Why Ontologies Are Important in Mathematics Education

Kay Owens
Charles Sturt University
kowens@csu.edu.au

Charles Sturt University had the motto "For the common good" but listening to the wisdom of the voices of the Wiradjuri Elders, *Yindyamarra Winhanganha* – the wisdom of knowing how to live well in a world worth living in – now guides us. We teach and research in mathematics with a deep-seated belief about mathematics and teaching it, and its purpose and value. While we are concerned about the selection of content and the way we teach and research, the underlying reason for our work directs us. This paper draws together key ideas for grappling with our ontologies, our purpose, and beliefs.

Ontology is an important part of preparing for a research project but it is often not discussed in terms of our personal development. In this paper, I reflect on the lived development of my ontology. The reflection is interrogated by the works of Pinxten and Skovsmose. The interrogation strengthens the argument that ontologies are important for mathematics education. This is a philosophical paper and not a report of an empirical study.

Starting Points

February 2025 was the 60th Anniversary of the Freedom Ride, NSW, organised by SAFA (Student Action for Aborigines). I belonged to this organisation and the Evangelical Union at the University of Sydney. I learnt as much in my university societies as I did in formal lectures. My ontological journey and purpose in the world began. SAFA was a group, led by Aboriginal activist Charly Perkins, of communists, other socialists like Fabians, humanists, anarchists, Christians, top medical students, top law students, top history and sociology students, scientists, an engineer, and only a couple of country students (including Aboriginal Gary Williams). They prepared well for a year to get publicity for the blatant discrimination and poor living conditions of Aboriginal people in country NSW, things of which city dwellers were totally unaware. I was a keen, socioeconomically and politically ignorant first year student, scared of failing and knowing the unspoken of how much it meant to my parents that I was there on scholarship. I was enthralled by learning new ideas. I learnt about a variety of socialist perspectives and different Christian perspectives. After a stint teaching in NSW, I worked in an Australian colony, PNG, for 15 years with amazing people from across the world and the country. We kept our Aboriginal and PNG connects and friendships over 50 years.

I can say my life has been so enriched and directed as it builds on my often non-described, almost unplanned, lived perspective. It took me to marry a like-minded person and to live in Papua New Guinea (PNG). My perspective permitted me to study and teach mathematics but to learn about mathematics differently, similarly health education about which I was also passionate and taught in Australia and PNG and which influenced my mathematics education in terms of cultural values and group learning. Over my 30 years of teacher education, I have actually taught all subject areas (except Physical Education) for early childhood and primary, and mathematics education and mathematics from early childhood to tertiary. The highlights were teaching Literacy and Numeracy together, Mathematics and Creative Arts together, and Mathematics and Human Society & Its Environment (with SAFA as an example of People Power) to the same students so I could integrate their learning. My ontology encouraged me to listen and work with Indigenous people in Australia and PNG and to make many global transcultural research colleagues.

(2025). In S. M. Patahuddin, L. Gaunt, D. Harris & K. Tripet (Eds.), *Unlocking minds in mathematics education. Proceedings of the 47th annual conference of the Mathematics Education Research Group of Australasia* (pp. 341–348). Canberra: MERGA.

At our Discussion Group at ICME15 on overcoming neocolonialism, our Maori colleagues pointed out that if cultural practices are to be used in mathematics, then the cultural practices must be learned first and culturally because the culture is lost if mathematics comes first in the students' learning. For example, the wall messages of the meeting house might have mathematical shapes and relationships but the cultural meaning should be learned first. Indigenous cultures are rich, holistic and integrated rather than deconstructed into mathematics and art. This paper establishes and analyses my ontology discussing various philosophical perspectives to show the significance of ontology for mathematics educators.

Moving Away from the Limitations of Educational Psychology

Most of us would adhere at least to social constructivism but that is not where I started. I did psychology at university and behaviourism was strong. We did 'experiments' and I learnt how to write scientific reports, design instruments for assessment, about validity and reliability, and over the years testing with t-tests and then factor analysis and various other multivariate analyses (thanks to computational tools). When I was at school, I could do maths if I understood the words (poor English or maybe the emphasis on rote learning hampered me[4]) and I loved the exercises about triangles and calculus – they were like a game of chess working out which method to use. But I wondered about the purpose of mathematics and the reason for spending so much time on mathematics. I came from a blue-collar working-class family who had no idea. After three years of university mathematics, I still did not know the answer to my question. When I started to teach mathematics at the PNG University of Technology, I finally found out how different areas of mathematics were important for a whole variety of technologies from electrical engineering and communications, to surveying and valuation, to accounting and business studies, to architecture and building management, to forestry and fisheries, to mining and food technology. Colleagues planned mathematics programs to suit each technology. Furthermore, I learnt how calculators and then computers could assist students to understand probability and statistics, linear programming, and queuing theory, and to write computer programs for carrying out calculations and for presenting moving graphs. How grateful was I for my mathematician colleagues and an advanced university whose computer usage for teaching was better than the university I returned to in Australia.

