



---

Volume 27, Issue 2 2022:  
Special Issue: Navigating unexpected terrain in postgraduate research:  
Reflections from the field

On Snakes and Ladders: Ontological detours into quantum physics from my PhD in education

Thomas Everth

Editors: Laura Gurney, Hossein Hosseini, Nicolina Newcombe and Kerry Earl Rinehart

---

Cite this article: Everth, T. (2022). On Snakes and Ladders: Ontological detours into quantum physics from my PhD in education. *Waikato Journal of Education*, 27(2), 11–17. <https://doi.org/10.15663/wje.v27i2.919>

Link to this volume: <https://doi.org/10.15663/wje.v27i2>

---

### Copyright of articles

*Authors retain copyright of their publications.*

Articles are subject to the Creative commons license: <https://creativecommons.org/licenses/by-nc-sa/3.0/legalcode>

Summary of the Creative Commons license.

#### Author and users are free to

**Share**—copy and redistribute the material in any medium or format

**Adapt**—remix, transform, and build upon the material

The licensor cannot revoke these freedoms as long as you follow the license terms.

#### Under the following terms

**Attribution**—You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use

**Non-Commercial**—You may not use the material for commercial purposes

**ShareAlike**—If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original

**No additional restrictions** – You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.

#### Open Access Policy

*This journal provides immediate open access to its content on the principle that making research freely available to the public supports a greater global exchange of knowledge.*



---

## **On Snakes and Ladders: Ontological detours into quantum physics from my PhD in education**

**Thomas Everth**

The University of Waikato  
New Zealand

### **Abstract**

*The climate emergency mandates a refocusing of society and education on the relationship between humans and the more-than-human world. Emerging from decades of social constructionism that openly promoted climate science denial, social and educational theorising now engages with new materialist philosophies and the agency of matter. Physicist Karen Barad's book Meeting the Universe Halfway, cited over 13,000 times, offers an ontological foundation for new materialism based on her idiosyncratic application of quantum physics. While critically reviewing Barad, I found myself unexpectedly "sliding back down" into the terrain of my physicist pastime, rereading quantum mechanics in depth. I reflect here on how this "ontological detour" empowered me to "climb up a ladder" towards the theoretical foundation for my PhD project in climate change education. I argue that ontological grounding and cross-disciplinary engagement are vital for advancing research and gaining perspectives through lateral connections.*

### **Keywords**

Climate change; quantum-physics; Karen Barad; realism; ontology; epistemology

### **Introduction**

My PhD research is centred on teachers' experiences in the time of the climate emergency. The current trajectory of humanity is frightening, not only for the climate scientists who know it best (Renouf, 2021) but also for teachers, who need to convey the situation to the next generations (Bencze & Alsop, 2014; Bright & Eames, 2020; Kwauk, 2020). My research with "climate activist teachers" is motivated by the broader question of how society, particularly our education system, must transform itself to meet the challenges ahead. A summary of the approaches in Aotearoa, New Zealand, published by education researchers at Waikato University and myself, introduces the issues (Everth et al., 2021). And further, I can recommend reading Tannock's (2021) book *Educating for Radical Social Transformation in the Climate Crisis*.



The theorising for my research led me beyond the educational domain and into interrogating humanity's relationship with reality. This paper is about aspects of this quest and the "ontological detours" it has generated. Working through the literature review for PhD research can sometimes seem like the proverbial game of Snakes and Ladders. One comes across exciting new sources, which, like the ladders in the game, provide uplifting evidence to defend the thesis's approach. But sometimes, one might encounter a widely cited author whose book is essential reading, yet doubts begin to emerge about the author's theorising. And with deeper reading, these doubts consolidate. Behold, a "Snake"! And before long, one becomes engaged in an unexpected detour into new territory, which demands significant time and effort. Yet, just then, possibilities of deeper learning and perhaps even advancement of the field may beckon. Here I report on such a snake-like encounter with the widely cited book *Meeting the Universe Halfway* by Karen Barad (2007). It sent me back to my past time as a physicist, the world of quantum mechanics, and towards consolidating the ontological foundations of my research. And I argue that a well-considered ontology is an essential aspect of social science research in *The Anthropocene* (Crutzen & Stoermer, 2013). I hope that my ontological quest might be inspirational to others doing research in our time.

