiation in this work can denote a teaching moment when, for example, an artwork, is used to prepare students to attune themselves to Life as Plant before going outdoors to investigate living plants existing in specific sites.

**THEORY: BOUNDARY NEGOTIATING OBJECTS**

The work of Lee (2007), and her assertion that “artifacts can be used to push boundaries” (p.308), and thus extend into ‘boundary negotiating artifacts’ (Lee, 2007) is utilised. Lee’s conceptual development of Star and Grisemer’s original research on boundary objects (Star & Grisemer, 1989) appears to be particularly salient when considering opportunities to direct students towards a deeper affective integration with ethics and values in biology didactics. This work has been drawn upon because of its consideration of both disciplinary and topical boundaries and the multiple ways in which diverse boundary objects can be situated in relation to boundary-crossings between different contexts and communities (Star & Grisemer, 1989).

**METHODS: STORIES FROM PRAXIS**

Using ‘narrative biographical stories’ (Kelchtermans, 2009), drawn from specific teaching moments, the role of multimodal ‘boundary objects’ in three higher education courses is considered. These stories are taken from specific courses the author has developed and taught for a minimum of four years. The collected narrative data consist of planning notes, photographs of student work produced in the lessons and analysis of the themes arising in reflective notes made by the author post-teaching. Boundary objects are “Objects which are both plastic enough to adapt to local needs, and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites” (Star & Grisemer, 1989, p.393).

The narratives presented here are by no means a complete story; it is ‘interactive sense-making’ (Kelchtermans 2009) in action and, as such, exists within an ongoing cycle of teacher-generated reflective narratives in order to create “possibilities for enhanced meaning making” (Loughran, 2002, p. 40) through “the ability to frame and reframe the practice setting, to develop and respond to this framing through action” (Loughran, 2002, p.42). Through making meaning from these post-teaching reflections, the plasticity of the boundary objects appears flexible enough to cross boundaries between different epistemic arenas, but robust enough to afford biological curriculum content, such as plant ecology.

From these repeated cycles of planning, teaching, reflection and analysis have come emergent ways to link art and science through teaching encounters that create affect, and make curriculum connections between material and imaginary worlds. Critical to these actions of negotiating boundaries is the differentiation of “order, sequence and choice” (Hopmann, 2007, p.118) and the decisions a teacher makes in relation to curricular content, didactical processes and didactical objects used with her students. Hence, the order and sequence of the reflected teaching is discussed and framed by the didactical choices made, in specific teaching situations. Wolfe (2017) has noted: “Extinction-whatever else it may be - is never a generic event and its always a multi-contextual phenomenon requiring multi-disciplinary modes of encounter” (p.viii). In this context of extinction, the teacher’s approach intentionally crosses disciplinary boundaries and utilizes boundary objects chosen for their affective affordances.

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RESULTS: SITUATED VIGNETTES

In the following section three vignettes are used to make public an individual teacher’s reflections on teaching situations in three courses in which change has been enacted in relation to a) planetary contexts discussed in the background section and b) student responses, as documented in the author’s teaching notes made post-lesson. As Brizuela, Stewart, Carillo & Berger (2000, p. xvi) note, in their work on qualitative research, “ethics and validity emerge from researcher’s acts of inquiry as they revisit and question these issues and themselves throughout the research process”. This was the case in the current work, and in the author’s ongoing praxis as a teacher/researcher.

These situated reflections, although grounded in individual teaching praxis, have been reflected on in the context of reading relevant studies, and from 2015, in the case of the first vignette, in a funded interdisciplinary research project concerning perceptions of plants and animals and student teachers. Thus, these reflections have become contextualized, both within the literature and emergent research. These seemingly small events in the teaching become integrated with the research findings to be put back into practice within courses at the university and more broadly, in workshops for practising teachers external to the university. In this respect, a single teacher can exist in a constellation of networks of teaching and research practices oriented in various groups concerned with both teaching and research. Critically, for the author, these constellations have become embedded in an iterative cycle of reflective practice, as an individual teacher and with others involved in higher-education teaching, both within, and beyond, work groups and departments.

The first vignette concerns student secondary (gymnasium) biology teachers, the second an optional international course: Teaching for Sustainable Development in a Global World. The third, and final example, is from a course for student teachers in early childhood education (ECE). As the groups in focus are both student teachers and education for sustainability students the generic term ‘students’ will be used throughout.

