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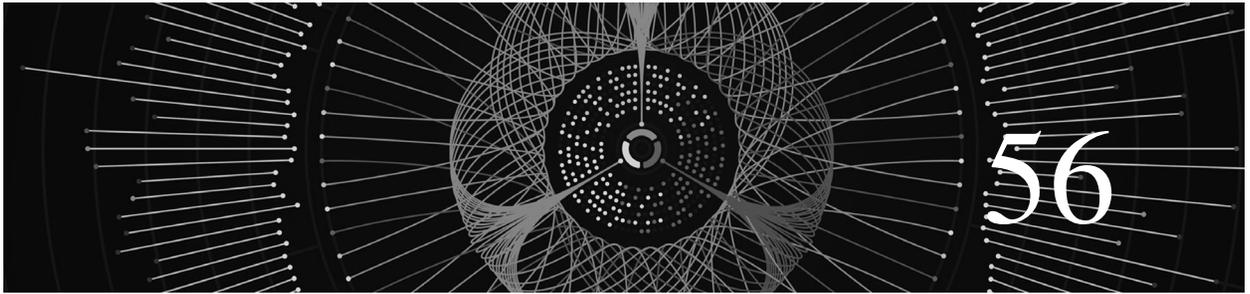
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Indigenous Knowledges and Science Education: Complexities, Considerations and Praxis

Renee Desmarchelier

INDIGENOUS KNOWLEDGES AND SCIENCE

The push to teach Indigenous knowledges and ways of knowing through school curricula is not new. Many colonizer countries have government-based initiatives to purportedly better cater for Indigenous students through including Indigenous knowledges and perspectives in curriculum and pedagogy or to promote more understanding relationships between non-Indigenous and Indigenous populations. In particular, New Zealand, some jurisdictions in the United States, Australia and Canada have official initiatives that include Indigenous knowledges in the science curriculum (Aikenhead and Michell, 2011). These initiatives may receive large rhetorical support but little action and implementation in classrooms, particularly in ‘Whitestream’ (Grande, 2000) classrooms catering largely for non-Indigenous student populations.

As stated in the United Nations Declaration of the Rights of Indigenous Peoples (United

Nations General Assembly, 2007), Indigenous peoples have the right to have the dignity and diversity of their cultures appropriately reflected in education (Article 15/1). The representations of Indigenous knowledges/cultures/peoples in education in colonized countries often requires a largely non-Indigenous teacher workforce (such as myself) to effectively and respectfully engage with knowledge systems they may be unfamiliar with. Opportunities for students to come to understand the historical and social contexts that have marginalized Indigenous ways of knowing can potentially be deployed in Whitestream classrooms that are inclusive of Indigenous ways of knowing. The potential of this curricula inclusion to make tangible contributions to Indigenous sovereignty movements cannot be overlooked (Aikenhead and Michell, 2011).

The profound benefits and complex challenges of including Indigenous knowledges in education have consistently been recognized across multiple educational sectors and

national contexts for the last two decades. In the opening pages of Semali and Kincheloe's (1999) edited volume *What is Indigenous Knowledge?*, the authors acknowledge the contested and complex nature of social, cultural and political contexts surrounding Indigenous knowledges in the academy. Indigenous knowledges have been represented as 'primitive, wild, the natural' (1999: 3) and viewed with condescension by Western observers. Despite recognition that the study of Indigenous knowledges can place academics 'on dangerous terrain' (1999: 3), Semali and Kincheloe encouraged embracing this uncertainty, saying 'we perceive the benefits of the study of Indigenous knowledge sufficiently powerful to merit the risk' (1999: 3). The richness of Indigenous knowledges is seen in providing multi-dimensional intellectual evocation that challenges and encourages interaction between Indigenous and Western epistemologies for the purpose of finding new ways to produce knowledge.

The richness of Indigenous knowledge systems lies in their ability to address everyday challenges of human survival (Sefa Dei, 2011) and interrelate knowledge, cultural beliefs and history to enhance lives (Semali and Kincheloe, 1999), while making no claims to universality that attempt to validate other ways of knowing (Kincheloe and Steinberg, 2008). Indigenous knowledge systems have been accumulating observations over extremely long periods of time (Dentzau, 2018). Such knowledge systems are dynamic and undergoing constant renegotiation as people and communities exist in complex relations with land, culture and society (Sefa Dei, 2008). The ever-changing trends of modernity and post-modernity have influenced Indigenous knowledge systems to evolve in line with contemporary challenges (Sefa Dei, 2011). Sefa Dei (2011) describes that Indigenous knowledges are found within the contexts of Indigenous communities in story, myth and folklore, as well as in forms of material culture like symbolic ornaments, body wear and cultural artefacts. In addition,

Sefa Dei includes pharmacology, food sustainability and environmental management, as well as cultural norms, systems of social organization and cultural ceremony/festivals as examples of Indigenous knowledge.

