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This paper examines the questions concerning whether and how the domains of science and science education might expand the practical and conceptual landscape available to artistic and creative educators. It does so through a philosophical inquiry that parallels that of Martin Heidegger's in his seminal work: *On the origin of the work of art*. Following alongside, and in constant dialogue with Heidegger's arguments, this paper explores the nature of things and practices in science education and the relationship between the two. This inquiry allows us to re-imagine the landscape of science education in terms of key pairing between *things*, *works* and *truth*. In doing so, we come to better understand and appreciate the extent of the educational landscape that both art and science educators share.

KEYWORDS

Art, science, work, education, things, practice.

INTRODUCTION

The aim of this paper is to invite the reader to examine the possibility of whether the domain of science education may be a viable expansion of what we may take as the landscape of artistic and creative education. This paper is not an articulation of, nor a defence of the emerging interdisciplinary field known by the acronym STEAM (Science, Technology, Engineering, Arts and Mathematics), which makes its own distinctive contribution to questions and approaches concerning the integration of science with creative and artistic education. This paper instead seeks to examine the deeper ontological and metaphysical foundations of science, scientific practice and science educational practice, with the view to recovering those dimensions of science and science education that bring them more strongly into sympathy or resonance with art, art practice and artistic education. The task of this paper, therefore, is one of revealing a hitherto relatively unexplored artistic landscape hidden beneath longstanding assumptions about the nature of science, art and education. The paper will not attempt to outline in any detail the significant task required to bring the exiting literature on artistic and creative education into a detailed exploration of this novel scientific-artistic territory. As stated earlier, the paper serves as an invitation to the community of practitioners – in science education and artistic and creative education – to imagine and enact ways of engaging with science that do justice to art and science at the metaphysical level at which they are examined in this present paper.

More precisely, the paper concerns itself with a philosophical inquiry into the things and practices of science education with the view to asking whether and how these science-education-things and

science-education-practices may be understood (perhaps even best understood) as also artistic and creative things and practices. If this is the case, then domain of science education becomes available to the conceptual and practical tools and approaches of artistic and creative education. Although it is possible to imagine this project as a critique of the 'dominant' ontological and epistemological claims of science education – as difficult as these may be to define unequivocally – the questions posed in this inquiry are emphatically in the spirit of exploring what science education offers in *addition to*, rather than instead of, conventional renderings of science and science education. This makes it necessarily an open task that would benefit from contributions from artistic and creative educators and practitioners.

With the guiding question in mind (what is an artistic and creative landscape available through science education?); and the targets of that inquiry (the things and practices of science education); this paper draws upon a particular philosophical perspective on art through which to examine where art may be found within science education. That philosophical perspective is derived from Martin Heidegger's seminal essay: *On the Origin of the Work of Art* (1971), hereafter OWA. The reasons for selecting this work are two-fold. Firstly, from across Heidegger's substantial and broad philosophical works, OWA is arguably the clearest exposition of Heidegger's understanding of the relationship between (i) works of art, (ii) the artists that create these works, and (iii) the discipline of art itself. The choice of OWA therefore stems from the possibility that at the conceptual level of this artistic trinity there may be some fruitful correspondence with science, scientists and works of science. Secondly, Heidegger's approach to the question concerning the origin of the work of art acknowledges the circular and reciprocal relationships between these three elements, and hence keeps the question of the origin of the work of art open and alive; and in keeping with the aims of this paper:

Thus we are compelled to follow the circle. This is neither a makeshift nor a defect. To enter upon this path is the strength of thought, to continue on it is the feast of thought, assuming thinking is a craft. Not only is the main step from work to art a circle like the step from art to work, but every separate step that we attempt circles in this circle. (OWA, p. 18)

In a more formal sense, this paper follows the structure of OWA, in an effort to remain in conversation with it: hence, the duplication of OWA headings: *Thing and Work*, *The Work and Truth*, and *Truth and Art*.

THING AND WORK

Mindful of the intention to examine things and practices, I want to begin my inquiry as Heidegger does by first attending to the *thingly* nature of works (of art). The aim is to see whether there are things in science education – as works of science – that work as works of art and may be approached with the same educational sensibility. Scientific works are the material artefacts of the science classroom for sure, but also the creative works that emerge from scientific practices either by the science teacher, scientists, science students or any combination thereof. The list of entities covered by scientific works so defined is inexhaustible and so addressing each distinctive work comprehensively is beyond this

paper. So, for the sake of illustration, I want to restrict myself to a scientific work that is familiar to scientists and non-scientists alike: the Periodic Table of Elements.

