

“... but you cannot buy the sunset”: Abstraction, attachment and detachment¹

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Pre-print (text submitted after peer review, before formatting etc.). Published article available at <https://flm-journal.org>

Huru, H., Andersson, A. & Wagner, D. (2023). “...but you cannot buy the sunset”:
Abstraction, attachment and detachment. *For the Learning of Mathematics*, 43(3), 7–12.

When mathematics students are given word problems, the people and the places are abstractions because they refer to hypothetical people and places. For example, a word problem might say “Eirá built a *lavvu*”. Students are not expected to think about the person Eirá or a particular *lavvu* in a particular place. Students are expected to think of any person constructing a cone in some kind of idealised space with level ground, perfectly straight poles, etc. Gerofsky (1996) showed how the tradition of mathematical word problems treats context as a *throw-away*. Is Eirá disposable? Can we ignore the structure of the ground and the plants growing where Eirá would want to put her *lavvu*? What considerations will Eirá need to find a good spot for her *lavvu* where she will have a good night’s sleep with water nearby for her-self and her dog? Do we want to encourage children to ignore traditional local structures? To support students of minoritised groups, as teachers we must consider the practical aspects related to the mathematical. While context adds richness to any task it can also honour the knowledge a student and their culture carry. We wonder if students detach themselves from mathematics because they find that mathematics seems to require them to detach themselves from people and places to whom they wish to remain attached.

In this article, we explore the concept of abstraction in two ways. First, abstraction is central to conceptions of mathematics: the first realisation that a line carved into a bone can represent a real thing; a group of eight lines can be written by a symbol like ‘8’. We see abstraction as a process that attaches an idea to experience, but also detaches, such as the symbol ‘8’ having a meaning of its own. Second, we explore how abstraction can lead to detachment from or attachment to land, nature, culture, and identity—connection and disconnection from seeing the world as ‘all the relations’ (words used by many Indigenous people in Canada to refer to all beings—humans, the four-legged ones, the ones that fly, the ones that swim, the trees, the rocks, ...).

In mathematics classrooms, attachment/detachment and connection/disconnection follow from interaction among teacher(s), student(s), the situation, the learning task, etc. Even learning activities that are based on students’ culture may potentially remove the students further from their cultural identities and their traditions if these activities are not designed with care. Here we raise cautions about abstraction. We identify land-based and Indigenous pedagogies as possible orientations that provide tools for reflecting on abstraction in mathematics classrooms, and seeing mathematics through students’ cultural and traditional lenses. We wish to see abstraction in mathematics in terms of attachment: when abstraction recognises processes of detachment from things that are holding us back and creates possibilities for more meaningful attachments

¹ This article overlaps but extends our book chapter Huru, Andersson & Wagner (2023).

of people, particularly Indigenous people, to land nature, culture and identity in mathematics education.

To illustrate our observations on abstraction, we use stories and examples connecting with our own histories as researchers, our experiences, and where we are coming from. Hilja identifies as Kven, also as a mathematician, a teacher educator, a daughter and a granddaughter with a heritage language and culture of great importance to her through which she has an attachment to the culture and to the land. Annica identifies as a woman with a Swedish mother and a migrated working-class father. She also identifies herself as a mother, a mathematics teacher educator, and a researcher with a special interest in human relationships, languages, and cultures in mathematics education. David identifies himself as a mathematics educator, a father, and a settler with recent ancestors migrating from Europe fleeing war. He has lived among Indigenous people in eSwatini and now lives on land stolen from the Wolastokiyik people (on land commonly called Canada). We have mainly chosen examples from Indigenous and minoritised peoples of the Nordic countries: the Sámi people and the less known Kven people and the Forest Finns of Norway, two communities we will describe in more detail later.

Abstraction and identity

At first thought, mathematics and its characteristic abstraction may be seen as a threat to Indigenous students and others identifying with minoritised groups because of the danger of detaching them and their thoughts from their own contexts. In ethnomathematical approaches to learning and land- and culture-based activities, processes of abstraction might include moving from the experience of a landscape to topographical lines in a map, from the content or meaning of a story to a set of equations to solve, or from a heritage artefact to geometrical shapes, in which case the traditional uses and meanings may be removed or ignored.