However, I also learnt that my PNG students:

- Had multiple counting systems and often not base 10.
- Were excellent at taking risks to solve problems.
- Could visualise, thinking spatially, and find their way travelling capably across land, rivers, and sea without a compass.
- Came from a diversity of rich and interesting cultures with beliefs and abilities to make extraordinary houses, boats, tools, artefacts, headdresses, bags, songs, and dances.

This then is the background for my developing ontology, something I cannot easily express but it guides my living, teaching and research. It's a lived ontology rather than a written one and maybe I need not make apologies for that.

Ontology

Modernism and mathematics might suggest that what is true or acceptable can be developed by reasoning from an axiomatic base. It might suggest that irrational thoughts such as a God that does not seem to follow rational thought should be dismissed. However, as Skovsmose

[4] I often smile that we used counters for a few days to develop multiplication tables, which I was good at, but it took me until first year university mathematics on set theory to actually know the meaning of that long word, multiplication.

(2024) and Ernest (2018) point out, mathematics without ethics can lead a person to use mathematics for immoral purposes as occurred in World War II. Skovsmose's (2024) critical philosophy of mathematics avoids absolutism to put the logic of mathematics above all else. As mathematics is constantly being constructed, it does not reach a definitive form but rather it is merely a construction. For example, at school we learnt geometric proofs of a particular Euclidean kind but once dynamic geometry software developed, proof took on other meanings for geometry. Mathematics can develop new concepts, proofs, topics, and applications. Mathematical rigour is contested and new topics develop. However, mathematics can also create power and culture (Ernest, 2012, 2018).

Mathematics can have powerful roles, untruthful roles, money-making roles, and profiteering roles. However, it can bring truth, justice, and improvement of society. My Swedish friend and colleague Annica Andersson completed a doctorate on teaching school students, who were majoring in social science, upper-level mathematics. She showed that their projects on social issues, in which they needed to use mathematics and share it with the school in posters, created agency for students. They had agency not only in *doing* their mathematics and creating something mathematical, as opposed to following someone else's mathematics and reproducing it, but also they were *doing* mathematics for truth, justice, and improvement of society. That teaching reflects Annica's ontology and epistemology (Andersson, 2010).

Our ontology is our perspective and understanding of the world around us and it influences our epistemology, that is our focus on how we know and even the limits of our knowing. This paper presents some of the challenges from mathematician philosophers. For me there is the grappling with Christian views and humanistic views. Ethnomathematics has brought for me a large number of different perspectives on mathematics and ontologies and many research friends. Hence it is interesting for me to read their reasoning too.

NEED Humanism and Ethnomathematics

One person who has influenced my thinking over the past 35 years has been Rik Pinxten who has also spent a long time listening to the voices of his own Belgian family and community, First Nations in America, migrants and displaced people. He recently published a book, *Humanism Revisited*, which portrays its author Rik Pinxten the person grappling, as he does, with an issue that is intellectually troubling him, not just for himself but for the world and others. Rik Pinxten the story-teller reveals sufficient of his personal life and experiences to give a humanness to his discussion. As one reads this book, it is as if he is sitting discussing his thoughts with you, what is troubling him. And yet this is no ramble, it is a clearly presented argument which has been carefully crafted to present his points. He bases his arguments on lived realities and other scholarly works. These works he also presents clearly for the reader. The last time I read a book that made me feel part of a conversation was one by Bill Barton (2008) on *Languages of Mathematics.* Again, at least for mathematics educators in Australia, Aotearoa, and the Pacific, this is essential reading with an equally well-developed argument for perceiving mathematics as being about quantitative, relational, and spatial aspects of life but not necessarily as European/school mathematics has developed it. Rather he has seen mathematics incorporating the perspective of Maori.