The term Indigenous Knowledge is not without contention. An artificial division between Indigenous Knowledge and Western Science is often proposed (see Agrawal, 1995), and there is recognition that both are constructed categories that emerge from particular, often colonial, historical constructs (Ramnath, 2014). As Smith et al. (2016) point out in relation to mātauranga Māori (Indigenous knowledge in Aotearoa New Zealand),

there is an easy tendency to oversimplify the way IK mātauranga is defined in opposition to western knowledge and science and then to make claims about how IK mātauranga is produced. Hierarchies of knowledge and knowing also re-inscribe false binaries between one form of knowledge and another, and therefore between one kind of indigenous subjectivity and another. (2016: 133)

Smith et al. (2016) highlight that the knowledge that sits behind practices such as 'mediating the material and spiritual world, escorting a spirit on a physical and spiritual journey, binding ancient genealogies with contemporary realities, sustaining relationships while healing collective grief, seeking visions and teachings from our ancestors, or cleansing people and spaces' (2016: 32) has historically been the subject of research rather than being applied to knowledge creation in the academy.

Notwithstanding the recognition of false dichotomies, it is often a clash in epistemological and ontological roots (Kincheloe, 2009) that is cited as driving perceived incompatibilities between Indigenous knowledges and science. The central role of Cartesian dualism in science allows for the separation of the knower and the known and the separation of humans from nature, leading to the possibility of observing objective reality (Semali and Kincheloe, 1999). This allows for science's internally endorsed validation system – if

science is objective and logical, how can it be wrong? This could be viewed as a reduction of reality to that which is accessible to Western science, because as Nandy (1992) contends, from an Indigenous perspective it negates the possibility of unobservable spiritual and metaphysical forces. Through dualism, objectivism and colonialism, science has become a system of domination that is privileged in public spheres because of people's media and educational socialization into accepting its authority or power.

For science (and other) teachers to chart a course through such contested ground remains a challenge in most educational contexts. Epistemological conflict in terms of science and Indigenous ways of knowing, being and doing is only one of the challenges facing teachers grappling with classroom implementation. Enacting critical pedagogical praxis based on multiple cultural understandings requires a political consciousness and will to teach in emancipatory ways as well as willingness to engage with ideas about what science 'is'.

A 'Standard Account of Science'

In order to consider different cultural ways of understanding the natural world, it is first necessary to consider what science 'is'. In the modern era science claims a collective perceiving of rationality via the scientific community and the authority, though scientific method, to produce universal knowledge in the form of scientific theories. Implicit in an understanding of science are quantitative data, hypothesis testing and causation (Dentzau, 2018). Western Modern Science (WMS) operates on the basis of a Cartesian materialistic world that is both reductionist and mechanistic (Ogawa, 1995). The acronym WMS has also been taken to represent 'White Male Science' (Pomeroy, 1994, as cited by Aikenhead, 1996), reflecting its Eurocentric, male history.

Cobern and Loving (2001: 58–60) attempted to define a 'standard account of

science'. These authors contend that science is a 'naturalistic, material explanatory system used to account for natural phenomena that ideally must be objectively and empirically testable' (2001: 58). Contained within this statement are the ideas that science describes nature in a way that is empirically testable, that is objective, and that provides a systematic explanation of natural phenomena. Cobern and Loving take these ideas further to define science as 'grounded in metaphysical commitments about the way the world "really is"' (2001: 60, emphasis in original). This statement acknowledges science's presupposition of the possibility of knowledge about nature and the existence of order and conformity in nature, as well as the essential premise of cause and effect. In conjunction with these points, the authors also acknowledge the role of consensus within the scientific community in determining what science 'is' and what qualifies as science.

Scientific theories describe widely accepted laws, methods, applications and foundations that have been formulated and can apply to situations other than those in which they were derived (Rosenberg, 2006). That is, the theories are universally applied, and operate independently of human thought. This universalist view can recognize that there may be some cultural considerations that influence science; however, these do not determine the truth claims of science (Matthews, 1994). For example, culture, gender, race, ethnicity or sexual orientation of the knower is irrelevant, as the knower and the known are separated (Stanley and Brickhouse, 2001). Working in this way, science constructs theories and the behavior of the natural world is seen as the ultimate proof of these. Cobern and Loving's presentation of the 'Standard Account of Science' is one that provides a basis for the operation of the scientific community, science in educational institutions and in the public domain. It represents a view of science that is part of the public consciousness.

