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From the Archimedean point to circles in the sand— Post-sustainable curriculum and the critical subject

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ABSTRACT

Critical thinking (CT) is frequently mentioned as a key competence in sustainability curricula. In this context our era is often diagnosed as being 'post-truth', indicating an epistemic concern. However, emerging 'post-sustainable' views in education indicate that environmental crises are posing increasingly existential concerns, which might partly explain why simple consciousness-raising sometimes faces denial or fails to promote sustainable action. To overcome this challenge, we undertake a philosophical critique of modern (individual, rational, autonomous) subjectivity assumed in CT and much of curricular thinking. We follow the 'ontological turn' where criticality means self-reflective questioning of one's own being-in-the-world. One acute question concerns energy, especially fossil fuels, which constitute much of the autonomous experience of modern, critical subjectivity, while simultaneously endangering the future horizon of that same subjectivity. Climate strikes at schools and the yellow vest movements indicate, in their own ways, how ecologically problematic fossil fuels are bending modern rationality into unpredicted directions. Metaphoric Archimedes and his 'circles in the sand' demonstrate the vulnerability of critical thought facing post-sustainability. This vulnerability should be addressed in curriculum theory, since it is interdependent persons—rather than independent subjects—who are open to sustainable transformation and action.

1. Introduction: Thinking about post-sustainability

Ecological crises are 'defining macroconcerns' for today's education (Kincheloe, 2011, p. 236), and curricula for sustainable development frequently mention critical thinking (CT) as a key competence for teachers and students. In this context our era is often diagnosed being 'post-truth' (Burbules, 2022), indicating an epistemic concern: the critical thinker is expected to accept the indisputable fact that environmental crises are human-caused (Lynas et al., 2021), and judge any claims to the contrary (such as fake science and denialism) as implausible (Guzzo & Dall'Alba, 2020).

But this epistemic post-truth approach alone is lacking. A growing body of evidence suggests that 'climate anxiety' and other emotions caused by these crises are negatively affecting how people function in everyday life—especially the young (Hickman et al., 2021; Pihkala, 2020). Anxiety, doubt, and even denial suggest that the critical subject themself feels threatened by

the knowledge (Grušovnik, 2012). In this article, we consider the 'post-sustainable' position (Bonnett, 2020; Foster, 2018; Jickling & Sterling, 2017; Takkinen & Pulkki, 2023), where the thinker understands and accepts the facts about the environmental crisis but doubts the solutions presented by the mainstream. Educational thinkers have drawn attention to the epistemic imbalance of being able to diagnose the crisis, yet not being able to present equally plausible solutions to it. In recent educational thought, the term 'post-sustainability' underlines the fact that (a) the environmental crisis is worsening at an ever quicker pace, and that (b) sustainable development (SD) is an inadequate educational paradigm for tackling this (Jickling & Sterling, 2017).

Without aiming to prove SD or similar roadmaps unattainable (e.g. in Sconfienza, 2019), we rather take note of the fact that many students and teachers already hold post-sustainable views, thus they might reject over-optimistic environmental education as unconvincing (Kelsey & Armstrong, 2012). For example, the annual Sustainability Youth Barometer shows that in Finland—where all three authors work—young people widely accept the factuality of the environmental crisis (Kiilakoski, 2022). So the problem is not so much about accepting the data but living with that knowledge.

Our central purpose is to address the phenomenon of post-sustainability in the light of the so-called ontological turn (Barnett, 2015; Kincheloe, 2011) that challenges the epistemic 'tools and dispositions' approach by framing criticality as constant questioning of one's own being-in-the-world (Dunne, 2015). This approach is needed, as post-truth and post-sustainability are structurally dissimilar diagnoses, requiring different kinds of criticality. Traditionally CT assumes a relatively stable epistemic and rational ground, from which the knower-subject is able to reject the epistemically and ethically problematic claims of political indoctrination, fake science, misinformation, or conspiracy theories. However thinking critically about ecological crises is different, as it effectively shakes this rational ground by a) revealing the impermanence of the thinker's own lifeworld, b) rendering questionable modern scientific rationality which was—embarrassingly—caught by surprise by the anthropogenic planetary changes of its own making and c) revealing that some of the thinker's own rational autonomy is enabled by the same structures that are causing the crises.

