

Towards a socio-ecological perspective within mathematics education

Alf Coles

University of Bristol

In this theoretical report, I offer some tentative steps towards the articulation of a socio-ecological perspective within mathematics education. A socio-ecological perspective can be seen as a description of strands of current research which push us to think outside of the constraints of current curriculum and schooling structures. I propose several commitments within a socio-ecological perspective, including: a dialogic view of ethics; and, the idea that it is an epistemological error to view individuals as the unit of survival and learning. Implications for the mathematics curriculum include the proposal of viewing number as measure and developing a communal mathematics in classrooms. In the discussion at the BSRLM conference where this work was presented, the issue of ethics seemed to find resonance, in the sense of a dialogic ethics occasioning a re-thinking of the relationships in which we are enmeshed.

Keywords: socio-ecological; dialogic; ethics; epistemology

Introduction

It hardly needs stating that the world is in a precarious position. Biodiversity loss, global warming, political instability, war, forced migration ... any one of these issues might force us to re-think our roles as educators. Adorno (1997/1966), in the seminal speech “Education After Auschwitz”, called on educators to centre their efforts on making another Auschwitz impossible. The speech began:

The premier demand upon all education is that Auschwitz not happen again. Its priority before any other requirement is such that I believe I need not and should not justify it. I cannot understand why it has been given so little concern until now.

We are surely now in a phase of “Education Before ...” and I leave readers to fill in the blank with their scenario of choice – climate breakdown? breadbasket failure? In this article, I attempt to think through what the current times mean for mathematics education and how the curriculum might change, in light of this context.

UNESCO (2021) ask: “What should we continue doing? What should we abandon? What needs to be creatively invented afresh?” (p.2), as part of their call for a new social contract for education, that will help to repair past injustice while transforming the future. The notion of transforming the future might appear paradoxical. I take it to indicate that assumptions of past stabilities, which might have been possible from a more or less colonial perspective (of power, race, class, as well as climate) have gone; we know the future will be different from the past, and we still have the collective power to steer those differences. Another way of framing the question I am exploring is, can mathematics education contribute to steering towards a liveable future? In this report, I offer some theoretical ideas and draw out possible implications for curriculum innovation. In conclusion, I report on some of the discussion at the online BSRLM conference where I presented this work.

Strands of past work on socio-ecological ideas

In the 1970s a “socio-ecological psychology” had a brief period of prominence (Oishi & Graham, 2010), in which there was an attempt to shift psychological studies away from solely looking for factors of behaviour inside the individual (Bronfenbrenner, 1977). Work under this label largely died away within psychology, although Oishi and Graham (2010) argue for its enduring relevance. The “socio-ecology” is also a phrase used in management studies where there is an attempt to take neither the social nor the ecological as fixed background of the other; various models of social-ecological interaction are proposed, as ways of supporting organizational planning (Boons, 2013). A strand of thinking of “political ecology” emerged in the 1980s, which conceptualizes the co-production of nature and society (Watts et al., 2000).

Furman and Gruenewald (2004) propose a concept of socioecological justice, as a broadening of the concerns of social justice, recognising the intertwined nature of social justice and environmental justice and the tensions between “racism, classism environmentalism, and economic development” (p.48). They challenge all educators interested in social justice to consider the links between ecological and social issues.

Within mathematics education, it has been reported in several places (e.g., Boylan & Coles, 2017; Barwell, et al., 2022) that there is only limited research looking at ecological or environmental issues and which has been reported in English-language mathematics education journals. Nonetheless, there are highly relevant and significant strands of related work, for instance within critical mathematics education (see Andersson & Barwell, 2021, for an overview), Indigenous education (Gutiérrez, 2017), socio-political research (Valero, 2004) to name just some.

A final strand of thinking I consider is within education (but not mathematics education) and this is work that takes place under the heading “socio-scientific issues”. These are complex and often controversial issues which are used in a pedagogical context to promote argumentation, critical thinking and, generally, to raise the scientific literacy of those involved (Sadler, 2004).