THE CRUCIFIX AND THE PERIODIC TABLE OF ELEMENTS

A poster displaying the Periodic Table of Elements (hereafter PT) has, almost without exception, a ubiquitous position in countless science classrooms across the world. The fundamental features of the PT are always depicted: the staggered 18x6 grid of squares resembling a frozen game of Tetris; the branching rows of the Lanthanides-Actinides added for completeness despite being seldom if ever referred to; the roman alphabet elemental symbols, atomic weights and numbers, bold-face in each box – all of which give the PT the look of a translation table for an extra-terrestrial language. Oftentimes, different sections are colour-coded in bright, gelato hues. Occasionally an attempt is made to include a picture of the element as it is most commonly found in the real world; although this usually reduces to a monotonous series of generic and indistinguishable lumps or vials of variously coloured liquids, solids or gasses. The table, in poster form, inevitably takes up a central and highly visible place on a wall that is otherwise typically crowded with propaganda posters for careers in science or students' very rushed attempts to translate a Wikipedia entry on some seminal topic into an eye-catching and informative display. For the most part the PT, like everything else on the walls sits there, a mere thing, waiting to be called upon or noticed – an illustration of Heidegger's observation about works of art: that '[a] picture hangs on the wall like a rifle or a hat. Works of art are shipped like coal from the Ruhr and logs from the Black Forest...All works have this thingly character' (OWA, p. 19).

For me, the ubiquitous presence of the PT in the science classroom, has always recalled memories of my education in a Roman Catholic school environment, where analogously, every classroom, office or meeting place (including the gymnasium) prominently featured a crucifix. Like the PT, this abstracted or highly figurative sculptural depiction of human-divine suffering, despite its metaphysical relationship with the transcendental other, also reduced somehow to being a mute and passive object.

Yet, juxtaposing the PT and the crucifix in an educational context raises a dilemma that is well addressed in Heidegger's OWA. It concerns our uneasiness in accepting the PT (or the crucifix) as a *mere things* and nothing else. That these objects sit within complex ecologies of symbolism, meanings and practices suggests that to each adheres something else that confers upon it an ontological status beyond its brute materiality. Perhaps these things are symbolic (*sum-ballein* in Greek); they are literally a sum or tethering of the 'mere thing' and some mysterious aspect that affords the combination a new ontological status. And is this not what education aims at – to inject the extraordinary into the ordinary? This response, however, raises questions about what it is that is appended to the mere thing and what is responsible for such a tethering: what makes the PT poster symbolic of science and is that process or practice sufficient to account for its being a work of science? The latter question is pertinent here in that it raises the possibility that artistic and creative education may bear on the things of science education in different ways depending on whether things in the classroom and elsewhere are taken as symbols of science or works of science.

THING, WORK AND EQUIPMENT

Thus far we have been working with the presupposition that a thing like the PT poster on the science classroom wall is an amalgam of a thingly character – the mere thing; the paper printed with ink – and something else that modifies its ontological status. Heidegger too takes up this presupposition as vehicle for his own inquiry into what makes a work of art not just a thing. However, in doing so, he ends up drawing the conclusions that three long-established theories concerning the nature of things have fundamental limitations that impinge upon our understanding of the ready availability of works.

Of the three, Heidegger begins with the most ancient and enduring characterisation of things. In this view things are combination of *substances* and their *properties*:

The block of granite, for example, is a mere thing. It is hard, heavy, extended, bulky, shapeless, rough, coloured, partly dull, partly shiny. We can take note of all these features in the stone. Thus we acknowledge its characteristics. But still, the traits signify something proper to the stone itself. They are its properties. (OWA, p. 22)

Heidegger is quick to draw parallels between the substance-properties formulation and its linguistic equivalent in the subject-predicate format of propositional statements. Although he does not pursue the issue to any great length, he does raise the dilemma as to whether the substance-properties formalism gives rise to subject-predicate forms in language, or whether conversely, a privileging of the subject-predicate linguistic structure is projected onto all our encounters with things. In science, and particularly science education, the horns of this dilemma represent respectively the positions of the scientific realist and the social constructivist. If nothing else then, Heidegger's reticence to tackle this world-word paradox in the context of art may be taken as a further invitation to dwell in the space of things rather than prematurely collapsing them into dualistic experiences of subjectivity and objectivity. Indeed, his rejection of the substance-properties formulation of things, even setting aside linguistic considerations, rests on the view that by forcing us to attend to what in the thing's nature is literally accidental (its properties) we are distanced from our experience of the thing to the point where it vanishes. Science educators are familiar with this ontological vanishing act. For instance, they oftentimes go to great lengths to enumerate the properties of atoms, but in doing so end up obscuring the very phenomena that taking atoms as substantively real serves to explain.