So whereas CT in the post-truth context is often seen to *reinforce* the subject's rational autonomy, a post-sustainable context seems to *undermine* it. Later we illustrate this difference with the two symbolic figures of Archimedes (Table 1). Archimedes$_1$, the mathematician and astronomer, is purported to have stated he could move the Earth using a stable Archimedean point—expressing the autonomy and confidence of a traditionally understood critical subject. However, Archimedes$_2$, the mortal man, is purported to have been killed while protecting his drawings in the sand during the siege of Syracuse for which he designed defences. The actual research problem thus came too close and disturbed the thinking, indicating the critical

Table 1. An outline of two kinds of criticality in the sustainability context.

Metaphor	'Archimedean point'	'Circles in the sand'
Ecological crises	Sustainable development (feasible roadmap)	Post-sustainability (deep uncertainty)
Main concern	Post-truth phenomena	Environmental emergency, unattained sustainability goals
Criticality emphasis	Epistemic (How to know?)	Ontological (Who am I? How to live with the knowledge?)
Obstructs sustainability	Deficit and false information	Threatened subjectivity
Critical focus	Ethically and epistemically questionable thought-patterns (of others)	Unsustainable and unjust social-cultural structures (in oneself)
Fossil energy relations	Forgetful dependence	Conscious yet troubling relatedness
Positioning	Objective, detached	Immersed, entangled
Subjectivity	Autonomous and individual (stability)	Vulnerable and relational (transformation)
Curricular vocabulary	Skills, competences, tests	Community, recognition, trust

subject's vulnerability. Analogously, we suggest that current ecological crises necessitate a reappraisal of the thinking and knowing agent and its relations to its environment, especially in view of the role of specific energetic and material (fossil fuels) structures in constituting subjectivity.

2. From critical thinking to criticality

Burbules and Berk (1999) famously define 'criticality' not as a neat synthesis of CT and critical pedagogy (CP), but a tentative acceptance of both while remaining aware of their various advantages and shortcomings. By maintaining this tension of incompleteness, criticality seeks to extend the scope of critical reflection to the point where CT and CP effectively 'pull up their own roots for examination' (Burbules & Berk, 1999, p. 61). According to Burbules and Berk, this is particularly necessary in the paradoxical situation known as an *aporia*, where existing ways of thinking seem to face a dead-end.

CT is often defined as having the skills and disposition to think critically—i.e. reflect on decisions on what to believe and do (Bailin & Siegel, 2009; Ennis, 1987)—so that false or biased beliefs can be avoided. As such, CT has its roots in logic and analytical philosophy, and criticism of its early emphasis on skills alone led to the evolution of terms like 'critical thinker' and 'critical spirit'—meaning an ideal person equipped with both the skills *and* willingness to distinguish truth from falsehood. A critical thinker is also ready to give up their beliefs, should they be proven false. In this respect, CT education should encourage young people to accept the facts that increasingly point to the anthropogenic nature of the environmental crisis (Guzzo & Dall'Alba, 2020).