Science and Indigenous Peoples

The history of scientific knowledge production about Indigenous peoples has served to rationalize an array of liberal capitalistic practices worldwide (Nakata, 2008). Early anthropological documentation of Indigenous peoples used extensive empirical field data to describe the physical, mental and social characteristics of Indigenous peoples on a comparative basis to people in Western communities (Nakata, 1998, 2002, 2008). These studies are an example of the cultural embeddedness of science and how a particular knowledge achieves legitimacy and authority at the expense of other knowledge systems (Nakata, 2002). There has been a shifting basis of inquiry about Indigenous peoples but 'knowledge production about Indigenous people still works within a wider set of social relations that rationalize, justify and work to operationalize a complicated apparatus of bureaucratic, managerial and disciplinary actions that continue to confine the lives of Indigenous people' (Nakata, 2008: 189, my emphasis).

While Indigenous knowledge systems are increasingly acknowledged in scientific areas of study, especially in regard to sustainable development practices, often these enterprises have everything and nothing to do with Indigenous peoples (Nakata, 2002). Western scientists claiming value in Indigenous knowledges can often tacitly decontextualize and relegate it to a lower order of knowledge (Semali and Kincheloe, 1999) through suggestions of a lack of rigor and imprecision (Dentzau, 2018). By labelling Indigenous knowledge systems as 'ethno-science' such as ethnobotany, ethnopharmacology, ethnomedicine and so on, Indigenous ways of knowing are situated as culturally grounded, while Western science is represented as transcultural or universal (Semali and Kincheloe, 1999). In addition, categorizing Indigenous knowledges in Western scientific terms fragments the holism inherent in Indigenous ways of understanding the natural world.

The documentation and storage of Indigenous knowledges in databases located within academic institutions (for example, gene banks and electronic networks) from an Indigenous standpoint may look similar to former colonial enterprises that took possession of land, resources and labor for economic self-interest (Nakata, 2002).

Intersecting Knowledges

Indigenous knowledges and science do not have to sit in opposition and can be seen as complementary rather than separate realities (Aikenhead and Michell, 2011). In seminal work, Agrawal (1995) argues that to commit to a dichotomy between Indigenous knowledge and science is to reproduce the dilemmas of earlier debates, where anthropologists such as Malinowski were able to relegate Indigenous knowledges to primitive status through showing their distance from Western scientific knowledge. It is important to understand what happens to Indigenous knowledges when they are conceptualized simplistically and opportunistically from the perspective that they are everything that is not science (Nakata, 2008). Aikenhead and Michell (2011) offer a way of understanding the two systems as differing primarily in terms of knowing and experiencing nature: 'this cultural difference may be expressed as follows: the way scientists see the world can clash with the way Indigenous Elders inhabit the world' (2011: 8). With these considerations, Nakata's (2002) notion of the cultural interface becomes a useful way of conceptualizing the interactions between Indigenous and Western systems of knowledge:

This notion of the Cultural Interface as a place of constant tension and negotiation of different interests and systems of knowledge means that both must be reflected on and interrogated. It is not simply about opposing the knowledges and discourse that compete and conflict with traditional ones. It is also about seeing what conditions the convergence of all these and of examining and

interrogating all knowledge and practices associated with issues so that we take a responsible but self-interested [from an Indigenous standpoint] course in relation to our future practice. (Aikenhead and Michell, 2011: 286)

OFFICIAL KNOWLEDGE, CURRICULUM AND IDEOLOGY

In order to effectively engage the synergies and intersectionalities of WMS and Indigenous knowledges in science teaching, an understanding of the ways in which knowledges are structured in curricula is necessary. Principles of social and cultural control are strongly related to which knowledges become important in classroom settings (Apple, 2004). Some knowledges achieve the status of ‘official knowledge’, being defined as worthwhile to be passed onto future generations (Apple, 2000b). Recognizing the power these knowledges then hold within schooling, and therefore society more broadly, is important to the context of considering Indigenous knowledges in curricula.

Problematizing the ideological basis of curriculum construction is a necessary step to reveal the power imbalances between Western and Other knowledges in schools. In this respect, Apple’s (2004) questions about the selective tradition of knowledge in curriculum are important: ‘Whose knowledge is it? Who selected it? Why is it organized and taught in this way? To this particular group?’ (2004: 6). These ‘simple questions’ speak to the complex and at times contradictory relationships ‘among “legitimate” (and at times “sacred”) culture and “popular” (and at times “profane”) culture’ (Apple, 2018: 63). The mere act of asking these questions is not sufficient, however. One is guided, as well, by attempting to link these investigations to competing conceptions of social and economic power and ideologies.

Apple denies the supposed neutrality of curriculum generated through institutional

epistemologies. He contends that there is ‘evidence that the institution of schooling itself is not a neutral enterprise in terms of its economic outcomes’ (Apple, 2004: 7). Apple recognizes that there it is more than economic capital at stake; schools also distribute and preserve cultural capital. In this way, dominant groups do not have to resort to overt methods of domination as schools can create and recreate official knowledge that preserves hegemonic culture and elicits its social control. All curricular reforms are rooted in particular histories and are driven not only by ‘technical considerations, but also profoundly by cultural, political and economic projects and by specific and often unquestioned ideological and valuative visions of what schools should do and whom they should serve’ (Apple, 2018: 63).