The second conceptualisation of things grounds their thingliness in the sensory field: 'The thing as a unity of a manifold of what is given in the sense' (OWA, p. 24). Here the thing becomes the synthetic experience of something within the vast field of what is available to the senses. Heidegger objects to this position on phenomenological grounds, arguing that ordinarily we seldom encounter things as such assemblages of sensory input against a background of inconspicuous, inchoate, noise; and that when we do, it requires a particularly abstract mode of attention. For example, to hear the particular sound that a particular thing makes is already to have lost a grip of the thingly origin of that sound. Heidegger rejects this perspective for having the opposite effect of the first; that is, the purely aesthetic and sensory brings things too close to us for them to be brought clearly into sight.

A third seminal account of things sits more forthrightly into communion with the idea of practice. Accordingly, everything we encounter consists of matter like the substantial part of the substance-properties view, but what is added to the matter instead of properties is *form*. This formulation applies just as well to natural things (a granite boulder) as to things formed by human intervention (the carved granite block). The concept of form-matter can be abstracted to the highest degree and brings within its dominion such ideas as the rational bringing form to the irrational, or the subject providing the form for objects (OWA, p. 27).

As intuitive as the form-matter formalism seems, the potential for an asymmetry in the relationship between form and matter remains a major issue for it. We can think of the distribution and arrangement of matter in natural things (as regular or irregular as they may be) as forms arising from the action of nature or natural processes. Similarly, things that humans have created (as works of art or science) also have this feature of having a form arising out of the action of an agent acting on mere matter. Whilst we may not be willing to extend the same characterisation to natural processes, in the domain of human activity at least, we would readily characterise such form-conferring activities and actions as *practice*: artistic practice, scientific practice, educational practice, or any other type (of form-giving) practice. This account of practice in the context of the form-matter pairing tends to foreground the agentive role of the practitioner as the best candidate for what makes a thing a work of art or science.

At first blush, then, it would appear we have resolved the interim question of what must be added to the mere thing in order to make it a work of art or science, namely: we must undertake some special practice that gives form to matter – whether that form is material, spatial, temporal, conceptual, symbolic, representational, etc. Indeed when we consider how science education research has focussed for decades on the defining role of teachers' and students' practices in the formation of authentic or inauthentic forms of scientific matter, representations, concepts, understandings, competencies, etc.; one gets the impression that practices of certain kinds lead to the reliable production of certain products, outcomes or works (e.g. knowledge and skills). However, we should instead see this prevalent performative approach as a clue to the inadequacy of practice (defined solely in term of per-form-ance) in capturing how practices give rise to artistic and scientific works.

Whilst '[m]atter is the substrate and field for the artist's formative action' (OWA, p. 27), and the 'matter-form structure...readily presents itself as the immediately intelligible constitution of every entity, because here man himself as maker participates in the way in which the piece of equipment came into being' (ibid, p. 29); the formative or performative role of the scientist, or artist, or teacher, or student obscures an important relationship between the nature of a work and the nature of a mere thing that is *at work* within the thing when used as 'equipment' in this way to serve some defined purpose or goal.

Heidegger offers a clue to what is at work in the use of equipment when he refers to van Gogh's painting of peasant shoes:

A piece of equipment, a pair of shoes for instance, when finished, is also self-contained like the mere thing, but it does not have the character of having taken

shape by itself like the granite boulder. On the other hand, equipment displays an affinity with the art work insofar as it is something produced by the human hand. However, by its self-sufficient presence the work of art is similar rather to the mere thing which has taken shape by itself and is self-contained. As a rule it is the use-objects around us that are the nearest and authentic things. This the piece of equipment is half thing, because characterised by thingness, and yet it is something more; at the same time it is half art work and yet something less, because lacking the self-sufficiency of the art work. Equipment has a peculiar position intermediate between thing and work, assuming that such a calculated ordering of them is permissible. (OWA, p. 28)

For Heidegger, a thing-as-equipment such as the poster of the PT, has an important characteristic that emerges directly from the equipment's being halfway between thing and work. As we have noted earlier, the ubiquity of poster of the PT makes it almost invisible: it dissolves into the spatial, temporal and agentive field of the classroom; whether or not it is being used. The poster of the PT sits reliably on the wall, and when gazed upon purposefully, it becomes seamlessly entangled with the practice of its interpretation and application. It is precisely its *reliability* that gives to a thing its character as equipment. Moreover, only whilst the thing-as-equipment *remains* reliable does its equipmental nature hold; for the reliability of equipment sets up stable worlds of practice:

The peasant woman wears her shoes in the field. Only here are they what they are. They are all the more genuinely so, the less the peasant woman thinks about the shoes while she is at work, or looks at them at all, or is even aware of them. She stands and walks in them. That is how shoes actually serve. It is in this process of the use of equipment that we must actually encounter the character of equipment. (OWA, p. 33)

The peasant woman is made aware of the world of *practices* and *being* that the shoes are a part of only when they fail or she otherwise becomes aware of them as things outside her practice. Only then does their reliability enter into the realm of conscious reflective awareness: the burden of her labour standing out as such against the backdrop of her previous seamless, skilful coping in the world. It is in this sense that the teacher who put up the poster of the PT in a most prominent place set this thing to work as reliable equipment and therefore to setting up a scientific world in which she and her students may practice. What the reliable nature of equipment entails is that things-as-equipment (whether in the science or art classroom) do carry the quality of mere things in their self-sufficient being-there, but more importantly, they are also at work (like works of art or science) in setting up worlds: the world of science or the world of art. Thus we see immediately that the purposeful use of things-as-equipment reveals one aspect in which the landscape of artistic and creative practice and education coincides with that of science and science education. Whatever their epistemic differences, science and art align insofar as their reliable material practices serve an ontological role in bringing forth scientific and artistic worlds, respectively, into being.

WORK AND TRUTH

So far we have seen how thinking about equipment allows us to understand how even reliable performative, instrumental or technical engagements with things in the classroom permit the teacher to set up worlds for themselves and their students, and more to the point, can achieve the setting up of such worlds because equipment has an aspect to it that brings it close to the nature of works of art. Thus the science teacher's practice shares at least this capacity to set things to work as works-of-art in the science classroom. But are there other ways in which the things and practices of science education come to shape educational landscapes in ways that are readily navigable by, or at least comprehensible to, artistic and creative educators?

Heidegger allows us to progress with this question by pointing to the fact that works of art hold a particular relationship to truth. Indeed, in OWA, Heidegger returns to the very same painting of peasant shoes by van Gogh to explicate the work's relationship to truth by describing how the painting itself lead him to understand the essential character of equipment:

Not by a description or explanation of a pair of shoes actually present; not by a report about the process of making shoes; and also not by the observations of the actual use of shoes occurring here and there; but only by bringing ourselves before van Gogh's painting. This painting spoke. In the vicinity of the work we were suddenly somewhere else than we usually tend to be...The art work let us know what shoes are in truth. (OWA, p. 35)

Van Gogh's work of art functioned to un-conceal the being of the shoes-as-such: that is, their being equipment by virtue of their reliability helping setting up a world. But this revelation did not arise because the painting was a true representation of shoes, a reproduction or symbol of shoes. That would again render the work a mere thing, formed matter, a substance with properties, or another piece of equipment. Instead, Heidegger suggests that the work of art is a work of art because it reveals the truth, not in the sense of a correspondence with reality, but rather in the ancient Greek sense of truth as 'aletheia' (OWA, p. 36).

This opening up, i.e. this un-concealing, i.e. the truth of beings, happens in the work. In the art work, the truth of what is has set itself to work. Art is truth setting itself to work. What is truth itself, that it sometimes comes to pass as art? What is the setting itself to work? (OWA, p. 39)

What we must attend to in this account of the work of art is the emphasis that Heidegger places on the "truth of what is" setting itself to work. This shifts significantly the role of the artist or scientist practitioner, in making art or science, from simply engaging in a practice that involves forming matter or using equipment. Heidegger is not claiming that there is no role for the artist in making a thing a work of art – quite the contrary, the artist must play a role in which she disappears in the making so that the truth may be set to work and the work is let be:

To gain access to the work, it would be necessary to remove it from all relations to something other than itself, in order for it to stand on its own for itself alone...It is precisely in great art...that the artist remains inconsequential as compared with

the work, almost like a passageway that destroys itself in the creative process for the work to emerge. (OWA, p. 40)

It is possible to present (and be present to) great works of art in the unmediated way that Heidegger thinks is their due. He offers the Greek temple at Paestum as one example of such a great work of art. The temple was for the historic people of Hellenistic Paestum a work of art because '[b]y means of the temple, the god [was] present in the temple' (OWA, p. 41).