### The climate emergency: Searching for realism in crisis times

The climate emergency is here, and the world is standing at a human-generated precipice resulting from a failed relationship of society with the more-than-human world. And, I argue, the failure to avert this crisis has been aggravated by anti-realist ontologies and epistemologies, which dominated late 20th-century thinking. The physical facts of climate change have become undeniable. Anthropogenic greenhouse gas emissions are heating Earth's climate at an unprecedented rate (Keller et al., 2018; Trisos et al., 2020), and if critical tipping points are crossed in the coming decades, Earth may be pushed irreversibly towards a hot-house that places the habitability of our planet at risk (Duffy et al., 2021; Schellnhuber et al., 2016; Steffen et al., 2018). According to Ceballos et al. (2017), human actions have already triggered a sixth mass extinction event.

Yet despite clear warnings by climate scientists (Arrhenius, 1896; Hansen et al., 1981; Ripple et al., 2017, 2021) and the IPCC since 1988, greenhouse gas emissions accelerated during the last four decades. This was also a time of systematic climate science denial, orchestrated by the fossil fuel industry and so-called "conservative" political interests (Oreskes & Conway, 2010) and worsened by the rise of populist fact and science-denying post-truth politics (Ford, 2018). However, it may come as a surprise to many that the campaigns against climate science and science facts were actively aided by the then prevailing anti-realist and constructionist stance in the social sciences, particularly in science and technology studies (STS), where the deconstruction and relativisation of science facts had become a core tenet of post-modern thinking (Schindler, 2020). In a culmination of anti-realism, Riegler (2001) concluded that the external reality is at best "irrelevant" (p. 4). This stance set social constructionism up on a collision course with the growing normative facts of climate change observations and caused some of the leading voices in the social sciences to overtly support the narratives of climate science denial in defence of relativism, as Hansson (2020) extensively documents. However, eventually, dissenting voices were heard in the academy. Latour (2004), one of the leading authors of the STS movement, lamented about the STS community's tenets: "Why does it burn my tongue to say that global warming is a fact whether you like it or not? ... What were we really after when we were so intent on showing the social construction of scientific facts?" (p. 227). Yet others now argue that STS bears no responsibility for our situation today (Hoffman, 2018).

It could be well argued that if the academy had sided early with climate scientists, humanity might find itself in a much better geopolitical situation with regard to climate change today. For education in times of the climate crisis, the social sciences' past emphasis on constructionist theories and the deconstructing, politicising and relativising of science facts remains problematic to this day, with

relevance for contemporary research. When I went through the training to become a science teacher at Waikato University in 2010, this conflict was palpable to me. And when I returned in 2020 to begin my PhD, it re-emerged as a yet unresolved and significant aspect of my theorising. And it reared its head anew when encountering new materialism and, in particular, the work of Karen Barad.

### New materialisms, the agency of matter and Barad's quantum theories

When searching for ontological anchors during my early PhD literature review, new materialist writings that acknowledge the agency of matter and the more-than-human world seemed like a breeze of fresh air. I can recommend the collection of essays by Coole and Frost (2010) as an excellent entry into the broad church of new materialist literature. Among my readings, MacLure's (2017) hard to refute five-word statement, "discourse does not discipline matter" (p. 7), stands out. It instantly points to a core argument of critique of the constructionist relativism that had troubled me. What else needs to be said to justify an ontological turn towards exploring reality beyond the human mind? And via the pedagogy of re-conceptualising climate change as an entanglement by Blanche Verlie (2017), I finally arrived at Karen Barad's (2007) seminal book *Meeting the Universe Halfway*, which inspires Verlie's theoretical approach.