VIGNETTE ONE: LEARNING TO LOOK AT PLANTS

Learning to Look at Plants was a science didactics module for students of secondary school biology on a four-year teacher-training programme. The module was initially planned with an inquiry-based focus drawing on scientific narratives that aimed to animate plants beyond “victims in a series of photosynthesis experiments that don’t always work” (Slingsby, 2006, p. 53). Before moving from the campus classroom to the garden the students experienced an introductory talk, which planned to:

Look at plants in relation to plant forms, adaptations and survival strategies in relation to their habitats and ecosystems. We will discuss the notion of ‘plant blindness’ and ‘zoocentric teaching’ and how, as teachers, we can support learners in looking more closely at plants and the plant stories we can tell to shift their attention from animals to plants

[Extract from Course Guide].

After the introductory talk, the subject-content and didactical choices were enacted by the teacher, (the author), in the following sequence:

a. Choose some interesting plant stories (in relation to current scientific research on form and function, environment, adaptations and survival) related to the curriculum and discuss them.
b. Outline some specific obstacles in teaching plant biology drawing on relevant educational research papers concerned with ‘zoocentrism’ and ‘plant-blindness’ (Nyberg & Sanders, 2014)
c. Take students out to look at specific plants with magnifying glasses, share some thought-provoking stories and dissect a carnivorous plant while telling the story of how, and why, it is adapted to trap insects. Then, discuss current scientific research on mutualistic relationships between carnivorous plants, tree shrews or bats (Clarke, Moran, & Chin, 2010; Schöner et al., 2017).
Tripp (1993) writes about ‘critical incidents’ in teaching. Two events were critical in changing the way the original planning and teaching of this module were developed: the first, on one-occasion, early on in the programme, when the opportunity arose to add an additional teacher to the session—a teacher of ‘bild-didaktik’, which is the teaching of image-based subjects. This changed the epistemic focus of the module towards a more art-based focus using historical plant models and encouraging students to make observational artworks. The second was when, in response to this co-teaching approach, the teaching moved towards an interdisciplinary style of science teaching (Colucci-Gray & Burnard, 2020). This teaching partnership drew on the author’s previous fine art experience alongside recognition of the contribution that art, as a way of thinking, could make to science education in both planning and teaching these classes. In response to the aforementioned critical incidents this module was then reframed to include a specific painting, as a ‘boundary object’ (Star & Grisemer, 1989) between classroom and botanic garden. The chosen painting, and its educational use as a boundary object, is discussed in the following section.

Over the last two years the teaching of this module has involved the use of Dürer’s painting, Das Grosse Rasenstück, (The Great Piece of Turf) from 1503 as a ‘boundary object’ (Star and Grisemer, 1989) used to negotiate (Lee, 2007) boundary crossings between classroom and botanic garden, and between human observer and emergent understandings of ‘Life as Plant’. Dürer’s painting is recognised, as an image that resonates with “the vibrancy of lived life” (Aloi, 2019, p. 57) as a plant. In addition, Dürer provides an intimate portrait of everyday plants without a human presence (Sanders, 2022). Thus, for a teacher of biology the painting offers a visual narrative through which students can begin investigating Life as Plant, as documented in the next section.

In these indoor classes, laminated colour reproductions of the painting were used in small groups to consider plants and plant-life. Students were given coloured marker pens that had the capacity to be rubbed off. This meant that changing ideas could be mapped, and re-mapped, onto the surfaces of the images. Each group then placed their images, and the mapped marks and words, onto the classroom board using magnetic holders and chose a spokesperson to talk through their encounters with the painting and the thoughts and ideas it brought up for them in relation to plant-life. The diversity of responses was surprising, not just in content, but also in form. Some students responded by writing questions concerning plants and their lives, others drew lines around areas on the painting that had captured their interest and promoted their discussions; others highlighted, in text, possibilities to draw out conversations concerning speculative inter- and intra-relationships in the painting— for example, what insects might pollinate the flowers, what animals might eat the plants, what other organisms might be present in the soil. Thus, this multimodal tool, through presenting a ‘being with plants’ position, opened up opportunities to participate in knowledge-building discourses of biological science through the medium of art. It is in these relational moments that multimodal experiences seemed to afford a more integrative discourse between ‘being with’ and ‘knowing about’ approaches to biology didactics, specifically notions of life and death in relation to Life as Plant and reflecting from a self and other perspective; actions that art and artistic practices can afford in the context of plant biology education (Snæbjörnsdóttir et al., 2020).