However, importantly Apple (2000b) reminds us that ‘the powerful are not that powerful. The politics of official knowledge are the politics of accords or compromises’ (200b: 10). These compromises occur at different levels, through political and ideological discourse: at the level of state politics, at the level of what is taught in schools, at the level of the daily activities of teachers and students in classrooms, and at the level of how we are to understand all of this. As such, they are not impositions but represent how dominant groups try to create situations where the compromises favor them.

Indigenous Knowledges in Science Education

The culturing of knowledges within science education has been recognized in literature since at least the mid 1990s (Agrawal, 1995; Aikenhead, 1996; Bechtel, 2016; Chigeza, 2007; Lewis and Aikenhead, 2001; Roth, 2009). Drawing on Phelan et al.’s (1991) definition of culture, Aikenhead (1996) categorizes canonical scientific knowledge as cultural ‘beliefs’ and recognizes science as ‘itself a subculture of Western or Euro-American

culture' (1996: 9). Science has its own set of values, terminology and way of discussing, publishing and engaging in research (Bechtel, 2016). When science is recognized as a sub-culture, learning science can be viewed as cultural acquisition. Aikenhead argues that, as a sub-culture, science exhibits a well-defined system of symbols and meanings that have their origins in a Western male history. The project of acquisition of the sub-culture of science may necessitate a cultural 'border-crossing' (Aikenhead and Jegede, 1999). For people from non-Western cultures, making the crossing into Western science requires assimilation that can marginalize or replace their own worldview. Similarly, those of a Western background are also required to cross cultural borders between their life-world and the world of science (Aikenhead, 1996, 1998).

Treating science as a cultural enterprise represents a radical shift in thinking for some science educators (Aikenhead, 1996). The argument for the cultural nature of science is succinct: 'Science does have norms, values, beliefs, expectations, and conventional actions that are generally shared in various ways by communities of scientists' (1996: 9). School science is a sub-culture which expects students to acquire these norms and values and make them part of their world to varying degrees. Often, school science provides stereotypical images of science that are suggestive of an ability to generate absolute truth through socially sterile, non-humanistic methods. This form of scientism acts like a hidden curriculum, emphasizing the need for students to think like scientists (Aikenhead, 2001). The goal of science education's cultural transmission runs into ethical problems when Western culture in the form of science is forced upon students who do not share its system of meanings, resulting not in enculturation but assimilation and a form of cultural imperialism (Aikenhead, 1996). This does not deny that border crossings are also necessary for many Western students who identify with sub-cultures that are non-masculine, humanities orientated and non-Cartesian.

Given the emphasis that science has in curricula and in the jobs market, Aikenhead's (2001) position is particularly salient because when students reject the assimilation into the Western culture of science, they become alienated from science, which is a major global influence on their lives. When students do not attain the cultural capital associated with scientific understanding, they are limited in their ability to participate effectively in Western society (Aikenhead, 2001). Often in the case of Indigenous students (or other marginalized groups) this perpetuates a 'discourse of deficit' around educational, social and economic achievement.

UNDERSTANDING THE COMPLEXITIES OF CLASSROOM IMPLEMENTATION

Teachers often have concerns about their abilities to successfully deliver classroom teaching inclusive of Indigenous knowledges and perspectives. There are some well-documented teacher apprehensions that are common across different national contexts. For example, some teachers (usually non-Indigenous teachers) feel they do not have the relevant knowledge and expertise about Indigenous knowledges and cultures to incorporate these into their teaching in a non-tokenistic way (Baynes, 2016; Baynes and Austin, 2012; Kanu, 2011; Quince, 2012). Students coming into Initial Teacher Education programs tend to have low levels of content knowledge about Indigenous issues or histories which may not be added to significantly or effectively through their studies (Moodie, 2019). Where teachers do not see science as a cultural enterprise, it is difficult not only to see the curricular connections between Indigenous knowledges and science but also to mitigate the cultural border crossing necessary to not relegate Indigenous knowledges to lower status than science (Bechtel, 2016). Schooling system level decisions and attitudes can also influence

teachers' confidence in implementation. Where teachers feel alienated from discussions around integration and lack resources or struggle with a lack of school support and perceive racist attitudes in students, colleagues and administration, implementation is stifled (Desmarchelier, 2016; Kanu, 2011).

At the level of the teacher, a range of factors influence the ways in which a teacher might choose (or not) to engage with Indigenous knowledges in their teaching praxis. As already outlined, epistemological clashes can exist between scientific and Indigenous worldviews. The impact of such clashes on teaching is often cited as a major contributing factor to how/if teachers reach classroom implementation (Baynes, 2016; for an in-depth discussion of scientific epistemological positioning see Cobern and Loving, 2008). However, advancing to classroom implementation, or choosing not to implement, depends on more than just a teacher's scientific epistemology.