*Meeting the Universe Halfway* surpassed 13,000 citations in 2021, elevating it to the top rankings of social science literature as a foundational work in new materialism. Barad (2007) draws on feminist socio-politics and her idiosyncratic interpretation of Bohr's quantum physics to propose a theory of *agential realism*. The foundation of agential realism lies in Barad's elevation of the quantum-indeterminism of the microcosm, where certain properties of microscopic quantum objects remain indeterminate until "measured" through an interaction with a macroscopic entity, to an ontology of indeterminism at the human and the social scale. According to Barad (2007), anything that relates to something else, Barad calls these "relata", including human bodies, things and words, remain indeterminate outside specific agential intra-actions (p. 150). Barad (2007) then goes much further to claim that relata do not preexist their relations, "rather, relata-within-phenomena emerge through specific intra-actions" (p. 140). According to Barad (2007), performative discursive practices are causative for the appearance of all material phenomena. This has, as Barad (2007) states, "far-reaching consequences for grasping and attending to the political possibilities for change, the responsible practice of science, and the responsible education of scientists" (p. 34). Clearly, Barad (2007) is writing about central aspects of the theorising for my own research, and arguably that of many other social science researchers, as evidenced by her citations.

However, Barad's (2007) application of quantum physics to the macroscopic realm does not correspond with views held widely in the physics community nor with the observation that reality at the human scale appears to be classical with more or less persistent objects, subjects, their properties and the information they can encode. In fact, preexisting relata and their properties determine which intra-actions can and do occur and how. Climate change, for instance, would not be an issue if preexisting hydrocarbon fossil fuels had not been turned into CO<sub>2</sub> by human actions and if the properties of the accumulating CO<sub>2</sub> molecules in the atmosphere did not cause them to absorb Earth's outgoing infrared radiation strongly. I sensed that I had arrived at a "snake field" on my theoretical quest. Was Barad's theory perhaps the old idea of the social-discursive generation of reality, now shifted from a relativist epistemology to a relativist ontology dressed in an authoritative cloak of quantum physics? Was it wise to rely on Barad's (2007) ideas for my research? So I felt compelled to reread quantum physics myself and engage with a critical appraisal of Barad's premises.

## The emergence of classical reality at the human scale from quantum physics

Returning to quantum physics reconnected me with advances made over the last decades in *decoherence theory*, which plausibly explains how classical reality at the macro-scale emerges naturally due to quantum interactions at the micro-scale in a well-connected open universe. Since Zeh (1970), decoherence theory has been developed into a robust framework by Zurek (1994, 2003, 2021) and many others (Blume-Kohout & Zurek, 2006; Brandão et al., 2015; Joos, 2006). An excellent summary of the field is provided by Schlosshauer (2019) in Memoriam of Zeh. And further, classical reality and the persistence of entities, their properties, and encoded information is essential for the emergence of complex self-organising systems, the evolution of life, and the emergent phenomena that predicate our own existence (Clayton & Davies, 2008; Jheeta, 2017; Maturana & Varela, 2012). Contrary to Barad, and backed by decoherence and emergence theories, I argue that there is a significant break between the quantum indeterminism at the microscale and the emergent domain of classical reality at the human and the social sphere with its novel properties.

Barad's ideas of quantum physics and her scale-jumping from the micro to the macro-scale have been critiqued by others (Faye & Jaksland, 2021; Hollin et al., 2017). And further, Jaksland (2021) and Holzhey (2021) speak of the inherent risks of Barad's authoritative application of quantum physics to the construction of social theorising. Jaksland (2021) argues that drawing on complex transdisciplinary theorising risks speculative theories being applied uncritically by those who cite such work and take its basic premises for granted. And with regard to quantum physics, Holzhey (2021) argues broadly against the use of fundamental ontologies of physics for social politics and states that a pragmatic physics of emergence "may be helpful in devising strategies to deactivate the normativity of fundamental ontologies, including those of physics itself" (p. 262). Holzhey (2021) concludes that it is not the reduction to matter's fundamental ontologies but the "novel character" (p. 268) of emergent properties at the human scale that matter. I agree, and argue, based on my ontological detour, that Holzhey's ideas dovetail with accepting classical reality as suggested by decoherence theories and support a refocusing on what emerges at the "politicico-mechanical" interface of human society with the environment that predicates our existence. I argue, that for the many readers of Barad (2007) in the social sciences, this critique of her work that arose from my unexpected detour could be helpful. For a full version of this paper, see (Everth & Gurney, 2022).

## Conclusion

I am deeply convinced that the fate of civilisation will be decided at the nexus between natural sciences, ecology, social theorising, politics, economy and, arguably, the agency of matter itself. Unquestionably, transdisciplinary engagement that brings together expertise from many fields will become essential. However, in emphasising Jaksland (2021), my detour might inspire others to be cautious when citing transdisciplinary work without going back to sources and emphasises the need to engage with the critique of fundamental ideas directly. Perhaps this is a key point I can make, irrespective of the relevance of the context of my quest. And as unexpected journeys go, such engagement may lead to unexpected insights and promote productive theoretical discourse.