Today's curriculum underlines the empirical robustness of the environmental sciences, while the redemptive scenarios are presented as hopeful assumptions about economic, political, and technological transformations. It should not surprise us that this kind of education raises young climate strikers like Greta Thunberg—to take the most famous example to date—who asked 'what is the point of learning facts in the school system when the most important facts given by the finest science of that same school system clearly mean nothing to our politicians and our society?' (Thunberg, 2018). Here we encounter the *aporia* in concrete form: the Swedish educational system that provided Thunberg with knowledge of the climate crisis, could not even in principle provide her with the means to live in a sustainable manner, even if she took all the curriculum's possible courses and classes. It is often assumed in CT, that by pursuing epistemically and ethically right things, the critical subject will consequently improve their standing and grow into successful adulthood (Burbules & Berk, 1999, pp. 46–47; Siegel, 1988). But climate strikers seem to conclude that the only way they can maintain their epistemic and ethical coherence is to boycott the very means (school) that should ensure their personal future prosperity and autonomy. The *aporia* threatens the critical thinker's subjectivity, personal utilitarian evaluations, and future horizons, thus justifying Thunberg's question: 'what is the point of learning facts?'

Critical pedagogy (CP) contextualises criticality in social and political relations. This approach, originating from Marxist critical theory, asks who the knowledge or the school system will eventually serve (Burbules & Berk, 1999); knowledge is never neutral, but connected to questions of identity, power structures, oppression, and social emancipation (Kincheloe, 2011). The climate strike movement is thus a good example of CP (as well as CT), since it mobilises millions of students to seek agency and emancipation for themselves and future generations, by challenging political structures that seem otherwise unaffected by the warnings from climate science. Indeed, as Burbules and Berk (1999) state, '[c]ritical pedagogy would never find it sufficient to reform the habits of thought of thinkers, however effectively, without challenging and transforming [oppressive] institutions, ideologies and relations' (p. 52).

We can also use this emancipatory lens to understand the recent yellow vest movement, which, in contrast to that of the climate strikers, has moved millions of people in relatively affluent Western societies, to *oppose* climate discourse. Though CT might conclude that opposing scientific consensus like this constitutes an epistemic error, and thus the yellow vests have no justifiable reason to protest, epistemic concerns are not the only issues at stake here—there are also genuine feelings of anxiety and powerlessness (Martin & Islar, 2021). From that perspective, climate science can appear an elitist discourse, which is undermining the livelihood of working people. What is the point of worrying about the long-term facts of climate change, when it actually feels like the lesser of two evils in a scenario that pits the '"end of the world" *vs.* the "end of the month"' (Martin & Islar, 2021)? Yet in spite of these feelings of anxiety and powerlessness, the yellow vests face an *aporia* by seeing access to cheap fossil energy and consumption as a way to regain their threatened autonomy in post-sustainable times.

These movements provide timely and demonstrably relevant challenges for educators right now. In the integrative spirit of the criticality movement (Burbules & Berk, 1999), climate strikers show that CT (knowledge) is impotent without emancipation, while the yellow vests show that CP (emancipation) is equally at a loss without epistemic accountability. But even if integrative criticality may help overcome some of the limitations of CT and CP, post-sustainability still seems an insurmountable problem for *subjectivity*.

Crudely put, the demands of the climate strikers (swift climate policy) and yellow vests (cheap fossil energy and lower living costs) conflict—each endangers the future horizon of the other. These opposing views are not only intersubjective (between people and societal actors) but also intrasubjective—the same person might want both a stricter climate policy and cheaper energy. Within this intrasubjective conflict lies the materiality of fossil fuels, and oil in particular. Oil has, by its blatantly physical attributes contributed to post-sustainability by (a) destabilising Earth's living systems (e.g. CO_2 emissions and plastic waste); and (b) conditioning modern subjectivity to depend on abundant cheap energy. So the *aporia* of post-sustainability for the critical subject is that one cannot live either *with* oil (climate striker) or *without* it (yellow vest).