Rik Pinxten intentionally avoids losing the reader at the start by not discussing the nuances of past humanism and enlightenment philosophies. He clarifies the purpose of his book, and the context of the world today that disturbs him, and should disturb all humankind. It is time to grapple with our ontologies, to recognise the plurality and value of these rather than being left behind in some former humanistic ontology that does not meet the world's current needs. He clarifies that the dualistic ontology based on Jewish, Christian, Islamic thinking about which humanism reacted had, in fact, insidiously led to the idea of one ontology of humanism, that of a dualistic humanism/enlightenment - of *us* who know and have, and *them* who need these

things. This ontology led to colonisation by missions, educators and governments, not forgetting of course the power, greed and wealth that was taken or the destruction that it caused. Indeed, this Eurocentric humanistic ontology needs changing.

Pinxten encourages us to recognise that people and individuals are a product of their society. In discussing freedom, he mentions the impact of social media, and the rich, deal-making men who continue to bring societies to the brink of destruction. However, he could have expanded on the choices that people make to find information. People have a choice to listen to Sky News or ABC but they do not see freedom as meaning a responsibility to be well or unbiasedly informed (Steve Thornton, personal communication). However, Pinxten notes that not all people have choice. Nevertheless, those from a capitalist background, Islamic, or Chinese-obedience society background, need to recognise how the dualistic thinking of the group who think they are right, supported by members of institutional, powerful groups, for example, churches or political parties are encouraging far-right fears without concern for others and heading people and the earth into catastrophe. The ontological stance must move from the neocolonial in which race, gender and cultural identity forgets the class struggle, poverty and interdependence. It is time for an anthropologically inspired ontological turn.

Pinxten encourages us to look at ontologies that are not based on European humanism. He carefully unpacks his NEED humanism that recognises **N**on-**E**urocentric humanism, **E**cological humanism, and **D**urable humanism. Indeed, each is utterly important for this world of ours especially with the current autocracies and plundering of the earth's resources and the high proportion of people without basic needs, rights and justice. He does not forget mathematics and mathematics education in this commentary for they have and continue to pursue a mathematics centred on European studies alone without regard for the diversity of mathematics that may be found among First Nations, disposed and other voiceless or landless people of the world.

I read Rik Pinxten's current book after reading a book by Garry Worette Deverell (2023) on Indigenous theology. Deverell draws together two knowledges to discuss Christ as country (analogously), to see Christ as cosmos, seed, staple food and drink, an ancestral voice, and teaching custodian. This is an example of what the Australian Universities suggest as an Indigenous standpoint in merging ontologies and perspectives and knowledges as ways of doing:

> In the language of the academy, the concepts of First Nations ways of Knowing, Being, Doing might be translated respectively as ontology, epistemology and methodology (for the research community) or pedagogy (for teachers and learners). (Charles Sturt University, 2025, p. 18)

Ontologies of Indigenous cultures whether they be those of Australia (the great south land Gondwana), *Ngurra,* or the First Nations of the Americas, or others, the point is these ontologies enlighten people who have western/European/Christian (or Jewish, Islamic, or Chinese obedience society etc) backgrounds. Pinxten tells the ontology of the Diné (Navajo Native Americans) whom he personally knows and appreciates from living, yarning (talking with), grappling with ideas, and working with them on mathematical ideas and curricula (e.g., Pinxten, van Dooren & Harvey, 1983; Pinxten, van Dooren, & Soberon, 1987, Pinxten & Francois, 2011), and Quechua supported by Descola's (e.g., 2016) work. He notes the more recent discussions by scientists and alternative thinkers about animals and plants, even the world (Gaia), in terms of community, care and empathy. Another mathematician philosopher, Natalie Sinclair (e.g., 2024), has also discussed similar ideas in which mathematical ideas and tools can be used to generate new spatial imaginaries about the world, that is, new ways of imaging the relations that pertain to existence and experience.

Pinxten provides some of the historical and recent developments that bring the world into crisis where greed is favoured over people, and nation alliances bring solidarity but also less

freedom while other nations' leaders flaunt but extinguish democracy. These are new crises: ecological destruction (some mass population deaths), new inequalities (riches out of reach of government, and encouragement of greed), exhaustion of resources, and population mismanagement. With his sketched historical background and crisis summaries, Pinxten presents his arguments for NEED humanism and provides ethnomathematics as an example.