In the struggle to safeguard our future, I agree with Demeritt (2006) that social science theorists and commentators need an "epistemologically secure foundation from which to speak truth to power" (p. 456). I argue that confidence in speaking truth to power is a central aspect and aspiration of research outcomes and will strengthen the defence of doctoral dissertations. And for education, epistemologically secure foundations enhance the ability to explain the world to our students with confidence. My ontological detour into quantum physics in search of my own foundation now entices me to explore realist philosophies of emergence at the human scale. However, more snakes and ladders may likely await on the path ahead. Roy Bhaskar (Bhaskar et al., 2010; Bhaskar, 2011) is next on my reading list.

## Acknowledgement

I acknowledge the support of my PhD supervisor Dr Laura Gurney for the development of my critique of Barad's theory. Our cooperation resulted in the publication of a joint paper on this topic (Everth & Gurney, 2022).

## References

- Arrhenius, S. (1896). On the influence of carbonic acid in the air upon the temperature of the ground. *Philosophical Magazine and Journal of Science, Series 5*, 41, 237–276.
- Barad, K. (2007). *Meeting the universe halfway: Quantum physics and the entanglement of matter and meaning*. Duke University Press.
- Bencze, L., & Alsop, S. (2014). *Activist science and technology education* (1st ed.). Springer. <https://doi.org/10.1007/978-94-007-4360-1>
- Bhaskar, R., Frank, C., Hoyer, K.G., Naess, P., & Parker, J. (Eds.). (2010). *Interdisciplinarity and climate change: Transforming knowledge and practice for our global future*. Routledge.
- Bhaskar, R. (2011). *Reclaiming reality: A critical introduction to contemporary philosophy*. Routledge. <https://doi.org/10.4324/9780203843314>
- Blume-Kohout, R., & Zurek, W. H. (2006). Quantum Darwinism: Entanglement, branches, and the emergent classicality of redundantly stored quantum information. *Physical Review A*, 73(6), 062310. <https://doi.org/10.1103/PhysRevA.73.062310>
- Brandão, F. G. S. L., Piani, M., & Horodecki, P. (2015). Generic emergence of classical features in quantum Darwinism. *Nature Communications*, 6(1), 7908. <https://doi.org/10.1038/ncomms8908>
- Bright, R., & Eames, C. (2020). Climate strikes: Their value in engaging and educating secondary school students. *Set: Research Information for Teachers*, 3, 4–11. <https://doi.org/10.18296/set.0180>
- Clayton, P., & Davies, P. (Eds.) (2008). *The re-emergence of emergence: The emergentist hypothesis from science to religion*. Oxford University Press. <https://doi.org/10.1093/acprof:oso/9780199544318.001.0001>
- Ceballos, G., Ehrlich, P. R., & Dirzo, R. (2017). Biological annihilation via the ongoing sixth mass extinction signaled by vertebrate population losses and declines. *Proceedings of the National Academy of Sciences*, 114(30), E6089–E6096. <https://doi.org/10.1073/pnas.1704949114>
- Coole, D., & Frost, S. (2010). Introducing the new materialisms. In *New materialisms: Ontology, agency, and politics* (pp. 1–43). Duke University Press. <https://doi.org/10.1215/9780822392996-001>
- Crutzen, P. & Stoermer, E. (2013). “The ‘Anthropocene’” (2000). In L. Robin, S. Sörlin & P. Warde (Eds.), *The future of nature: Documents of global change* (pp. 479–490). Yale University Press. <https://doi.org/10.12987/9780300188479-041>
- Demeritt, D. (2006). Science studies, climate change and the prospects for constructivist critique. *Economy and Society*, 35(3), 453–479. <https://doi.org/10.1080/03085140600845024>
- Duffy, K. A., Schwalm, C. R., Arcus, V. L., Koch, G. W., Liang, L. L., & Schipper, L. A. (2021). How close are we to the temperature tipping point of the terrestrial biosphere? *Science Advances*, 7(3), eaay1052. <https://doi.org/10.1126/sciadv.aay1052>
- Everth, T., Bright, R., Morey, C., dePetris, T., Gaze, S., Barker, A., Soanes, A., Gurney, L., & Eames, C. (2021). Building capacity for climate-change education in Aotearoa New Zealand schools. *Set: Research Information for Teachers*, 2, 34–39. <https://doi.org/10.18296/set.0202>