All the strands of work above feed into my own thinking about socio-ecological work in mathematics education. And while there are differences in the approaches just listed, there is a common concern to re-think relationships between the social and the ecological and humanity’s place within both.

A socio-ecological perspective within mathematics education

A group of scholars within mathematics education (who are organizing a related ICMI symposium for March 2023) are using the phrase “socio-ecological” to capture a broad range of perspectives which all, in different ways, attempt to help theorise relations between the social (in which the political is centrally included), the ecological and the ethical. There are several key ideas emerging, which I will address in turn: (1) not taking the ecological (or “nature”) as fixed background for other concerns; (2) questioning what gets centred in our research (e.g., a river at the centre, or, the air, the soil); (3) working against the “epistemological error” of taking the individual as the unit of survival, evolution and learning; (4) a dialogical ethics.

The ecological is not a fixed background

It is perhaps fair to say that mathematics education has, so far in its history, taken the ecological, or the environment, as a fixed background for concerns. This has, surely, been a reasonable and valid assumption and it continues to be an assumption that can

be necessary, to engage in much on-going and important work. However, the assumption is now at least important to recognize, when it is made. What does it do to research into the language of the classroom, for instance, when the quality of air students breathe is dangerous to their health?

What is centred in our research?

The broad focus of mathematics education research can be seen to have shifted from a predominant attention to students (in the 1970s) to include a focus on teachers (in the 1990s) and, more recently, to include a focus on teacher educators. What is centred here is always a human actor – students, teachers, teacher educators. And, as stated above, this is a reasonable choice. As above, what feels important now is to accept that it is a *choice* and that there are alternatives. Solares-Rojas et al. (2022) offer a powerful example of what research might look like if a river is at the centre.

Working against epistemological error

Bateson (1972), writing 50 years ago, pointed to an epistemological error at the heart of the exploitative relationships in which humans tend to engage the living world. And that error is to conceptualise the individual as the unit of survival, evolution and learning. It perhaps only takes a moment's reflection to recognize that an individual species cannot survive on its own – a species which destroys its environment either has to find a new environment, or it destroys itself. Now that the human environment has reached a global scale of influence, we have no new environments to find. Ultimately it is not an individual, or individual species which survives, it is a relationship. And, furthermore, it is relationships which evolve. While we can think about individual species evolution, a more revealing perspective is to consider the co-evolution of organism and medium (which usually involves other organisms).

And so, to learning, perhaps the epistemological error (Bateson, 1972) which is most deep rooted (certainly in my experience, the hardest one to re-think). It just seems as though, as an individual, it is *me* who is learning – what can it possibly mean to state that this is an error? The point here is perhaps not to deny that we have a phenomenological experience of learning, and that this captures something important in the world, but rather to ask if this is the only, or the most useful, level of description. If we reflect on our own learning, or the learning of our students, we can perhaps also recognise that any learning is embedded in a complex system of relationships. Even taking an example of sitting alone and contemplating a mathematics problem and having a new insight (such that I might say I learnt something new), such activity is situated within the complex relationships of language and mathematical symbolism that have evolved over centuries. And while I might view what has happened as taking place entirely within a unified self, another description is that it is my relationship to a text, or piece of mathematics, which has altered (developed, or learned) – and, which may alter further relationships if I begin to communicate to others about what has happened. Such a perspective speaks to deep changes in worldview, of which I can only point to superficially.

A dialogical ethics

This section draws on ideas which are set out in more detail in Barwell, et al. (2022). If we aim to work against the epistemological error that Bateson (1972) points to, then

our epistemology must concern relationships, and relationships get us in to questions of ethics (Abtahi et al., 2017; Boylan, 2016).

Bakhtin proposes that we think about ethics in terms of answerability or answerable acts, which he defines as follows: “An answerable act or deed is precisely that act which is performed on the basis of an acknowledgment of my obligative (ought-to-be) uniqueness” (1993, p. 42). I act ethically if I act on the basis of an acknowledgment of my unique obligations. And an on-going obligation is towards the living world; the living world demands answerability from each one of us.