In Sámi contexts culture-based mathematics activities have led to concepts of decolonisation (Nutti, 2013) as well as innovative instructional practise through culturally responsive pedagogy (Fyhn, Nutti, Nystad, Eira & Hætta, 2016). The framework of cultural symmetry has been shown to be applicable to a wider definition of culture such as the mathematics of coastal fishermen in Northern Norway explored by Fyhn & Robertsen (2020). The literature discusses the role of language as well as cultural practice and heritage in mathematics education (Culligan, DeWolfe & Simensen, 2023; Huru, Räisänen & Simensen, 2018) and the need for structural or political action (Keskitalo, Fyhn & Nystad, 2017; Wirkola & Andersson, 2023).

In our exploration of abstraction, we need to consider how mathematical abstraction and the related detachment affect students' identities and strengthen rather than remove the students from belonging. Forms of mathematical communication may suggest that the knowledge is completely detached from context as "it generally steps away from particularities, context, and thus culture" (Andersson & Wagner, 2021, p. 27). However, mathematical communication is always in a context, even if the language of mathematics masks contexts, and the human "move for abstraction is a move within culture, so we do not see abstraction as culture-free" (p. 27).

Learning is about more than knowledge; it is also about becoming (Radford, 2008). Taking a socio-cultural and socio-political perspective, we see students' learning as social activity, which implies that learning processes "are constituted in the encounter between contextualised, historically-grounded human beings and their activity in particular settings and spaces that are socially structured" (Valero 2004, p. 10). Identities are recognised as socioculturally developed.

[They] are neither located entirely with the individual nor entirely a product of others and the social setting. [...] they are the constantly changing outcomes of the iteration between how others construct [a person], and how they construct themselves, in and away from social situations (Kelly, 2006, p. 513).

Stories of belonging and attachment are political. If citizens, students, and mathematics teachers accept the narratives and stories that have been served regularly, and do not stop to question these, they support the status quo that school mathematics underpins.

To illustrate the importance of identity we give a short introduction to the Kvens and Forest Finns, two native peoples and border minorities in Norway and Sweden². For these people, attachment to the land is part of their identity, together with attachment to traditions, stories, traditional artefacts, etc. (Huru, Räisänen & Simensen, 2018; Culligan, DeWolfe & Simensen, 2023). Both groups have suffered from assimilation and colonisation together with the Sámi people in Norway and Sweden³. As a result, the language of the Forest Finns is extinct and the Kven language is critically endangered with little or no transgenerational transmission (Toivanen, Laakso, Spiliopoulou Åkermark & Sarhimaa, 2013). Neither of these minorities are commonly visible in mainstream media or public spaces. Thus, the Forest Finns and the Kven people are invisible in several ways.

Knowledge about these peoples among the majority in Norway and beyond Norway is limited. When people with limited knowledge of the complex history, culture, or traditions of the peoples say things about them, they can ‘other’ the people of these cultures even more (see Andersson & le Roux, 2017). We know that Indigenous groups in other countries have similar experiences. For generations, these groups may have been told by authorities and others that their language and culture is not of value, or maybe that it belongs to the past. Detachment has occurred directly or indirectly as a consequence. Hence, contributing to our reflection is the invisibility and silencing of many Indigenous groups. Now, minoritised groups all over the world are reclaiming their narratives, for themselves and others to recognise the value of their languages and cultures. In our three countries, Norway, Sweden, and Canada, there are processes of reconciliation through governmental initiatives for truth and reconciliation commissions, with hope for lasting changes in attitudes, insight, and understanding.

We are inspired by two writers outside of mathematics education for their thoughts on belonging: The poets Hans Børli, a Forest Finn, and Genevieve Ryan, a young Australian non Indigenous woman. Børli wrote *Vi Eier Skogene*⁴ [We Own the Forests] in response to men from the city who claimed to own the land that his ancestors cleared and cultivated. In the poem, he explains how ownership and belonging is viewed by his people. The poem begins (translation ours):

I have never owned a tree.
None of my people
have ever owned a tree—
though the family’s life path wound
over centuries of blue heights
of forest.