Considering the interconnectedness of epistemology, pedagogy and politics offers a way of understanding how and why teachers might come to particular strategies for praxis (Desmarchelier, 2016). A more multifaceted understanding of epistemology drawn from diverse theoretical fields – like scientific considerations, personal epistemology and critical epistemology – contributes to a more nuanced understanding of teacher positioning. Linking these with pedagogical approaches, and understanding the need for teachers to have the will to act politically, can result in a deeper appreciation of what it takes for a teacher in a school to deploy a critical educative approach to Indigenous knowledges in science education (Desmarchelier, 2016).

Considering how teachers' personal epistemologies influence their approaches to curriculum and pedagogy in the classroom is central to understanding how teachers may engage with curriculum initiatives that contain unfamiliar knowledge and epistemologies. Schraw and Olafson (2003) offer a general definition of epistemology from

a personal epistemology perspective: 'the study of knowledge and knowledge acquisition' (2003: 180). There is a growing body of psychology and educational psychology literature that quantitatively and qualitatively analyzes and describes teachers' personal epistemological stances and relates these to how they teach in the classroom (Brownlee, 2001; Schraw et al., 2011). Where teachers are positioned epistemologically relates not only to their perspectives on what knowledge 'is', but impacts their willingness to include diverse ways of knowing in the classroom.

From a critical epistemological perspective, knowledge is never neutral or objective but ordered and structured in particular ways. What constitutes 'official knowledge' is connected to the powerful position of dominant cultures in a society (Apple, 2000b; McLaren, 2007). A critical epistemology is intimately related to the ability to deploy critical pedagogical approaches. In order to enact a critical epistemology of practice, Kincheloe (2010) recognizes that there must first be a rich, nuanced, historically grounded understanding of the self. This type of self-reflection allows for an examination of how practice is shaped by our own, and others', socio-cultural conditions. This position embraces the complexity of the nature of being in the world, rather than seeking to reduce this complexity to its constituent parts. The impact of this type of self-analysis for teachers is social and pedagogical transformation through thinking in new ways.

A critical perspective holds that all decisions about what knowledges are taught and how such knowledges are taught represent political choices (McLaren, 2007). Being political in this context does not mean engaging in party politics or participating in the electoral process, but instead relates to recognizing the power in our actions, thinking and social conventions (Carr, 2008). As Freire (1985) reminded us, 'washing one's hands of the conflict between the powerless and the powerful means to side with the powerful, not to be neutral' (1985: 122). Being able

to critically analyze the power dynamics at play in knowledge production is a necessary first step to being able to deploy a critical epistemology (and therefore pedagogy) in teaching inclusive of Indigenous knowledges (McGinty and Bang, 2016; Moodie, 2019)

Pedagogical change inspired by curriculum change contains inherent risks for teachers. In the case of the inclusion of Indigenous knowledges, some of this risk is associated with taking a political position about the construction of knowledge, particularly scientific knowledge, which might be questioned by colleagues, students and their families, particularly if these parties do not see their own positions as political (Desmarchelier, 2016). Risk is a socially constructed phenomenon that different teachers will consider differently in terms of what is seen as a risk and to what degree (Le Fevre, 2014). In the case of pedagogical change that is linked to a specific political and epistemological context, and designed to have socially just outcomes, the perceived risks in increasingly conservative and neoliberal schooling systems may be high.

Engaging with Indigenous knowledges may lead to discussions of Indigeneity and racism, and acknowledging the existence of racism in the classroom may disrupt a teacher's sense of self (Carson, 2005). This is of particular salience when Indigenous content and perspectives are mandated through curriculum. Where teachers are reluctant to engage politically with an issue, finding an epistemologically and politically safe space may influence their pedagogical choices. In this case, a pluralist approach where Western science acts as 'gate-keeper' and other knowledges are used as examples (Chigeza, 2007) is a likely result. This gives a teacher safe ground through not compromising the perceived integrity of a dominant knowledge system, in this case science, or necessarily needing to confront issues such as racism and privileging of certain ways of knowing. This approach has the potential to lead to tokenism if it results in a 'bolting-on' of Indigenous

knowledges to already established pedagogical approaches.

In order for teachers to be successful in implementing classroom praxis inclusive of Indigenous knowledges in science education, all three areas of epistemology, pedagogy and politics need to be engaged appropriately and their interactions considered (Desmarchelier, 2016). Critical epistemologies, influenced by scientific and personal epistemologies that are open to multiple ways of knowing the natural world, need to be embraced in order for critical pedagogies to occur in the classroom. Critical pedagogies rely on a personal political stance that motivates teachers to work in a critical way, a school political environment that allows teachers to enact critical pedagogies, and the national-level political environment to produce policies that give legitimacy to this praxis.