- Everth, T., & Gurney, L. (2022). Emergent realities: Diffracting Barad within a quantum-realist ontology of matter and politics. *European Journal for Philosophy of Science*, 12(3), 51. <https://doi.org/10.1007/s13194-022-00476-8>
- Faye, J., & Jaksland, R. (2021). Barad, Bohr, and quantum mechanics. *Synthese*, 199, 8231–8255. <https://doi.org/10.1007/s11229-021-03160-1>
- Ford, D. (2018). *Politics and pedagogy in the “post-truth” era: Insurgent philosophy and praxis*. Bloomsbury Publishing. <https://doi.org/10.5040/9781350059931>
- Hansen, J., Johnson, D., Lacis, A., Lebedeff, S., Lee, P., Rind, D., & Russell, G. (1981). Climate impact of increasing atmospheric carbon dioxide. *Science*, 213(4511), 957–966. <https://doi.org/10.1126/science.213.4511.957>
- Hansson, S. O. (2020). Social constructionism and climate science denial. *European Journal for Philosophy of Science*, 10(3), 37. <https://doi.org/10.1007/s13194-020-00305-w>
- Hoffman, S. G. (2018). The responsibilities and obligations of STS in a moment of post-truth demagoguery. *Engaging Science, Technology, and Society*, 4, 444–452. <https://doi.org/10.17351/ests2018.259>
- Hollin, G., Forsyth, I., Giraud, E., & Potts, T. (2017). (Dis)entangling Barad: Materialisms and ethics. *Social Studies of Science*, 47(6), 918–941. <https://doi.org/10.1177/0306312717728344>
- Holzhey, C. F. E. (2021). Emergence that matters and emergent irrelevance: On the political use of fundamental physics. In B. Bianchi, E. Filion-Donato, M. Miguel, and A. Yuva (Eds.), *Materialism and politics* (pp. 253–268). ICI Berlin Press. [https://doi.org/10.37050/ci-20\\_14](https://doi.org/10.37050/ci-20_14)
- Jaksland, R. (2021). Norms of testimony in road Interdisciplinarity: The case of quantum mechanics in critical theory. *Journal for General Philosophy of Science*, 52(1), 35–61. <https://doi.org/10.1007/s10838-020-09523-5>
- Jheeta, S. (2017). The landscape of the emergence of life. *Life*, 7(2), 27. <https://doi.org/10.3390/life7020027>
- Joos, E. (2006). The emergence of classicality from quantum theory. In P. Clayton & P. Davies (Eds.), *The re-emergence of emergence: The emergentist hypothesis from science to religion*. (pp. 53–78). Oxford University Press.
- Keller, G., Mateo, P., Punekar, J., Khozyem, H., Gertsch, B., Spangenberg, J., Bitchong, A. M., & Adatte, T. (2018). Environmental changes during the Cretaceous-Paleogene mass extinction and Paleocene-Eocene Thermal Maximum: Implications for the Anthropocene. *Gondwana Research*, 56, 69–89. <https://doi.org/10.1016/j.gr.2017.12.002>
- Kwauk, C. (2020). *Roadblocks to quality education in a time of climate change*. Center for Universal Education at The Brookings Institution. <https://eric.ed.gov/?id=ED607008>
- Latour, B. (2004). Why has critique run out of steam? From matters of fact to matters of concern. *Critical Inquiry*, 30(2), 225–248. <https://doi.org/10.1086/421123>
- MacLure, M. (2017). Qualitative methodology and the new materialisms: A little of Dionysus's blood? In N.K. Denzin & M.D. Giardina (Eds.), *Qualitative inquiry in neoliberal times* (pp. 48–58). Routledge. <https://doi.org/10.4324/9781315397788>
- Maturana, H. R., & Varela, F. J. (2012). *Autopoiesis and cognition: The realization of the living*. Springer.
- Oreskes, N., & Conway, E. M. (2010). *Merchants of doubt: How a handful of scientists obscured the truth on issues from tobacco smoke to global warming*. Bloomsbury.
- Renouf, J. S. (2021). Making sense of climate change—The lived experience of experts. *Climatic Change*, 164(1), 14. <https://doi.org/10.1007/s10584-021-02986-5>
- Riegler, A. (2001). Towards a radical constructivist understanding of science. *Foundations of Science*, 6, 1–30. <https://doi.org/10.1023/A:1011305022115>