This poem is a thoughtful critique of the language of ownership that is used to support the rights and aspirations of some people over others and accentuates different kinds of attachment

² Kven and Forest Finn lands are in Northern and Southern Norway respectively and span the border to the neighbouring Nordic countries. We will use the term ‘Kven’ in our article although members of the same group commonly use the terms ‘Tornedalinger’ or ‘Lantalaiset’.

³ Sannhets- og forsoningskommisjonen (2023). *Sannhet og Forsoning – Grunnlag for et Oppgjør med Fornorskingspolitikk og Urett mot Samer, Kvener/Norskfinner og Skogfinner*. [Truth and Reconciliation—Basis for a Settlement with Norwegianisation Policy and Injustice against Sami, Kven/Norwegian Finns and Forest Finns.] <https://www.stortinget.no/globalassets/pdf/sannhets--og-forsoningskommisjonen/rapport-til-stortinget-fra-sannhets--og-forsoningskommisjonen.pdf>

⁴ <https://hansborli.no/dikt/vi-eier-skogene>

to things, places, nature, people, and even concepts. It shows how aspects of belonging, attachment, and detachment leads to ownership with the land and how this is different from the ‘modern’ or ‘Western’ approach that is familiar to most majority cultures. We follow Børli’s critique of common ideas relating to attachment and detachment.

Bang, Faber, Gurneau, Marin & Soto (2016) remind us “the severance of people from lands more broadly is a critical issue facing human species, as it has led to destructive social and economic systems” (p. 34). While we recognise that detachment may be especially significant for people identify-ing as Indigenous and other minoritised people, we see that detachment is felt even by students who identify in majority culture—evident in the following poem by Ryan (2006). Ryan wrote poems about her experiences growing up “in an exhilarating and confusing world”⁵ in Australia. She passed away when falling during a hike at the age of 20.

I am X.
I don’t know my own value.
I’m waiting for someone to work me out.
There are no clues I’ve never been able to understand the logic of mathe-matics
I don’t have the ability to know what I’m worth
I’m lost in a vicious triangle.
How can I simplify myself? (p. 162)

What is abstraction?

In this section we consider common notions of abstraction as detachment from context. It is at the heart of mathematics, described by Balacheff (1988) as the altered position that is required in mathematical communication of concepts: “The speaker must distance herself from the action and the processes of solution of the problem. [...] The elaboration of this functional language requires in particular: decontextualisation, depersonalisation, [and] detemporalisation” (p. 277).

Mason (1989) described abstraction as “the drawing away of form from the sensible” (p. 2) but argued that the connotations associated with this withdrawal from sensory experience need not be negative. He described the pleasure that mathematicians and others can derive from the act of abstraction, as it is a way of identifying a “common, root experience” (p. 2). His examples focused on pure mathematics— play with objects that have already been abstracted. We think of his approach to abstraction as play in a *detached* space. Because play requires interaction, even play with abstracted objects can form new attachments among the people playing together. However, this kind of attachment is different from attachment to sensory experiences. Like Mason, we want to be thoughtful about abstraction. We recognise the pain of detachment, but we consider how abstraction can have positive aspects. We especially want to think about abstraction at the moment of detachment from sensual experience as a space that may, for minoritised students, prompt detachment from pain and a painful history.

The poet Ryan saw herself replaced by a mark on a page— an X. However, abstraction is not limited to what we commonly associate with mathematics. Even her name is formed by marks on a page, a detachment from herself. When we write about Ryan here, we are not talking about the whole person, not her whole story. We are talking about a certain aspect of her, her poem, and may simply call her ‘a poet’, an even deeper abstraction and generalisation from the person.

Levels of abstraction can be illustrated with numbering: imagine Swazi children playing with ten stones. As with names, their talk about the stones is already abstracting. The word ‘stone’ could be any stone at all. When they say there are ten stones, they may use the stones to

⁵ As the back cover blurb of Ryan (2006) puts it.

describe or represent something like cattle. In that case, they are not really counting stones; they are counting cattle. The number ten is an adjective; it describes this group of stones/cattle. They go further and use the number ten as a noun or give it a symbol, '10'—as a number detached from things like stones or cattle. With this number, they can do operations. They can add numbers, multiply them, etc. They can go further and forget the numbers and do operations on symbols like x . And they can detach themselves even from symbols and talk about the operations—"addition is commutative", possibly reflecting on the fact that $3 + 7$ cows are the same number of cows as $7 + 3$. Skemp (1986) wrote, "An *abstraction* is some kind of lasting mental change, the result of abstracting, which enables us to recognise new experiences as having the similarities of an already formed class" (p. 21). Once a student or a community of mathematicians has gone through such steps of abstraction, they need not retrace these steps to return to or compare with real experience. They may accept that the stones represent cattle and that x can be the number of cattle belonging to their neighbour, Velaphi (a Swazi name meaning 'where are you from?').