Figure 1: Student responses to Dürer’s painting. (Photograph: Author, 2019).
Once the students accessed the botanic garden, further art-based tools were used to develop their experiences of being with, and knowing about, plants. Much of this work was the result of reflecting on how the students might be engaged with the life of plants, in the light of numerous obstacles, well documented in educational research literature (see for example Thomas et al., 2021).

Returning now to the teaching of this course, the revised introduction included a discussion of approaching plants through a ‘being with’ and ‘knowing about’ “angle of arrival” (Alsop & Dillon, 2018, p.52) and the differences between these approaches in relation to affective and cognitive learning arenas. Interestingly, this discussion caused some debate in the class, with a minority of students expressing the wish to skip the ‘being with’ part and go straight to ‘knowing about’. The fully revised programme included: group work with the Dürer painting in the classroom, outdoor activities focused on seeing diverse greens using a prepared viewing frame made of card through which to look at a specific group of trees and shrubs. An outdoor ‘toothpick safari’ (a quadrat frame used with small cocktail sticks and flags) to consider ecological narratives within the frame. The use of mirrors, to see the forest canopy from a different viewpoint and working in the greenhouses looking at multiple adaptations to environments such as, desert, rainforest and bog.

This expanded programme resulted in changes to students’ perceptions of plants and ways to teach with, and about, them. Thus, students appeared to understand, through verbal comments made during class discussions and activities, why the course was structured in this dual way and the role combining affective and interdisciplinary approaches can play in biology education.

Using the painting as a ‘boundary negotiating object’ (Lee, 2007) between classroom and botanic garden helped the students to attune their noticing and questioning skills before going outside. Once outside there were further activities constructed to frame their attention to specific aspects of plants and their ecological interactions. Thus, observing and noticing within an artistic frame was transferred and translated into a conventional scientific one: the quadrat. However, the ways in which the quadrat was used in the outdoor teaching went beyond measuring plant populations towards a deeper noticing; drawing on narrative-based discussions of what might be happening within the frame at multiple levels (Sanders & Davies, in press). In this way, the dynamic nature of Life as Plant in relation to predation, reproduction, nutrition etc. was made more public through the use of observation, speculation and narrative skills drawn from both artistic and scientific epistemologies.

VIGNETTE TWO BEING BIRD: MEETINGS WITH MORTALITY

The spaces in which we teach, and the objects available to us in our teaching, can impact on how we teach (King & Achiam, 2017). Especially, when we teach subjects that are intrinsically connected to the material world, as in the case of biology education. The second teaching situation is a short module offered to international students from other universities: Teaching for Sustainable Development in a Global World. The opportunity to teach on the course afforded the development of a completely new module. Again, as in the previous example, the author’s biography came into play; this time one of museum educator/researcher reflecting on the potential of taxidermic specimens (Sanders & Hohenstein, 2015; Meehitiya, Sanders, & Hohenstein, 2019).

This module drew on an extensive taxidermic collection within the faculty of education; a large repertoire of birds used to assist teacher students in their development of Swedish species recognition. However, in the teaching for sustainable development in a global world course, the birds’ ‘afterlives’ (Alberti, 2005) were used as a provocation to speculate on ethical questions concerning the lives these birds had lived and how they might have died. Hence the bird/human values interface was afforded priority over biological knowledge, such as naming the species and related information, for example habitat preferences and position in the food chain. Recurrent student-generated questions in these sessions included: ‘Are they real?’, ‘How did it die?’ and ‘Is it right to kill them just to have them as specimens?’.
After reflecting on student responses to this initial configuration of the course, the contents and sequence of the teaching were adjusted to allow for more boundary-crossings between biological knowledge concerning the identification of the bird, its lifecycle, habitat and potential threats and affective questions concerning their life experiences. This change resulted from a wish to create a more situated experience of specific birds and the environmental challenges they face. One of the dead birds in the faculty collection was an Albatross, so, in the new configuration, students were linked to the documentary film: https://www.albatrossthefilm.com/, in which an island, Midway, and its Albatross population are shown to be entangled with human life by way of plastic waste circulating in the Pacific. It is a meeting point between Bird and Human: Life and Death. The documentary maker, Chris Jordan asks, in the film: “Do we have the courage to face the realities of our time and allow ourselves to feel deeply enough that it transforms us and our future?”.