This *aporia* is solvable neither in an item-by-item fashion nor from an objective, impartial position (Burbules & Berk, 1999, p. 55), unlike when debunking COVID denialism or conspiracy theories (Burbules, 2022). It is one thing to instrumentally apply CT 'as tools' to lever aside ethically and epistemically questionable thought structures. But it is another thing to try to grasp the fact that the modern subject itself has—due to the underlying unsustainability of modernity—no epistemically or ethically stable or privileged position, from which to approach ecological crises. Post-sustainability reveals the baselessness and impermanence of modern subjectivity, which climate strikers and yellow vests both express in their own ways. Although self-reflection and transformation of the subject have been thematized in the criticality literature (Barnett, 2015; Dunne, 2015; Kincheloe, 2011), the challenge at hand is unprecedented. To confront the looming presence of post-sustainability, we suggest extending criticality to better scrutinise modern subjectivity and its relations to materiality—namely fossil fuels.

3. Fossil fuels constitute modern subjectivity

A critical subject is said to have rational autonomy, agency, and self-sufficiency (Siegel, 1988); and in the spirit of self-reflective criticality, we will examine the grounds for accepting this. The concept of the critical subject as self-sufficient and imperturbably rational is open to criticisms that point out the historical construction, embodiment, and intersubjectivity of any kind of subject actually existing in the world. We concentrate on one aspect of historical construction and embodiment: the energetic and material conditions under which contemporary critical subjectivity has been formed and operates.

The relevance of historical-material conditions can already be gleaned from some of the metaphorical ways in which the critical subject is described. Burbules and Berk (1999, p. 48), for instance, describe the critical subject as a 'consumer of information', while Pettersson (2023) alludes to CT's emancipatory emphasis as like giving people the 'keys to a car'. This raises the question of whether the kind of autonomous subjectivity contained in CT is actually inseparably connected to characteristic experiences of modernity: i.e. limitless choice (consumption), and freedom of movement (car). The metaphors hint at a problematic loop: what if the ideal critical subject, who is supposed to grasp the bleak realities of post-sustainability, is born out of the same historical and material conditions that create those realities? The problem is acute if critical thought partly rests on unsustainable material and energetic conditions.

An international study comparing ecological sustainability and the different ways people experience their selfhood shows that in countries with a high ecological overshoot (e.g. Australia, the US, and the UK) there is a stronger individual tendency to 'organize [one's] behavior by referring primarily to one's own thoughts and feelings' (Komatsu et al., 2019, p. 2).[1] In other words, strongly experienced individualism tends to occur alongside a high consumption of materials and energy. Interestingly, people in countries where individualism is stronger tend to believe *less* in the anthropogenic nature of global warming even if they are more aware of climate change than those from countries where individualism is weaker (Komatsu et al., 2019, pp. 6–7). Komatsu et al. thus conclude that independent selfhood—modernity's cornerstone—might actually be an epistemic obstacle when facing the unsustainability of one's culture. When discussing sustainability education, the same researchers argue that '[b]acked by a range of empirical data, […] SCL [student-centred learning[2]] is one mechanism that reproduces and reinforces ontological individualism, which, in turn, is one potential cause of our inability to move toward sustainability.' (Komatsu et al., 2021, p. 7). As the above-mentioned individualistic societies are also where the modern CT tradition was born, it can be questioned if CT's core premise of autonomous and individual rationality is correct or desired (Pulkki & Keto, 2022).[3]

Feminist, post-colonialist, and Marxist critiques remind that the actual possibility for rational reflection and autonomous action has been unequally distributed historically and between different groups of people (Burbules & Berk, 1999; Haraway, 1988; Salleh, 1997).[4] Even if rational thought and critical subjectivity, as abstract concepts, are universally potential, in practice their realisation depends on circumstances. Consequently, the context of *who* does the critical thinking, and about *what* is partly historically determined. The current circumstances are particularly poignant, seeing as the current scientific (i.e. rational) consensus (IPCC, 2018) suggests that civilizational collapse within a few decades is one end of the spectrum of possible futures. One would suppose that rationality also has to do with what there is to think about in a situation like this.