Cartesian maps are another form of abstraction potentially detaching people from land even when used to locate place. We remember that such maps were developed for colonising purposes. This, as any mathematical representation or model, is a simplification of one's surroundings. In the words of Doolittle (2018):

Concepts that are useful on a small scale, such as plane Euclidean geometry, and its grounding in straight lines, circles, grids and other rigid figures, fail to scale to environments that are large, compared to the earth, fail to scale to the natural landscape, and completely fail to capture or even describe some of the more complicated shapes of nature. (p. 108)

Belonging

In this section we illustrate problems with abstraction and aspects of belonging for mathematics students. There are mathematical concepts that formalise exclusion (and inclusion). Set theory is about belonging: asking if elements are included or excluded from a particular set. Such work does not recognise complexities of human interaction, in which belonging is more about identity and positioning than it is about inherent characteristics that authorise one's belonging in a set or group. Perceptions of belonging and identities are complex and cannot be divided into percentages, fractions, or be fully described by a Venn diagram. All such representations are simplifications, with need for caution in abstracting through simplification.

As expressed in Ryan's poem, she felt lost and without value in mathematics. It is common for individuals in mathematics class to feel alienated. Andersson, Valero & Meaney (2015) explored individual students' engagement in learning mathematics in different contexts. For example, in response to a request to be interviewed about her experiences with mathematics Petra, a majority Swedish 17-year old girl who had trained horses all her life, said, "I would not be of any use". Annica asked why and Petra elaborated, "Because I hate mathematics so that would be the only answer you would get from me" (p. 149). Despite describing herself as extroverted and easy-going, loving language, and succeeding in social science subjects, she did not recognise her own value in mathematics, nor her value to mathematics educators. She defined herself as excluded from mathematics.

Abstraction in society

In this section, we illustrate community problems with abstraction, beyond individuals: how mathematics is viewed, the social impacts it might have and possible impacts on all lives on our

planet. Advocates of education for sustainable development tend to promote pedagogies that highlight the interconnectedness of the local to the global and among the disciplines (e.g., MGIEP/UNESCO, 2017). The separation of disciplines, especially with a focus on abstraction, can alienate students from their local communities and fail to address the real challenges of our time.

We consider cattle farming. In traditional cultures farmers know their cows and often name them. They know each cow's character and interact with the cattle regularly. Mathematics, and the technologies that mathematics enables, make large-scale farming possible, with computer-driven milking machines, feed, and medicine delivery. With this abstraction, the farmer cannot know the cattle as well. Mathematics also enables the trade of cattle and other livestock in the stock market. With this further abstraction, people trade cattle without experiencing them. While the public may love regular access to beef and milk coming from the mathematics-infused cattle industry, there are dangers. Monoculture, a result of the detachment of cattle from the people who work with them, is a threat to sustainability. It invites epidemics—for example, bovine spongiform encephalopathy ravaged cattle populations in North America and Europe in the 1980s and 1990s.

Indigenous cultures have a sense of relationship with land and with nature different from that of the 'global citizen' or 'modern society'. This goes back to seeing relationship among all beings—seeing the world as 'all the relations'. This is about a mindset for respect and understanding of the limited resources embedded in the Indigenous and minoritised cultures and languages. The threat that cultures and languages face also affects land and ecosystems because *meilä oon tietoa ja ymmärrys jostaki mitä muilla ei ole*⁶.