The strength of Pinxten's argument, while he notes political manipulations, is to indicate that the extreme right voice for 'freedom' whilst it sounds humanistic (often backed by 'Christian' influences) is indeed a Eurocentric view of humanism and one that puts individuals before other issues such as the environment and what it means to live in poverty. The 'others', as opposed to us, mentality is used for political gain but for Pinxten, the situation is more deep-seated where the world's other ontologies must be recognised by humanists. Humanists need to avoid individualism and grapple with these issues as a group of humanists. It is a timely reminder that identity is individual, but of a group for action, and of a community for establishing values as interacting groups. Is not MERGA such a community? Perhaps its recent position statement on mathematics education indicates such a move. Pinxten's example is the story of Hannah Arendt and her move from individualistic humanism to recognising the impact of the group in Germany. However, he also shines a spotlight on the degree of change in thinking with the more recent interaction of Europeans with various other cultural practices, particularly awareness of North American Native cultures but also those of the East, Confusian practices. These interactions of groups and thought changes are present in the humanistic realm of Europe. His story this time is of Turpo who continues to follow his Quechuan group identity despite danger compared to the individual, greed-influenced president of Peru and a new wave of those who consider group humanism as 'primitive' and not to be followed. Neocolonial countries like Papua New Guinea face similar dilemmas. Hari (2023) who refers to many thousands of examples of non-Eurocentric humanism while Pinxten continues to focus on his own 'neighbourhood' that once incorporated poor Belgium-born families but now consists of poor from multiple cultural backgrounds with some similar and some different needs and gifts.

Importantly, he notes that the power of rich and powerful individuals, needs humanism to go *beyond individualism* that arose in opposition to the collective strength of the churches with political power *to* recognising the importance of the global and collective. This might be seen as a new stand for humanism to emphasise the collective, "a type of updated, respectful, postcolonial humanism" (p. 79), to be more political. I was surprised by the thought that humanists might not have already taken on this cause considering the strength of the humanist society at my own university in Australia in the 1960s to recognise Aboriginal rights (along with all 'left' political groups and Christian churches). However, he also notes that philosophers and theologians play their role in disconnecting ideologies from reality since for them "empirical reality is not relevant, and logical consistency or coherence is the primary value" (p. 84). Mathematics education is not immune from this and hence the reason for us to take a strong stand on our ontology.

Rik Pinxten recognises the need for practical implementation. He shares the key tenets of others such as Nussbaum (2011) on life, physical health, physical immunity, chances to observe, imagine and think, feelings, practical reasons, other biological species, play and creativity, built and political environments. All of these involve mathematics. In moving forward, Pinxten says:

> On all ten rubrics a general engagement for justice and equal opportunities for all has priority over any juridical or ideological value or norm. When looking at the real world, such an emphasis on human capabilities goes deeper than … basic human needs; … universally agreed-upon moral values (must come) first, prior to juridical regulating (p. 149).

Ethnomathematics shows how the values and ontologies of non-European peoples can influence this new humanistic worldview. For ethnomathematicians, Pinxten presents a sound ontological basis for their studies and expounds on this by saying:

> Ethnomathematicians started studying the out-of-school formal concepts and procedures in the particular linguistic and cultural environment of the child. The technologies developed and used successfully in many cultures – the architectural sophistication, the cosmologies, the formal aspects in rituals and in music, and so on – all these showed a huge variety of formal or abstract reasoning. Ethnomathematical educationalists would then go on and start organizing further learning processes on the basis of these local or culture-specific skills. … no longer will the teacher erase the supposedly wrong or 'undeveloped' notions and practices of the pupils in order to plant the one true doctrine in their heads. Rather, the educational process will develop as a dynamic, interactive relationship where the local categories are taken to be valuable concepts and procedures on which more and other notions and views can possibly be grafted. Or, to put it differently, education resembles more a process of intercultural negotiation than one of assimilation. Thus, a holistic approach at the intuitive level is respected and can gain the same status as the dualistic view of the westerner, if not a better entry in the field of formal reasoning (Baker, 2023, p. 153)

Pinxten's own work with the Diné is his lived ontological approach and Vandendriessche and Pinxten's (2023) book is a companion to this book *Humanism Revisited.* Thus Pinxten presents both a theoretical and logically reasoned revised humanism. It is non-Eurocentric, ecological and durable in terms of not only saving humanity and the planet but also a way of living, thinking, and philosophising. This truly is a humanistic ontology needed in all aspects of the world but essential for education including mathematics education.

We need to relearn living together and with the whole of nature. There is no time dimension to this, it is essential. It recognises differences in humanity and takes these as foundational capabilities for pluriversal humanism (Tim Ingold, in Pinxten, 2023). Mathematics then becomes an understanding of all humanity with "quantitative, relational, or spatial aspects of human experience" (Barton, 2008, p. 10). This perspective, often referred to as the QRS system, has been built upon for epistemology by others such as Alangui in the Philippines and Trinick in Aotearoa (NZ) and their colleagues. For example, Trinick et al. (2023) refer to the Cultural Symmetry Model in which the cultural practices and knowledges are forefront in education.