Salminen and Vadén (2015) argue that the elements which define modernity—e.g. science, technology, and the division of labour—are really only possible because of fossil energy. Other conditions—social, economic, epistemological—are also necessary, but insufficient on their own, without fossil fuels' ability to get work done. Fossil fuels also have a significant role in the modern experience of freedom and autonomy. Salminen and Vadén state that ironically, 'the separation between human freedom and natural resources is possible only if copious amounts of cheap energy are available. Likewise, human cognitive and technological abilities can be seen as a thing on their own, as abstract reifications, only under circumstances of increasing energy inputs' (2015, p. 27).

Later, in their 2018 analysis of the 'fossil subject'—i.e. subjectivity in the fossil era—Vadén and Salminen claim that '[t]here is a structural parallel between the way in which the modern subject detaches itself from its material and social surroundings and the way in which a fossil fuel economy detaches production from consumption, products from waste, actions from consequences' (2015, p. 33). In this respect, the experience of a subject independent of its environment is a fairly modern phenomenon, enabled by historically contingent material conditions.

A famous psychological study shows that a higher social class and wealth often result in an individualistic and solipsistic self-understanding—taking merit for successes already enabled by advantageous circumstances (Kraus et al., 2012). This condition, traditionally called *hubris*, is also acute in persons with abundant access to fossil fuels (Vadén, 2021, pp. 168–171).

Our treatment of subjectivity and energy in the context of CT might seem a strange endeavour, but our central claim is precisely that the critical thinker should become aware of how critical rationality is both underlaid and undermined by the—fundamentally non-human—flows of energy and matter. This entanglement is an important aspect of Morton's (2013) ontology of the hyperobject. Hyperobjects are elusive phenomena, such as climate change or plastic pollution—extending spatially and temporally beyond full human comprehension. Since the hyperobject of climate change enmeshes the critical thinker with the fossil fuel economy, no purely objective or detached view can emerge: 'I become (and so do you) a litmus test of the time of hyperobjects' (Morton, 2013, p. 5). Later, in *Dark Ecology* (2016), Morton goes further to describe how this gloomy aspect of ecological awareness—'insofar as illumination [of ecological crises] leads to a greater sense of entrapment' (p. 110)—threatens the very subjectivity and autonomy of the thinker. In Morton's view, ecological thinking is a strange loop, like a Möbius strip, where the distinction between a subject's inside and the world outside no longer holds (2016, p. 108). Thus by asking 'what thinks dark ecology?', Morton (2013, p. 5) lures us to conclude that the critical thinker is actually (a part of) the ecological crisis thinking about itself.

More recently, Morton and Boyer (2021) have explicitly asked what the Anthropocene means for subjectivity. They distinguish between a *hypersubject* and *hyposubject*, where the former strives for autonomy, hegemony, and self-preservation, while the latter—literally meaning a lower or lesser subject—indicates a more humble way of being in the world. Even though Morton and Boyer describe hyposubjectivity as an imploded form of subjectivity (Morton & Boyer, 2021, p. 66), they suspect that:

> [T]hat sense of weakness and insignificance and lack of knowledge and agency is actually what needs embracing. Looking backwards, the road to our present condition is paved with mastery of things, people and creatures and with weird faith in our species' alleged ability to always know more and better (Morton & Boyer, 2021, p. 14).

In the context of CT and CP, the above critique of hegemonic, masculine, and scientist ways of knowing should sound familiar—as feminist, ecological, and post-colonial thinkers have been raising similar concerns for decades (Burbules & Berk, 1999; Pulkki, 2023; Siegel, 1988). However, Morton and Boyer emphasise that albeit unwanted, the hypersubject is above all *impermanent*. And since self-preservation is often understood to be a part of the experiential structure of any subject, this looming post-sustainable impermanence is strongly felt.