The temple, in its standing there, first gives to things their look and to men their outlook on themselves. This view remains open as long as the work is a work, as long as the god has not fled from it...It is the same with the sculpture of the god...It is not a portrait whose purpose is to make it easier to realize how the god looks; rather, it is a work that lets the god himself be present and this is the god himself. (OWA, p. 43)

The temple here serves as art because it manifests what Thomson (2011) refers to as the *ontotheology* of the Hellenistic people: which he simplifies to "what is" (ontology) and "what matters" (theology) for the those who built the temple, worshiped in it and conducted their lives around it. This means that the work of art does indeed exceed its materiality and in metaphysical ways that take it beyond the equipmental function discussed earlier.

The work of art is set forth out of its material, but in ways unlike equipment is. For instance, the stonemason who constructed the temple used stone as equipment to ensure the reliability of the temple structural function. The stone is used up as equipment in making the temple. Indeed the stone is used up and disappears into the stone's usefulness in the temple's architectural structure. But in the temple-as-work-of-art (a work in stone rather than of stone) the stone of the temple appears to us for the first time. The temple reveals the truth of stone in its revelation of the ontotheology – or truth as *aletheia* – of those who built and worshipped in it. In this latter sense, and unlike equipment, there is no limit to the truth that is un-concealed through the set up of a work in this way, and so the stone in the work is never used up. The work of art – in a way that is quite distinct from those that characterize mere things and equipment – remains open in so far as one can return to it again and again and have it reveal the truth inexhaustibly in different ways; and at the same time works of art, in their self-sufficiency also conceal something of their being from us by 'refusing themselves to us down to that one and seemingly least feature which we touch upon most readily when we can say no more of beings that they are' (OWA, p. 53).

TRUTH AND ART

The artist (or scientist) is not peripheral or incidental to making works of art (or science) in this Heideggerian, dual sense: that is, making things that (i) un-conceal the truth as *aletheia*, and (ii) resist our attempts to describe or explain them away by concealing from us their unmediated being. This two-fold process of un-concealment and concealment is the 'happening of the truth' that Heidegger sees as at work in works of art. Moreover, we must not mistake this two-folded-ness of truth in the

work for some kind of contradiction. Instead, following Heidegger, we ought to take this as *the* conflict or strife that is inherent in and constitutive of works of art:

Truth wills to be established in the work as this conflict of world and earth. The conflict is not to be resolved in a being brought forth for the purpose, nor is it merely to be housed there; the conflict, on the contrary, is started by it. (OWA, p. 62)

So very often we are likely to miss the presence of this conflict in works of science and thereby fail to encounter them as the works of art that they are. There is much of this workly quality in the poster of the PT when one takes it not as a representation of the world, not as a series of symbols, but rather as what passes as truth in our age: the poster of the PT at once offers us an iconic grasp of all of science, and simultaneously vanished from sight the nearer we approach the unmediated encounter with the ontology of science it brings into contact with.

If the poster of the PT is indeed a work of art in the Heideggerian sense, then it calls on the science teacher, and the art teacher too, to do more than re-produce it; refer to it; use it as equipment; or treat it as mere object, a prop or a scientific artifact. Rather as a work of art it invites us to preserve its truth – not as a conservator would – but as a witness would. This requires a kind of reverential type of knowing that lets the work reveal, self-sufficiently, ‘what is’ and ‘what matter’ in so far as we (individually and collectively) are capable of authentically being present to such mattering.

CONCLUSION

This paper began in the spirit of trying to discover whether and how the things and practices of science education might constitute a new landscape within which artistic and creative educators could venture and apply and refine their own valuable and unique approaches. Yet, in the course of following Heidegger’s careful inquiry into the nature of works of art in relation to science education, it appears less likely that art educators can find within the domain of science education a truly novel ontological terrain. Instead – and notwithstanding epistemic and phenomenological distinctions – it may be more proper to claim that both the science and art educator look upon the same broad features in the educational landscape; albeit from slightly different vantage points.

Heidegger’s seminal work on the origin of the work of art allows us to see more clearly three prominent landmarks that are available to both kinds of educational practitioners and researchers.

The first landmark is characterised by the relationship between things and works and underscores the importance of equipment in both art and science. This relationship suggests that even within the kind of utilitarian use of materials in the service of formative and performative modes of education, there remains something in their disciplinary reliability that helps set up worlds of art and science for teachers and their students.

The second landmark directs us away from a merely functional approach to education that centres on representation, and towards an understanding of and appreciation for ‘what is’ and ‘what matters’.

Finally, the central feature in the common landscape described here is the *truth*. But this *truth* is neither circumscribed by the ever-shifting sands of a relativist account of truth, nor fixed prematurely by the monolithic account of truth-as-correspondence. Instead Heidegger asks us to see truth as that eternal and abundant conflict that is readily available to all of us in works of art and science alike. It is the kind of truth that invites us to dwell a little longer in the landscape.

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