> The first step is to describe the cultural knowledge and identify the cultural values connected to the practices and artefacts under investigation, which is best done in collaboration with elders, who are knowledgeable about these practices and artefacts. As traditional practices are tightly connected to Indigenous language, there is a need to ensure that those discussing the practices know the language to engage in discussions of practices and artifacts. The second step is to examine the cultural practices and discuss them from a range of perspectives, of which mathematics would be one. The third step involves considering how mathematics can add value to cultural artefacts and practices, without detracting from the cultural understandings. (p. 304)

Critical in this argument is that cultural understanding should come before the mathematics because, if the mathematics comes first, education does not share the culture properly.

Logical Mathematics

Many views of mathematics surround the issues of logic. This may lead to absolutist views and link to dualistic views of the world – what is right and what is wrong. Such logical views were the basis in the late 1800s of mathematicians such as Klein and Hilbert (Skovsmose, 2024). However, at this point Skovsmose (2024) discusses the idea of metamathematics using four criteria:

> *independence* of mathematical axioms, the *consistency* of a mathematical theory, the *completeness* of a mathematical theory, and the *decision problem* concerning the possible existence of an algorithmic procedure for determining whether a given mathematical formula is a theorem or not in a given mathematical theory. (pp. 78-79)

These might be interesting for assessing systems from ethnomathematics or critical mathematics education.

The formalism of mathematics is tempered by noting:

> Formalism advocates an if-then absolutism with respect to mathematical statements. The situation is quite different with respect to the truth of a mathematics theory. A mathematical theory can be applied in order to describe some empirical phenomena. It can provide more or less precise and reliable descriptions. The degree to which it does so is an empirical question. Formalism advocates an empirical graduation of truth with respect to mathematical theories. (pp.83-84)

This led to mathematics as being almost a game without regard for its purpose, an ethical issue. Furthermore, the structural view of mathematics by the Boubaki Modern Mathematics Movement developed many strands of mathematics from sets or the group. However, it ignored, as it did in its implementation into school mathematics (1960s and 1970s), other aspects of mathematical understanding. Yet set theory led me to understand multiplication.

Critical Mathematics Education

One little-recognised comment from van Hiele (1986), was his description of intuition that it might well be prior experience. The phrase 'teaching from the known to the unknown' has often been used in education but are students actually allowed to do this, outside of early childhood play. It is worth noting developments in mathematics education:

> Both Freudenthal and Brouwer argued that formal structures did not capture the essence of mathematical thinking. While Brouwer highlighted that mathematics is a mental activity, Freudenthal repeated many times that mathematics is a human activity. They first of all saw mathematics as an activity and not as a structure. While the Modern Mathematics Movement tried to teach students mathematical scores, Freudenthal tried to engage them in playing the music of mathematics. (Skovsmose, 2024, p. 101)

Critical mathematics education has taken the stage.

> Although the modern philosophies of mathematics—logicism, formalism, and intuitionism—have had a profound impact on mathematical practices in research, application, and education, they have remained oblivious to any such impacts …. unconnected to other forms of knowledge as well as to any socio-political issues. (Skovsmose, 2024, p. 102)

Mathematics has resulted in discrimination against students who have not the same background as Europeans of the modern world, especially through colonisation or power elites that have often been racially or linguistically identified. Nevertheless, mathematics may be used to address critically sociopolitical issues through reflective inquiries into critical issues.

Conclusion

I began my journey into critical mathematics education from teaching Sociology of Education and HSIE with an emphasis on recognitive social justice (that is people having a say in their future, for example, how government money is used to support them rather than the government bodies deciding). I read Gruenwald's view of critical theory and place-based education (2008; Gruenwald & Smith, 2007) and applied it to mathematics education (Owens, 2014). An ecocultural pedagogy both aims to decolonise and reinhabit mathematics education, particularly for Indigenous students, but it also takes account of different geographies. In particular, education must take account of the kind of places we inhabit and leave behind for future generations. In these places, the learner takes initiative, poses questions, experiments, solves problems, makes decisions, and is accountable for the results. Places and actions in places are visualised and people reason holistically about places that they visualise (Pinxten et al., 1983). This visuospatial reasoning is central to mathematics learning and thinking and this perspective emphasises cultural links to land as embedded in relationships and language.