- Ripple, W. J., Wolf, C., Newsome, T. M., Galetti, M., Alamgir, M., Crist, E., Mahmoud, M. I., Laurance, W. F., & 15,364 scientist signatories from 184 countries. (2017). World scientists' warning to humanity: A second notice. *BioScience*, 67(12), 1026–1028. <https://doi.org/10.1093/biosci/bix125>
- Ripple, W. J., Wolf, C., Newsome, T. M., Gregg, J. W., Lenton, T. M., Palomo, I., Eikelboom, J. A. J., Law, B. E., Huq, S., Duffy, P. B., & Rockström, J. (2021). World scientists' warning of a climate emergency 2021. *BioScience*, 71(9). <https://doi.org/10.1093/biosci/biab079>
- Schellnhuber, H. J., Serdeczny, O. M., Adams, S., Köhler, C., Magdalena Otto, I., & Schleussner, C.-F. (2016). The challenge of a 4°C world by 2100. In H. G. Brauch, Ú. Oswald Spring, J. Grin, & J. Scheffran (Eds.), *Handbook on sustainability transition and sustainable peace* (pp. 267–283). Springer. [https://doi.org/10.1007/978-3-319-43884-9\\_11](https://doi.org/10.1007/978-3-319-43884-9_11)
- Schindler, S. (2020). The task of critique in times of post-truth politics. *Review of International Studies*, 46(3), 376–394. <https://doi.org/10.1017/S0260210520000091>
- Schlosshauer, M. (2019). Quantum decoherence. *Physics Reports*, 831, 1–57. <https://doi.org/10.1016/j.physrep.2019.10.001>
- Steffen, W., Rockström, J., Richardson, K., Lenton, T. M., Folke, C., Liverman, D., Summerhayes, C. P., Barnosky, A. D., Cornell, S. E., Crucifix, M., Donges, J. F., Fetzer, I., Lade, S. J., Scheffer, M., Winkelmann, R., & Schellnhuber, H. J. (2018). Trajectories of the earth system in the Anthropocene. *Proceedings of the National Academy of Sciences*, 115(33), 8252–8259. <https://doi.org/10.1073/pnas.1810141115>
- Tannock, S. (2021). *Educating for radical social transformation in the climate crisis*. Palgrave Macmillan. <https://doi.org/10.1007/978-3-030-83000-7>
- Trisos, C. H., Merow, C., & Pigot, A. L. (2020). The projected timing of abrupt ecological disruption from climate change. *Nature*, 580, 496–501. <https://doi.org/10.1038/s41586-020-2189-9>
- Verlie, B. (2017). Rethinking climate education: Climate as entanglement. *Educational Studies*, 53(6), 560–572. <https://doi.org/10.1080/00131946.2017.1357555>
- Zeh, H. D. (1970). On the interpretation of measurement in quantum theory. *Foundations of Physics*, 1, 69–76. <https://doi.org/10.1007/BF00708656>
- Zurek, W. H. (1994). Decoherence and the existential interpretation of quantum theory, or "No Information Without Representation". In P. Grassberger & J.-P. Nadal (Eds.), *From statistical physics to statistical inference and back* (pp. 341–350). Springer. [https://doi.org/10.1007/978-94-011-1068-6\\_23](https://doi.org/10.1007/978-94-011-1068-6_23)
- Zurek, W. H. (2003). Decoherence, einselection, and the quantum origins of the classical. *Reviews of Modern Physics*, 75(3), 715–775. <https://doi.org/10.1103/RevModPhys.75.715>
- Zurek, W. H. (2021). Emergence of the classical from within the quantum universe. *ArXiv:2107.03378 [Quant-Ph]*. <https://doi.org/10.48550/arXiv.2107.03378>