


Decolonizing Science and Science Education in a Postcolonial Space (Trinidad, a Developing Caribbean Nation, Illustrates)

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Abstract

The article addresses how remnant or transformed colonialist structures continue to shape science and science education, and how that impact might be mitigated within a postcolonial environment in favor of the development of the particular community being addressed. Though cognizant of, and resistant to, the ongoing colonial impact globally and nationally (and any attempts at subjugation, imperialism, and marginalization), this article is not about anticolonial science. Indeed, it is realized that the postcolonial state of science and science education is not simply defined, and may exist as a mix of the scientific practices of the colonizer and the colonized. The discussion occurs through a generic postcolonial lens and is organized into two main sections. First, the discussion of the postcolonial lens is eased through a consideration of globalization which is held here as the new colonialism. The article then uses this lens to interrogate conceptions of science and science education, and to suggest that the mainstream, standard account of what science is seems to represent a globalized- or arguably a Western, modern, secular-conception of science. This standard account of science can act as a gatekeeper to the indigenous ways of being, knowing, and doing of postcolonial populations. The article goes on to suggest that as a postcolonial response, decolonizing science and science education might be possible through practices that are primarily contextually respectful and responsive. That is, localization is suggested as one possible antidote to the deleterious effects of globalization. Trinidad, a postcolonial developing Caribbean nation, is used as illustration.

Keywords

indigenous science, science education, postcolonial, Trinidad, decolonizing science, decolonizing science education, standard account of science

Aims

The article re-considers mainstream accounts of what is science, and how this standard account of science seems to represent a colonized (i.e., globalized) conception of science that is Western, modern, and secular. The article uses a post-colonial framework as a “radical and productive technique about how we think about and do” (Gilmartin & Berg, 2007, p. 120) science. Even so, though cognizant of, and resistant to, the ongoing colonial impact globally and nationally (and indeed any attempts at subjugation, imperialism, and marginalization), this article is not about anticolonial science. Instead, postcolonialism is about how remnant or transformed colonialist structures have affected science and science education generally, and specifically too within the specially referenced postcolonial Caribbean island of Trinidad. As an antidote, the theoretical article suggests a postcolonial science education as one that includes indigenous science that is contextual, community focused, and place-based in its recognition of how local populations come

to know about the world. This science also holds aims of scientific literacy and the teaching of innovation.

Globalization as Educational Colonizer

Colonialism is a political act where one party cedes power (usually under threat) to another. Historically, colonization has resulted in large economic gains for the colonizer, and economic, religious, cultural, historic, geographic, and social rape, reconfiguration, and sometimes annihilation, for the colonized. I acknowledge the many lenses influential to explicating a contemporary version of science education (such as sustainability science e.g., Glasson, Mhango, Phiri, & Lanier, 2010; anti-oppressive positions e.g., Kumashiro,

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2001; ecofeminism e.g., Warren, 2000; critical theory e.g., Tyson, 1999; and permaculture e.g., Holmgren, 2002). However, given my positionality as a science teacher-educator in the postcolonial Caribbean, this article utilizes a postcolonial perspective. Globalization, a contemporary guise of colonization, is suggested neocolonialist (Dei, 2006; Huggan, 1997), and postcolonialism stands as its antidote. Globalization is the framework used by this article as “a new form of colonization but, instead of being armed with weapons or with Bibles, the new *conquistadores* are bristling with the financial and electronic implements of economic domination” (Mortimore, 2010, p. 230).

Arjun Appadurai agrees that he is “with the broad majority in thinking that the core of globalization is a transformation in the way the market/the global economy/industrial capitalism function” (Kenway & Fahey, 2009, pp. 41-42). Simply (and possibly crudely) put, at its core, globalization is considered to be about the movement of money, in liberal and fairly unrestricted ways across state borders. The strategies formatted to facilitate such movements, and the resulting rewriting of the scapes (ethno-, media-, techno-, finan-, and ideo-; Appadurai, 1990) of the planet, might also be considered part of the globalization process. So that globalization, “which started as an economic or trade phenomenon,” has begun to “invade all other walks of life” (Mortimore, 2010, p. 234).