Through her analysis of petromasculinity, Daggett (2018) shows how this threatened subjectivity is channelled into wider social-political phenomena of which the yellow vest movement is one manifestation. Petromasculinity is, in its most unsettling form, based on purposeful and wasteful burning of fossil fuels in combustion engines. In its *defiance*, rather than ignorance, of climate change, it is essentially a violent reaction—'*Pereat mundus*! Let me burn oil, though the world perish'. As Vadén (2021) notes, it is 'precisely the enjoyment of *hubris*, the enjoyment of overkill, that explains why simple consciousness-raising and education about the effects of climate change and other effects of fossil fuel use are not enough. Such efforts may even propel *hubris*, the will to humiliate and enjoy the superiority brought by overpowering' (pp. 170–171). In contrast to this backwards reaction, is the forward reaction of ecomodernism which, while relying on the promises of green technology and geoengineering, essentially provides another means for the (masculine) subject to maintain autonomy by transforming the fossil-fuel dependent infrastructure into a more sustainable version (Daggett, 2018, p. 33; Morton & Boyer, 2021, p. 82; Vadén & Salminen, 2018, pp. 45–46).

All the above-mentioned authors conclude that the post-sustainable predicament is such that the modern (fossil- hyper- or petromasculine) subject cannot grasp it and stay unchanged. Thus educating these topics takes students into the vicinity of potentially annihilating/transforming forces, which may result in inaction or denial (Grušovnik, 2012).

4. From the Archimedean point to circles in the sand

By looking at criticality and post-sustainability in parallel, we gained a helpful cross-exposure to them both. Criticality sheds light on why thinking about post-sustainability is an ontological and existential task. Meanwhile, post-sustainability shows the importance of why criticality must go beyond a 'tools and dispositions' approach to question critical subjectivity itself. This self-criticality has been variously called 'strong' (Paul, 1982), 'high' (Barnett, 2015), or 'deep' (Vadén & Salminen, 2018), indicating that the most demanding kind of criticality is that which is directed at oneself.

Our metaphorical Archimedes$_1$ stands for the yet dominant SD paradigm, where rational measures (scientific, economic, technological) are taken to lever aside detrimental yet controllable developments in nature. Archimedes$_1$ assumes an undisturbed sphere of rational autonomy—the Archimedean point—from which Earth can be levered into a sustainable orbit. The real-life equivalent of Archimedes$_1$ is the rational individual, whom education equips with thinking skills and competences to act in beneficial and ethical ways. But post-sustainability implies that no stable fulcrum exists for sustainability efforts. As Arendt (1998, p. 262) reminds, '[w]ithout actually standing where Archimedes wished to stand' we act within terrestrial nature as though from the detached Archimedean point. The shallow instrumental thinking of 'modern man' supposes a stable point outside the Earth or in himself (Arendt, 1998, p. 285), while actually being an unstable subject standing on the unstable Earth.

The post-sustainable predicament resembles Archimedes$_2$, who reputedly planned defensive machines to protect Syracuse when besieged by the Roman army.[5] The Romans breached into the city and found Archimedes$_2$ concentrated in his thoughts and drawings in the sand. Irritated by the distraction, the inventor snapped: 'Do not disturb my circles!', after which a Roman soldier slew him. The research problem suddenly materialised and ended the research. In post-sustainability, there is no safe 'inside' either—the walls that separated the object of thought and the subject engaged in the thinking have been breached. Pushing the analogy further, it is possible that the drawings in the sand (representing critical thought seeking to understand post-sustainability) are in some ways *summoning* their own destruction—as Archimedes$_2$ died due to his commitment to his circles. This is vividly described by Morton and Boyer (2021): 'the world changes once you know you're on Cthulhu's tentacle. It's never the same again. The horror is in that reckoning. And madness follows.' (p. 54). Kortekallio (2019) takes a somewhat similar view of Jeff VanderMeer's book *Annihilation* (2014), where ominous changes in nature do not leave the researchers unchanged either. Albeit fictional, VanderMeer's horror of erratically changing nature is relatable to us witnessing ecological crises:

> What is annihilated here is not subjectivity as such, but the conception of the human subject as the sovereign master of a passive environment. In *Annihilation*, epistemic control over one's environment is a necessary but limited tool, as the "interconnectivity of living things" both transforms and transgresses human subjectivity (Kortekallio, 2019, p. 71).