NEOLIBERALISM, CURRICULUM AND BACKLASH

Giroux (2004) described neoliberalism as 'one of the most pervasive and dangerous ideologies of the twenty-first century' (2004: 495). At its core, neoliberalism holds the market as the central organizing principle, and that individuals within a society should be able to manage their own lives in a way that can lead to personal profits based on fair and equal competition (Kanu, 2011). In a similar way to the internal validation system of science (if science is objectively constructed, how can it be wrong?), neoliberalism is validated through its own assumptions and perspectives in relation to market forces and the value of goods and services (Morgan and Cole-Hawthorne, 2016). This leads to the focus of the individual to be generating wealth and consuming and the role of schooling being narrowly defined as to 'get a job' (Down, 2009).

Neoliberal tenets informing science education has profound implications. The focus of

equity in science education becomes the freedom to participate in an educative process focused on developing good neoliberal subjects (Tobin, 2011). Where the focus of schooling is to 'get a job', and systematic racism exists within that job market, such a science education reinforces current inequalities and privileges particular types of students to succeed in economically defined ways. Science education and curriculum could instead be harnessed to promote a more widely defined freedom and democracy through connecting and privileging Indigenous ways of knowing in understandings of environment, protection of species (including humans) and protection of collective rights (to name a few).

The narrowing of science curricula through a neoliberal framing can make focus more about human capital production and competitive national and global economies (Carter, 2017). From the 1990s there has been a shift in focus within science from the public good to the market good (Krishna, 2014). Krishna argues that 'Public good versus market good are based on two different opposing logics: that of open disclosure of research and thus enabling free circulation of knowledge; and that of suppressing information from reaching the public for making a profit' (2004: 141). This focus on the production of wealth works to further marginalize those already oppressed politically, socially and economically to maintain the status quo in terms of wealth and knowledge distribution.

Neoliberalism frames how curriculum initiatives to include Indigenous knowledges and perspectives are situated in a schooling system. The neoliberal state holds a particular view of schooling in which market-driven values are produced and legitimated (Giroux, 2004). Through the implementation of accountability measures, schooling is exposed to market forces in terms of more parental choice and competition between schools as accepted ways of driving up standards (Lingard, 2011). Down (2009) argues that this type of restructure shows instrumentalist values and results in a narrowly

conceived version of education. Some curriculums operate from the explicit position that students need to have desirable skills and dispositions as global citizens and workers in an interconnected global community, placing curricula within a neoliberal frame (Camicia and Franklin, 2015; Lingard and McGregor, 2014).

In order to be able to change lived realities in humanizing ways, Freire (2009) outlined the imperative to 'name the world' (2009: 88). It is through naming the forces of power that reside in a society that it becomes possible to reflect upon them and act otherwise. Naming is a precursor to dialogue. Without naming the world, there is no way to engage in the act of creating a new way of being, that is, enacting praxis. Denouncing reality through naming it also announces the possibility of a better world (Freire, 2004). As such, it is important to recognize and name the overarching influence of neoliberalism as one that can act to confine and constrain teachers' abilities to implement different ways of knowing in the classroom.

Davies (2005) contends that there are several definable elements of individuals 'appropriately subjected within neoliberal discourses' (2005: 8) (in italics in the following discussion). The first is *consumption*, seen as the definition of the self in terms of income and the capacity to purchase goods, which constitutes subjects' identities in term of their jobs. Secondly, the notion of *individual responsibility* leading to the possibility of each person within a society being responsible for their own wealth generation. Coupled with this is a removal of individuals' dependence on, and links with, the social. This results in individuals being *set adrift from values*, and with the focus on individual responsibility, less commitment is generated for outcomes linked to the social good. The development of a humanist self is less important than individual skills for survival linked to generating income. Within this neoliberal constitution of self, *surveillance* becomes key due to a lack of trust between

individuals generated by ‘the heightened emphasis on the individual’s responsibility and the de-emphasizing of inner-values and commitment to the social good’ (2005: 10). However, an *illusion of autonomy* is created. While the emphasis is on individual responsibility, more surveillance is introduced in forms such as accrediting bodies. Davies summarizes her view of neoliberalism as:

- a move from social conscience and responsibility towards an individualism in which the individual is cut loose from the social;
- from morality to moralistic audit-driven surveillance;
- from critique to mindless criticism in terms of rules and regulations combined with individual vulnerability to those new rules and regulations, which in turn press towards conformity to the group. (2005: 12)

Drawing on Davies’ (2005) characterization of the neoliberal subject, Table 56.1 outlines specific examples of the influence of neoliberalism on teachers’ engagement with Indigenous knowledges and perspectives in education.

(This analysis is drawn from Desmarchelier, 2016.)