As we argue in Barwell, et al. (2022), and drawing on Murray (2000), answerability can be seen as a complementary notion to Levinas’s “call to responsibility” (p. 134). For Levinas (2011), it is through recognition by an Other, through responsibility, that we come to recognise ourselves as a subject. That Other might be another human or some other, living or non-living, part of the world.

We answer the world, in acknowledging the uniqueness of our potential, and we recognise others for the uniqueness of theirs. And it is through *being* recognised in such a way by others that we gain the capacity for answering ourselves.

Curriculum implications

A mathematics educator with whom I spoke recently noted that it is because we know how to count things, that we have become conscious of the mess we are in. I imagine any curriculum innovation, to address the needs of the current time, will need to retain a core aim of children learning how to count. However, rather than viewing number as a label for discrete, individual objects, an alternative, more in keeping with a socio-ecological perspective, would be to work on number as measure and number as a relation (including an ordinal sense of number). Number as measure is the basis of at least two curricula (Davydov, 1990; Gattegno, 1974) both of which have been shown to have potential for spectacular results (e.g., see Schmittau & Morris, 2004).

A further curriculum innovation, inspired by a socio-ecological perspective, might be towards a communal mathematics (Tahta, 1998). In a communal mathematics there would be less emphasis on individual performance. We are perhaps so caught in our assumptions of how schooling currently works that it is hard to conceptualise what this could look like. However, even within school, there are subjects such as drama and team sports where, while individual performances can be noticed and appraised, what is important is the work of the group. Some relatively simple practices and routines that point towards a more communal way of working include: communal chanting or choral practices (Franke & Gruenewald, 2018); groups of students working on vertical boards (Liljedhal, 2016); the use of common boards to collect student responses (Coles, 1999).

Roe et al. (2018) propose a mathematics curriculum based on: measuring, flowing, connecting, changing, risking, deciding. I find just these labels inspiring, and the focus on measuring would link with the proposal, above, to consider number as measure in the early years of schooling. The importance of understanding risk feels particularly significant and the idea of deciding has a distinctly ethical hue.

Perhaps most obviously, a socio-ecological perspective might call for more inter-disciplinary work in schools (recognising how difficult this is to do well). As teachers, can we work with students to find the concerns of their community and link our curriculum to these concerns, and to activism in relation to these concerns? Can we link local and global issues, e.g., air pollution data, and help students consider the paradoxes and complexities of balancing individual and systemic issues? And, in any

curriculum innovation along socio-ecological lines, there would surely need to be an emphasis on the development of skills and competencies, such as questioning assumptions, a critical awareness of statistics, listening and empathy.

Discussion

Having presented the ideas above at the BSRLM Conference in November 2022, I was grateful to the comments and ideas raised by those attending. There were two comments about the approach to ethics and just how radical the re-framing of Levinas is, in relation to Western philosophical traditions. We are perhaps brought up to believe in the primacy of singular human identities, our egos and sense of self appear to come before any engagement in the world. And yet, Levinas is suggesting we become a self through the Other. The singular or the individual arises out of a relationship, rather than being a pre-condition for relationship.

The second issue raised around ethics was the question, how might such an ethical perspective inform discussion of issues around ecological and social justice issues. In one framework of a data analysis cycle, ethics are an explicit part (e.g., see <https://spidasproject.org.uk/da-cycle/>). In this model, ethics are framed around individual responsibility. What might it mean to consider ethical issues in a dialogical manner, instead? A dialogical approach might imply an imperative to recognise those affected by the issue in focus – to be curious, to empathise and to act in solidarity.

A further issue raised (and not resolved) was the emotional and political issues that may arise through tackling issues such as climate change, in the classroom. Eco-anxiety, to take one example, seems increasingly present in school-age children.

As two concrete next steps, one suggestion has been to re-start the BSRLM Working Group on Sustainability, to continue discussion and debate. And, a second is the opportunity for collaboration via a symposium on *Mathematics Education and the Socio-Ecological*, endorsed by ICMI, which takes place in March 2023.

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