Accordingly, educational thinkers recognizing post-sustainability tend to portray the ideal knower-subject as epistemically humble and open to transformation (Bonnett, 2020; Pulkki, 2023; Sauvé, 2017; Värri, 2018).

Table 1 sums up our argument: *when thinking about environmental crises, the critical subject is not in the 'Archimedean point' but rather drawing 'circles in the sand'*. Therefore in sustainability

education, epistemic emphasis (left-hand column) alone is insufficient, and ontological emphasis (right-hand column) should be elaborated.

We *don't* claim that critical thinking traditions as such are confined by this heuristic demarcation, and it would be incorrect and unfair to state that for example CT tradition is invariably limited in the table's left-hand column (Pettersson, 2023). However, it seems that criticality and CP literature more often commit to themes articulated in the table's right-hand column. Thus, in the spirit of criticality articulated by Burbules and Berk (1999) we 'pull up the roots' of critical thinking traditions and ask how they could develop to even better address sustainability challenges. Next, we outline how the emerging post-sustainable position presented in the right-hand column could be addressed in curricular thinking.

5. Critical subjectivity in curriculum theory

Siegel's *Educating Reason* (1988) is an early influential work that argues that CT is a fundamental educational ideal—whatever the curriculum is about, criticality must be at its core. With philosophical rigour, Siegel aims to prove that the rationality underlying CT is pure in the sense that it does not smuggle in any ideologies or conceptions 'misrepresentative of the world and the person's relation to it' (Siegel, 1988, p. 65). However, even if rationality would justify itself as Siegel claims, rationality does not predefine the composition of subjectivity that uses reason. So albeit rational, the CT tradition might nevertheless hold ideological assumptions about subjectivity.

Education and curricular thinking always presuppose a certain subjectivity, or what it means to be human (Biesta, 2006). Historically, a curricular emphasis on the individual and rational subjectivity is deeply rooted in Western philosophical traditions (Autio, 2006; Biesta, 2006; Kincheloe, 2011). Equally, Pinar and Bowers (1992) argue that due to their roots in the Enlightenment, critical curriculum scholarship and critical pedagogy also 'incorporate the silences, misconceptions, and hubris of this tradition' (Pinar & Bowers, 1992, p. 182).

So when Kincheloe (2011) suggests that psychological-educational views of rational autonomy are often 'simply manifestations of the effects of particular social, cultural, political, and economic forces.' (p. 209) we agree, and add the analysis of non-human forces: modern subject's experienced individuality, freedom, and even their rational-ethical autonomy is 'structurally dependent on vast amounts of energy' (Vadén & Salminen, 2018, p. 44). These social, cultural, and material structures normalise privileges and injustices that must be exposed by critical curriculum theorists. Morgan (2021) argues that expansive use of fossil fuels resulted in the 'fossil curriculum' taught in economically booming 'advanced capitalist societies' after WWII.

> 'It was at this point […] that models of curriculum planning were most clearly divorced from their grounding in ecological and material processes–the curriculum, it seemed, could float free from nature. It was in this period that students in schools were likely to be taught about the capacity of humans to control and manage nature' (p. 326).

Now, as the CT tradition emerged in the same cultural and temporal context as the fossil curriculum, it seems that some of the critical subject's autonomy is borrowed from fossil energy. Going back to Siegel (1988), CT might thus in this regard be presently 'misrepresentative of the world and the person's relation to it'.

While CT scholars might ask what are the ideal properties for a critical person thinking about environmental crises (Guzzo & Dall'Alba, 2020), Vadén and Salminen (2018) comment that '[a]ny proposed course of action with regard to climate change and environmental sustainability that relies on a change willed and effected by modern subjects is, at best, twisted' (p. 45). Twisted, because subjects cling to their own individual integrity thus limiting the possible

solutions as merely consumer activism or technological improvements. Vadén and Salminen conclude that '[t]he needed change is cultural and social, not individualistic or subjective (in the sense of happening in/through subjects)' (Vadén & Salminen, 2018, p. 46).