In colonizer countries where Indigenous populations represent relatively small percentages of national populations, emphasis in classrooms on the neoliberal purpose of education to ‘get a job’ can result in overshadowing of initiatives to include Indigenous knowledges. Where teachers perceive their role as primarily to assist students to individually achieve economic wealth (consumption), through participation in the workforce, initiatives that are linked to the ‘collective good’, such as reconciliation between non-Indigenous and Indigenous populations, may not be prioritized. Where the inclusion of Indigenous knowledges is linked to advancing one particular group of students – Indigenous students – who are a small minority or perhaps even absent from Whitestream classrooms, it may be even less likely that school administrations and teachers see such initiatives as important.

Combining the push to make students job-ready with increased accountability and surveillance measures, teachers may experience

Table 56.1 The impact of the construction of the neoliberal subject on classroom implementation of curricula inclusive of Indigenous knowledges

<i>Davies (2005) category</i>	<i>Explanation</i>	<i>Factors impacting classroom implementation</i>
Consumption	Defining self in terms of capacity to purchase (wealth)	<ul style="list-style-type: none"> • Focus on Indigenous economic outcomes • Education framed as ‘to get a job’
Individual responsibility	Responsibility primarily for self and own wealth generation	<ul style="list-style-type: none"> • Pathologisation of Indigenous students’ lack of educational achievement – it is an individual’s responsibility to successfully engage in education • Reluctance to implement curriculum inclusion when perceived as for one particular group • Suspicion of the intent of such curricula inclusions
Set adrift from values	Focus on individual responsibility over collective good	<ul style="list-style-type: none"> • Difficult for some teachers to be seen as acting politically • Focus on teachers’ responsibility to educate to ‘get a job’ rather than for the greater good • Prioritizing of other initiatives over the inclusion of Indigenous knowledges
Surveillance	Lack of trust in individuals, leading to increased accountability measures	<ul style="list-style-type: none"> • Lack of time for teachers to work towards implementation due to need to produce accountability evidence • Acts to shift teachers’ concerns from social good to their own individual responsibility of reporting
Illusion of autonomy	Autonomy in classrooms overshadowed by accountability measures	<ul style="list-style-type: none"> • Threat of deskilling through enforced unit/lesson plans • Invisibility of influence of accountability on teachers’ own professional choices

internal pressure to meet their individual responsibility to ensure students do well on standardized tests, meet standardized curriculum and receive mandated reports. This can place significant time pressures on teachers. Once teachers feel pressed for time, the illusion of autonomy can be created through teachers seemingly choosing to privilege attention to accountability measures to meet their individual responsibility. The time spent on accountability due to the surveillance measures teachers are subjected to then means there is less opportunity to engage in the often significant amount of professional learning required to feel confident in teaching Indigenous knowledges in science classrooms. While, on the face of these measures, some teachers persist with such inclusions to successfully deliver critical pedagogical approaches to Indigenous knowledges in science education, the neoliberal education system acts to confine and constrain their determination.

PRESERVING THE KNOWLEDGE STATUS QUO

Through returning to Apple's (2000b) point that official knowledge is the politics of accords and compromises, the rhetorical inclusion but practical marginalization of Indigenous knowledges can be theorized. Curricula inclusion of Indigenous knowledges and perspectives show where dominant groups have seemingly taken the concerns of the less powerful into consideration. Without specified institutional funding and support, which are often not given, these inclusions may be nothing more than rhetoric. The pressures of a neoliberal schooling system often outweigh teachers' intentions to commit to the collective good through critical pedagogical approaches to Indigenous knowledges in science education.

The conflict between rhetoric and practical implementation and the impact of sustaining the curricula knowledge status quo can also be

theorized through the work of Freire (2009) and Darder (2011). Apple (2000a, 2000b, 2004) points to the importance of recognizing the context surrounding educational practice and policy and the impact on which knowledges are being legitimized. Also important is Freire's (2009) concept of 'false generosity' where those in power profess sympathy for oppressed peoples but fail to address the structural forms of inequality present in the system. Extending on Freire's concept of false generosity, Darder (2011) recognizes the political backlash that happens when mainstream ideologies are threatened. Each of these theoretical frames has relevance when considering the positioning of Indigenous content and perspectives in curricula.

When considering the politics of 'official knowledge', powerful groups maneuver educational policies to promote their knowledge as legitimate knowledge. The construction of the 'right type' of neoliberal subject as described by Davies (2005) relates to the type of knowledge that is considered legitimate and worthy in many Western curricula. The knowledge selected for inclusion in curricula may be framed by concerns of globalization while showing recognition of a diversity of cultures.

The vision of what science education can be with the inclusion of Indigenous ways of knowing is in the educational imagination (and sometimes in the actuality) of teachers and schools (Baynes, 2016). However, as Apple (2000a) attests, 'while the construction of new theories and utopian visions is important, it is equally crucial to base these theories and visions in an unromantic appraisal of the material and discursive terrain that now exists' (2000a: 229). It is important to recognize the 'openings for counter-hegemonic activity' (Apple, 2000b: 10) that have been created through the 'compromise' of the inclusion of Indigenous knowledges in curricula. The possibility of change only exists with the tactical analysis of knowledge and power relationships and what is necessary to actually bring about pedagogical change in the classroom. If we fail to contest power

and the neoliberal stance, listening to diverse standpoints can only be seductive and end up actually affirming the dominance of particular forms of knowledge (Sefa Dei, 2011).