Through the introductory film and stills from the film, students witness both the biology of the birds in their habitat and their feeding actions alongside human impacts. In the classroom they are presented with the proximity of a large taxidermic specimen, which they can touch, and look closely at and experience. Through the speculative biographies they are asked to write and/or draw; they can imagine being bird, being Albatross, and reflect on how such teaching methods could be translated into the educational contexts in which they work or intend to work:

We would like you, during this reflection, to make an art work—this can be a drawing, a piece of speculative biography writing (where you imagine Life as Bird and write a mini biography), a short film or page of graphic novel. While you make this piece of creative work think about how this activity might function in an educational setting. Are there challenges to working in this way? Make some short notes on how this might be used in an educational context

[extract from Course Guide].

In this configuration, some of the work Alsop and Dillon (2018) write about in Encounters with a Narwhal in a Museum brings to bear on the educational interaction between a dead animal and possibilities to create affect in science education. They suggest that: “science education in formal contexts and in research tends to favour largely disembodied accounts of both teaching and learning. These commonly place an emphasis on knowledge, language and culture more than experiences, embodiments and affect” (Alsop & Dillon, 2018, p.51).

Alsop and Dillon (2018) consider the meeting with the Narwhal in a science museum as consisting of three encounters: (i) angles of arrival; (ii) fragility and loss; and (iii) awe and awkwardness. In relation to (i) they note: “How we encounter, in turn, affects our capacities to dispose, awaken and orientate. In this manner, the promises of educational experiences are in their evolving capacities to direct us toward something different and generative, whether it is knowledge, practices, objects, sensations, feelings or new ways of being in science education” (Alsop & Dillon, 2018, p.52). This consideration of how, as educators, we can arrive, with students toward something, is in itself, a ‘critical incident’ (Tripp, 1993) in teaching biology. This is especially important in biology education that is attempting to espouse affect and to contextualise biological knowledge in a wider socio-biological context, such as extinction or vulnerability to extinction due to human actions. Working with taxidermic specimens, such as the collection situated in our faculty, enables possibilities to set up such encounters in ways that can shift teaching and learning towards ‘different and generative ways of being’ with organisms, as noted by Alsop and Dillon (2018).

During the COVID-19 pandemic, such teaching activities have not been possible, access to the collection is not viable, as both students and teachers have been distributed in, and beyond, Sweden. However, again multimodal approaches came to the fore and students used drawing, mobile phone films, and other art materials to create their bird biographies. And so, Being Bird could be a film of swallows flying between apartments and a large supermarket in Alicante, Spain, a diorama of birds in a shoebox sitting in a Swedish garden or a graphic story concerned with an urban pigeon dealing with life in a city (Figure 2). In this online learning context, the living birds occupying spaces near and
around our students became proxies for the dead birds in the faculty department and perhaps, rather than being speculations on ‘afterlives’ (Alberti, 2005) the work the students produced reconnects to living lives, as encounters for the senses and emotions.

Figure 2: Life as a City Pigeon (extract from student work, with permission).

It will be interesting to think about these different spaces and relationships when the course returns to in classroom teaching and to reconsider the role of multimodality in terms of presence, and whether the animation created by life has a greater affect than being face-to-face with taxidermied death (Meehitiya et al., 2019), or if each experience affords complementary ways of Being Bird.

VIGNETTE THREE: YOUNG CHILDREN AND THE ENVIRONMENT: A WINDOW ON A CHANGING WORLD

ECE is rich with opportunities to create border-crossings between the material and imaginary worlds and, within the ECE curriculum, art and science, language and literature are often blended in the environments experienced by ‘the playing learning child’ (Pramling Samuelsson & Asplund Carlsson, 2008). An extended reflection on the literary element of this work has been previously published (Sanders, 2017). In the previously published work, the focus was on how children’s literature could be a metaphorical window through which to observe environmental sustainability (Sanders, 2017). Hence, understandings of ‘place-based learning’ were broadened beyond the ‘here and now’ of the material world of plants and animals in the local park into the ‘somewhere and nowhere’ of the literary world provoked by examples of children’s literature, for example Ekström, 2016; Light, 2006.