6. Conclusion: Persons, not subjects

We have argued that curriculum theory should emphasise ontological criticality when addressing ecological issues in the context of post-sustainability. Finally, we outline some concrete curriculum suggestions that might be elaborated in future research.

The suggested turn from autonomous subjects to persons emphasises the teachers' and students' *presence* in local and socio-historical conditions (Biesta, 2006, p. 42–43; also Dunne, 2015; Kincheloe, 2011; Värri, 2018). In this uncertain world, a looser framing of 'the pedagogical relationship between lecturer and students' (Barnett, 2015, p. 72) can create mutual trust and recognition, which encourages the young to take responsibility for the future (Värri, 2018, p. 119) and seek sustainable identities (Grušovnik, 2012). The courage for critical self-reflection and action grows from interdependence, vulnerability, and even humility (Kincheloe, 2011; Pulkki, 2023; Pulkki & Keto, 2022). To be sure, an effort where the ontologically individual subject would rationally want and enforce its own transformation by giving up its affluent fossil-fueled autonomy seems paradoxical (Komatsu et al., 2019, 2021).

CT's epistemic rigour is necessary when pursuing ethically and epistemically consistent life, but it also requires all-encompassing ontological criticality. Since such criticality requires self-reflective and sociohistorical understanding (Kincheloe, 2011), education scholars might preferably place criticality into higher education curricula (Barnett, 2015; Dunne, 2015). However, when Thunberg and millions of others started their school strike for climate, they were still in primary school. Post-sustainable feelings and actions are expressed in life, possibly escaping educational settings unless curriculum provides 'existential space' for lived criticality (Barnett, 2015, p. 73; Sauvé, 2017).

Also teacher autonomy and education are significant: culturally and historically conscious teachers understand how education and curriculum are affected by 'dominant myths' (Kincheloe, 2011, p. 206). This way they can avoid 'unreflective pedagogy' with the vocabulary of 'skills', 'competences', and 'testing' that reproduces ontological individuality and cultural unsustainability (Värri, 2018, p. 127).

To demonstrate how 'the "goods" and "bads" internal to the ways of life are distributed much wider than the limits of the responsibility of an individual subject' (Vadén & Salminen, 2018, p. 47) students and teachers can together address local environmental issues (Bonnett, 2020, p. 17). Both anecdote and scientific studies (Schwartz et al., 2023) suggest that collective (but not individual) action is connected with lower levels of climate anxiety. This, as such, mundane observation may be crucial also for curricular thinking: forming collective and agential personhood may be beneficial in the time of post-sustainability. Criticality means not only being aware of one's own social-political relations but also of one's material and energetic conditions. In the era of ecological crises a truly critical person is able to tell (or at least ask), which material and energetic stocks and flows enable their existence, and, together with others, to bring that knowledge to bear.

Notes

1. However individuality is not uniform, since 'minorities, women, indigenous groups, and the working class tend to have more interdependent selves' (Komatsu et al., 2021, p. 26).
2. Including CT and CP.
3. Also recently Pettersson (2023, p. 10), albeit defending the CT tradition, admits that the anglophone origins of CT expose it to criticisms of possible cultural biases and limitations.

4. Interestingly Hughes (2017) has pointed out how an 'amoral' attitude to energy characterises both societies that rely on human slaves for labour and societies that rely on fossil fuels. In these societies, the actual 'human-on-human structural violence' (2017, p. 23) disappears behind a supposedly rational calculus of measurable, transportable and salable labour.
5. For the sake of the analogy, we portray Archimedes$_2$ as planning defensive mechanisms, even if some suggest he was trying to solve a mathematical problem unrelated to the war.

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