Research with Indigenous communities needs the community to decide on what should be researched, how it should be researched and who should do the research, and they continue with ownership of the research. As UNDRIP, Article 14 (United Nations, 2007) says, the right to "have access … to their education in their own culture and provided in their own language". Their ontology involves the land, as Shaun Williams and NSW Aboriginal and Education Consultative Group (AECG) say "Healthy country, healthy culture". First Nations mathematics lies in their long-time culture. My role, as non-Indigenous, is to discuss ideas that can become of keen interest to the community with their ideas and knowledge that go well beyond my thinking. The final product needs to be their voice, shared as they see appropriate. Seeing mathematics differently to their colonised perspective needs discussion and more than one voice. Digging deeply into culture and cultural relationships means recognising culture and relationships as priorities; language, especially non-verbal and by others of the group, as complexities, within which the ontology, the research, the mathematics, and the education survive.

References

Andersson, A. (2010). Making sense of critical mathematics education. In L. Sparrow, B. Kissane, & C. Hurst (Eds.), *MERGA33 - Shaping the future of mathematics education* (pp. 37-44). MERGA.

Baker, M. (2023). The western mathematic and the ontological turn: Ethnomathematics and cosmotechnics for the pluriverse. In E. Vandendriessche & R. Pinxten (eds), *Indigenous knowledge and ethnomathematics* (pp. 243–76). Springer.

Barton, B. (2008). *The language of mathematics: Telling mathematical tales*. Springer.

Charles Sturt University (2025). *First Nations Statement (draft).* https://cdn.csu.edu.au/__data/assets/pdf_file/0004/4440568/FN-Ways-Background-Paper.pdf

Descola, P. (2016). Biolatry: A surrender of understanding (response to Ingold's A naturalist abroad in the museum of ontology). *Anthropological Forum, 26*(3), 1–8.

Deverell, G. J. (2023). *Contemplating country: More Gondwana theology*. Nielsen Bookdata.

Ernest, P. (2012). What is our first philosophy in mathematics education? *For the Learning of Mathematics, 32*(3), 8-14.

Ernest, P. (2018). *The philosophy of mathematics education today* (2018). Springer.

Gruenewald, D. (2008). The best of both worlds: A critical pedagogy of place. *Environmental Education Research*, *14*(3), 308-324. http://doi.org/10.1080/13504620802193572

Gruenewald, D., & Smith, G. (2007). *Place-based education in a global age: Local diversity*. Lawrence Erlbaum.

Hari, S. (2023). *Decolonizing the mind: A guide to decolonial theory and practice*. Amrit.

Nussbaum, M. (2011). *Creating capabilities: The human development approach*. Harvard University Press.

Owens, K. (2014). *Visuospatial reasoning: An ecocultural perspective on space, geometry, and measurement education.* Springer.

Pinxten, R. (2024). *Humanism revisited: An anthropological perspective* (1st edition. ed.). Berghahn Books.

Pinxten, R., & François, K. (2011). Politics in an Indian canyon? Some thoughts on the implications of ethnomathematics. *Educational Studies in Mathematics*, *78*(2), 261-273.

Pinxten, R., van Dooren, I., & Harvey, F. (1983). *The anthropology of space: Explorations into the natural philosophy and semantics of the Navajo*. University of Pennsylvania Press.

Pinxten, R., van Dooren, I., & Soberon, E. (1987). *Towards a Navajo geometry*. KKI Books.

Skovsmose, O. (2024). *Critical philosophy of mathematics*. Springer.

Sinclair, N. (2024). The unreasonable effectiveness of mathematics to generate new spatial imaginaries. In Bharath Sriraman (ed.), *Handbook of the history and philosophy of mathematical practice*, (pp. 1307-1327). Springer.

Trinick, T., Allen, P., & Meaney, T. (2023). The Cultural Symmetry Framework: A pedagogical approach for developing mathematics activities in an Indigenous Initial teacher education programme. In K. Owens & W. Alangui (eds.), *Proceedings of International Conference on Ethnomathematics 7*, ICEm 7, (pp. 303-308). https://www.researchgate.net/publication/378902702_Proceedings_of_the_7th_International_Conference_on_Ethnomathematics_-_ICEm7_2022_online

United Nations (2007) *Declaration on the Rights of Indigenous Peoples [UNDRIP]* Article 14.

Vandendriessche, E., & Pinxten R. (eds) (2023). *Indigenous knowledge and ethnomathematics*. Springer.

van Hiele, P. (1986). *Structure and insight: A theory of mathematics education*. Academic Press.