The courses began as opportunities to examine notions of place through intertwining investigations of biological life (for example, snails, spiders, common plants) experienced through a guided walk-as part of the teaching- and then imaginary teaching scenarios, using various living and taxidermic specimens alongside textiles and other objects, such as glass jars, in the classroom. An overview lecture connected the individual parts of the teaching, alongside student presentations of their imagined teaching scenarios. Initial forms of the teaching required students to develop pop-up artworks, or short plays through which they created storylines that weaved biological narratives. As these teaching experiences evolved over the first three years a small library of books would also be given to the students as source material to reflect on. Storylines, during this time, would often concern animal homes, food webs, journeys and predator/prey relationships.

After the initial three years of teaching this course, notions of possible futures became a ‘röd tråd’ (line of argumentation) in the developmental narrative of the class. Subsequently, books such as Fröet (Ekström, 2016) and The Flower (Light, 2006), were brought into the teaching, as a space to develop ‘what if’ discussions building on from ‘how’ questions with young children: ‘How can we grow
seeds? ‘How big can a plant grow?’ ‘What if there was no more soil?’ ‘What if we lived in a world without flowers?’ ‘What if we live alone with plants?’ In these discursive spaces it became possible to open up discussions with students about ways to frame young children’s literature in relation to environmental education and consider the “metaphorical abilities” of literature to facilitate “meetings between humans and other species” (Sanders, 2017, p.135) alongside ‘hands-on’ inquiries with the material world on the guided walks. These literary affordances have proved valuable in broadening discussions concerning relationships between human and more-than-human lives and reflecting on possible futures with young children. Furthermore, questions, emerging from the stories, have formed a didactical link with the work in colleagues’ teaching sessions on ‘productive questions’ in ECE science education and opportunities to link back to individual student reflections in follow-on discussions concerning boundary crossings between material and literary sources for biology education.

**CONCLUSION**

These reflective narratives suggest that multimodal objects can support higher-education students’ engagement with affective discussions in biology didactics and related classes. This is especially critical when considering the planetary context in which teaching biology is situated. These teaching situations seem to provide opportunities to provoke relationships that move beyond, “the domain of objects (i.e. natural history specimens) to the domain of ideas” (King & Achiam, 2017, p.132) and move beyond the science of biology into the realm of philosophy, ethics and values (Alsp & Dillon 2018; Bird Rose, Van Dooren, & Chrulew, 2017; Reiss, 2020). These are educational opportunities the author deems to be necessary in a world in which much of life is vulnerable to human activity. It can also create affordances as represented in vignette three in which ‘what if’ questions, associated with fictional works, can develop conversations anchored in possible futures for human and more-than-human lives.

Østergaard (2020, p.231) has noted: “it is of interest for both science teachers, teacher students and teacher educators to explore the artistic and the scientific inquiry as interwoven processes of knowledge building”. In this series of teacher self-reflections on biology, and biology-related teaching, a multimodal approach utilising objects relevant to both artistic and scientific inquiry appears» to push boundaries” (Lee, 2007 p.308) and extend these objects into ‘boundary negotiating artifacts’ (Lee, 2007). Thus, students are supported to move between ways of being with, and ways of knowing about, plants and animals in an era of extinction. Returning again to Østergaard, (2020, p. 231) he suggests, with the assistance of Ingold (2020): "At its most radical, art exposes science’s underlying assumptions, both ontological and epistemological, with the intention ‘to restore ways of knowing the world to ways of being in it’ (Ingold, 2020, p. 437”).

In the three vignettes, presented here, a nested approach to these ‘different ways’ of knowing and being has begun to emerge; through the use of an artwork, taxidermic specimens and film, and the openings made possible by children’s fictional works. An “eternal question” (Rönnerman, 2020) to emerge from this practice-based study is this: *how can such reflective practices be embedded in the lived experience of teaching?* This question is one that resonates beyond an individual biology teacher and her collegial networks; it is a question for institutional leaders (Rönnerman, 2020), and the cultures they wish to nurture.

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