One type of threat to Indigenous and other minoritised people is the disappearance of signs and clues of attachment or belonging. Cultural signs like place names disappear and are replaced by the names in the majority language. Together with these signs and clues, history disappears, and, in that sense, groups of people disappear, along with the places and names that ground them. The peoples themselves and the outsiders/authorities may describe belonging differently. The narratives told by the majority are often adopted/accepted by the minoritised groups that may end up positioning them-selves to *not* really belong to their land. For example, for the Kven and Forest Finn peoples the statement of belonging has been dominated by statements about belonging somewhere else—to the other side of the border and thus to one of the *other* Nordic countries. This affects students, but also adults who are (re)discovering their ethnic identities and heritage. We see discourses, beliefs, and values that may hinder development and sustainability. Thus, we appreciate land-based and place-based mathematics education to build from the strengths of local communities.

Harari (2014) explained that there is a key difference between *Homo sapiens* and the other human races (*Homo neanderthalensis*, *Homo erectus*, etc.). *Homo sapiens* can imagine and 'create' non-real things, like religions, nations, laws, human rights, and money, that can bond large groups of people together in a common cause/community. These things only exist because people accept them and believe in them. We see these in contrast to real things like a child, a tree, or a river. The non-real things only exist in the stories that we tell and retell each other. For example, the rules of ownership to land are abstract. Børil's poem questions these rules:

⁶ "We have a knowledge and understanding that others lack". Quoted from *Nyttårstale til det Kvenske Folket ved Inngangen til 2020* [New Year's address to the Kven people at the start of 2020], by on the website of the Norske Kveners Forbund [The Norwegian Kven Association]. <https://kvener.no/2020/01/uuenvuuen-saarna-kveenin-kansale-nyttarstale-til-det-kvenske-folket-ved-inngangen-til-2020/>

Indigenous cultures also have rules of ownership, based on common acceptance, often not documented in any written record. These are different from the ‘modern’ sense in national law, involving money, legal documents, *etc.* The traditional connection may be seen as more abstract (common acceptance of ownership), than the colonised connection with physical documents, but those papers are also abstractions and the language used in such paper is abstract. We can challenge the heart of colonialism by questioning claims on the land that disrespect the existing attachment and rules of those living there, and that assume new rules are better than the old, traditional rules.

The vicious cycle is opening old wounds, (re)thinking the colonialist way, over-simplifying the minoritised groups, their worldview, their origin, their right to belong. Critical historicity is crucial in understanding today’s lived lives. Rethinking worth and value in nature—culture relations may call into question colonised value systems such as acquisition of land as property. Bang *et al.* (2016) described this type of axiological innovation as one way to challenge the settler lifeways, that established a norm that led to “(a) erasure of Indigenous presence, (b) staged inheritance of land and indigeneity by White, (c) erasure of African descendants’ humanity through the structuration of chattel slavery” (p. 34). The dominating value system and views of land as property may explain fates we find in the spectrum from highly visible racism to the striking invisibility of some Indigenous cultures, all symptoms of structural discrimination towards non-dominant and marginalised cultures and peoples. We call for innovative mathematics teaching that creates a space for building identities, roots, and understanding of each culture’s way of being, and thus for our students to reattach to nature, land, and places.

Some possibilities for attachment within abstraction

In this section we make some suggestions about how to deal with abstraction in a positive way, towards strengthening students’ identities. Too often Indigenous peoples are positioned as passive actors in the game of land and in the safeguarding of our Earth. A quite recent judgment by the Supreme Court in Norway ruled that a major wind power development at Fosen is in conflict with the Sámi reindeer herders’ right to exercise their traditional livelihood, but construction of the wind farms was completed before the court ruled⁷. In this case and so many others, Indigenous peoples wait to be respected and for Indigenous values to be recognised as worthy by colonisers. To counter such experiences we explore how mathematics education can be reclaimed by Indigenous people as a set of practices that does not alienate. Yes, there can be abstraction, but the abstraction has to be done thoughtfully so that people do not lose themselves in the pursuit of mathematics.