False generosity can be seen in the gap between rhetoric and classroom implementation. Where teachers are lamenting their lack of knowledge about Indigenous knowledges/peoples/cultures, systematic and institutional support is necessary in order to progress to implementation. Often, there is a dearth of information available to educators to assist with practical unit and lesson planning activities (Moodie, 2019). Teacher capacity in terms of knowledge, attitude and pedagogical considerations can be the largest determining factor in successful classroom implementation (Kanu, 2011). Without structural support from education authorities and sustained commitment to providing guidance to these aspects of curriculum, teachers may struggle to understand what was required of them.

Attacks on the perceived legitimacy of Indigenous knowledges in science education may be read as a politics of backlash. Faludi (1991) identified backlash in terms of reactions against feminism and described how insidious politics framed the issues of women's rights in its own language. Darder (2011) identifies that 'the response to losing power as a consequence of shifting entitlement and privilege within schools can elicit a feeling of threat or displacement' (2011: 152). Moves to be more inclusive of Indigenous issues, knowledges and ways of knowing can threaten the legitimacy of a purely Western way of considering the world. Darder also argues that these types of biased and uncritical responses are rooted in radicalized notions of intelligence, extending in this case to the legitimacy of knowledges produced by Indigenous groups. In this way, the renormalizing of the reproductive function of schooling is achieved (Hattam et al., 2009). In addition, policies that aid in 'expanding institutional opportunities to diverse populations' (Darder, 2011: 153) threaten the neoliberal system through potential positive class and economic impacts for marginalized

populations. In these ways, a context can be created that does not value teachers' implementation of Indigenous knowledges as being equally important as other curriculum areas. This can be apparent in the overshadowing of such initiatives by neoliberal educational demands linked to ensuring students are ready for the workforce, particularly in a canonical subject such as science which is seen as a cornerstone of the modern economy.

CHALLENGING TEACHER IDENTITY FOR PRODUCTIVE PROFESSIONAL DEVELOPMENT

Recognition of the pervasiveness of neoliberalism, the politics of official knowledge, false generosity and backlash does not negate the hope and successes of some schools and classrooms in including Indigenous knowledges in science education. The possibility is still present for teachers to be agentic, to resist the neoliberal discourses and to implement different ways of knowing in the science classroom. Examples of successes in Indigenous majority and minority classrooms can be found (for example, Aikenhead and Michell, 2011; Cajete, 2000, 2008a, 2008b; Chigeza, 2007; Gondwe and Longnecker, 2015; Jacobs, 2013; Kim, 2016).

Teachers' re-interpretation of who they are professionally and the roles they are expected to play enables them to cope with educational changes (Le Roux, 2011). In many curriculum change initiatives, teachers are seen as the subjects in educational reform. This reduces teachers to being only the installers of curriculum, rather than the originators of curriculum (Carson, 2005). Allowing extended professional development (for example, through engagement with Action Research and Participatory Action Research) has been highlighted as a way of enabling teachers to regain some agency in terms of their pedagogies related to curriculum initiatives (Burridge et al., 2012; Moodie, 2019).

By attending to the question of identity in this process, Carson (2005) argues that:

we begin to shift discourse away from 'the what' of what is to be implemented, i.e. the change as 'some-thing' (in the form of an idea, policy, theory etc.) to be put into practice. Instead, we come to a notion that change involves a conversation between the self (identity) and new sets of circumstances that are external to the self. For educators, these new circumstances come into play from a variety of directions, only one of which is the official curriculum. (2005: 3)

Applying Carson's (2005) point to the idea of engaging with teachers' epistemology, pedagogy and politics, extended professional development programs may be able to engage teachers to renegotiate their identities (Kanu, 2011). Teachers' subjectivities are formed through their own personal and national histories and these factors impact on how a teacher will engage with the curriculum to affect the desired change (Carson, 2005). Teachers' identity positions are constructed within social norms and school structures. This often results in maintaining and giving authority to Western cultural values and ways of knowing (Kanu, 2011). Unease with epistemological, pedagogical and political issues has the potential to challenge teachers in terms of understanding their own identity and their identity locations within the education system. This challenge may be what is necessary to engage positively within the Cultural Interface, stand up to neoliberal pressures and be able to plan science lessons with Indigenous knowledges and perspectives without lapsing into tokenism. Of course, the challenge in this approach is to find (perhaps subversive) ways to get the neoliberal system to provide the financial and educational resources to support such teacher professional learning.

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