Kimmerer, identifying as native American, a science professor, and a mother, recognised what occurs with students when they do field work. Her students initially become detached from the land, plants, and animals:

When we put scientific instruments in their hands they trust their senses less. And when they put more energy into memorizing Latin names, they spend less time looking at the beings themselves. The students come already knowing a lot about ecosystems and can identify an impressive list of plants. But when I ask them how these plants take care of them, they cannot say. (2013, p. 224)

To change this detachment, Kimmerer starts her field classes by listing human needs, to discover which of the needs the different plants at the site may meet. The students and their

⁷ Licences for wind power development on Fosen ruled invalid as the construction violates Sami reindeer herders’ right to enjoy their own culture. <https://www.domstol.no/en/supremecourt/rulings/2021/supreme-court-civil-cases/hr-2021-1975-s/>

teacher build their shelter, together they choose a site and “mark the geometry on the ground” (p. 224), they mark the boundary with maple poles so “all fifteen of us can find a comfortable seat around the perimeter” (p. 225). Kimmerer moves students’ learning experiences from detachment towards attachment, to reconnect with a reciprocal relationship with the land, the plants, and the animals together with students who attend this field class because of their common interest in biology and botany, not because of certain backgrounds or identities. She invites her students to a wider ecological consciousness. Is it possible to learn from this ecology for our mathematics classrooms?

One example is the place-based mathematics education of Rubel, Lim, Hall-Wieckert & Sullivan (2016) in an urban environment, where students in a disadvantaged community developed their mathematical learning and identities. They mapped the location of money spent on government-sponsored lotteries and the location of distributed profits from these lotteries. Their work identified which neighbourhoods gained money from the lottery system and which neighbourhoods lost money. Another example, this from Kven communities, is the framework of Huru *et al.* (2018) helping teachers use the national curriculum together with Elders as support.

All value systems have a sense of what is real in accordance with their traditions: in mathematics, in law, in botany. Moves across different conceptions of reality can promote understanding of different perspectives, similar to cross-cultural conversations. Thus we see value in mathematical abstractions as long as there is conversation about what is lost in detachment and what is gained. Moves to particularise are similar—applying conclusions that were drawn from abstractions to particular situations. There can be danger in unthoughtful particularisation, too, because the application of an abstraction to a particular situation favours the rules of one conception of reality over another. Particularisation and abstraction are both moves from one kind of reality to another. The lasting change that Skemp (1986) associated with abstraction is connected to the inability to undo understanding or to undo seeing things from the ‘other’ side. The stories that we believe and common myths, like religious or juridical myths (Harari, 2014), when abstracted have “similarities of an already formed class” (Skemp, 1986, p. 21). This has the potential to erase any imagined hierarchies constructed in the stories that we tell each other.

The purpose of mathematical conversations should not be to win an argument or to promote one’s myths. In mathematics and in the mathematics classroom the tradition is to explore possibilities, preferably together, discuss until we agree, find a solution, a truth or at least a step towards that. Social activities are real because they have real people interacting with each other in a particular context and community. These respectful, real interactions can be experienced as attachment, minoritised students can gain strength and their identities be enriched. By flipping the reality of myths to rights and community responsibility, students can find themselves in mathematics and become stronger citizens of the world while remaining rooted in the cultures and traditions of their people and places to whom they wish to remain attached.

This can be done by recognising that some ‘modern’ myths are abstractions, and by questioning who sets the rules, for example in the game of mathematics or the game of land. Land-based education can underpin pride for young minoritised students like Kvens and Forest Finns, and aid students in seeing their history and tradition as strengths, giving them deeper understanding of rights and responsibilities for action. Børli’s poem opposes the city men with stakes in the stock market who believe they own the land—the rough soil (*steinrøys-jorda*) “which my fathers cleared / in the light of the moon’s lantern”. The men are strangers who stop by with their cars running before they head back to the city. But there are things you cannot buy and

own, like the sunset, the wind and “the joy of going home / when the heather blooms along the path”. This deep attachment to the land and nature of Indigenous peoples is a different kind of ownership—“like the child owns their mother”.

We hope our reflection sheds light on how accounts of his-tory have left us with some narratives that need correction. Conversation with students’ stories about belonging may open or strengthen counter-narratives and a closer connection with ‘all the relations’. We may open the possibility that our other-than-human relatives can inform us about mathematics and that mathematics lessons may provide healing, justice and wholeness. These conversations would include examining and discussing narratives we hear and think we know about the different peoples of the world. Belonging or not belonging to *mathematics* also needs counter-narratives to open up alternatives for students in how they see themselves in connection with mathematics and to work against alienation.

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