Even though it often happens that “ICTs [information communication technologies] are presented as co-terminus with the mechanisms of globalization” (Clegg, Hudson, & Steel, 2003, p. 41), globalization actually predates digital ICT beginnings (Robins & Webster, 1999, as cited in Clegg et al., 2003). Arguably, globalization started as soon as one group of people left their homeland, initiated the occupation of the lands of other groups, and appropriated their resources to send back to the “motherland.” By this argument, globalization is spotted throughout history. Contemporary globalization though, has occurred in two waves: 1820-1914, and then 1960 onwards (Baldwin & Martin, 1999). Both waves made the trade of goods and ideas less expensive, and both periods promoted large-scale trade and capital flow ratios through “radical reductions in technical and policy barriers to international transactions” (i.e., marketization; Baldwin & Martin, 1999, p. 1). One notable difference between the two waves is the specific branding and rapid propulsion of the second wave by ICTs. This propulsion is jetted as ICTs continue to become less and less expensive, and better and better able to facilitate the speedy and prolific transfer of both ideas (Baldwin & Martin, 1999), and money among a wider global population. Hence, globalization has been suggested to occur through two main processes: marketization and technological advances (Mortimore, 2010).

At the beginning of the first wave of globalization, the entire world was largely agrarian, and relatively homogeneously poor. The first wave followed on the heels of the Industrial Revolution and enabled the North (countries of the northern hemisphere) to use an expanding industrial agenda

to improve its economic fortunes. Free trade agreements saw the flooding of the markets of countries in the southern hemisphere (the South) with imports from the North causing an effective de-industrialization of the South. By the beginning of the second wave of globalization, there was already a large income disparity between the incomes of countries of the North compared with those of the South. This gap has been further deepened during the second wave which industrialized the South by shifting the means of production there to benefit from more cost-effective operations, and which has effectively de-industrialized the North (Baldwin & Martin, 1999). This account exhibits certain characteristics of globalization: capital transfer, increasing free trade, recruitment of staff from anywhere in the world, and a search for cheap labor (Mortimore, 2010).

The education systems of developing countries have been more strongly affected by globalization than large, developed ones. Conditionalities linked to the aid offered by multilateral agencies to developing countries have helped to push a global agenda that talks about knowledge economies, standardized tests, lifelong learning, global curricula, and English (to facilitate business transactions) as the global language of instruction (Al'Abri, 2011). Aims seeming to facilitate a de facto agenda geared toward the enticement of developing countries to prepare large numbers of workers to fuel knowledge economies that push toward capitalist, uncapped, sustainable growth and development. Unfortunately, oftentimes such agendas show little concern toward the personal and contextual, national needs of developing countries.

As Latin America and the Caribbean participate more on international economic playing fields, there is a parallel rush to make these mostly developing nations globalization-friendly. However, it may be incorrect to assume that “if only the traditional education system inherited from colonialism were to be strengthened, it would prepare people effectively for a competitive global economy, thus magically ensuring outcomes such as material sufficiency, harmony and social cohesion” (Hickling-Hudson, 2002, p. 576). For developing countries, many of whom are former colonies,

the economic model that global economic agencies such as Bank [World] and the IMF are enforcing even further saps the economies of countries which, recently emerging from a debilitating colonialism, are not strong enough to be flung into the deep end of neo-conservatism. The tearing down of protection for infant industries, thus destroying most of them, and the truncation of the social responsibilities of government suit the rich who have already built up their industries through protection, not those who are late starters. (Hickling-Hudson, 2002, p. 575)

Globalized development programs then can threaten to erode internal national growth of developing countries and these nations might be advised to ensure that “home is right” before attempting to become globally competitive (Sanchez, 2003).

For instance, even global initiatives such as Education for All (EFA) which focus on developmental goals can be disadvantageous to developing nations. Investigation of the EFA goals reveal a focus on lower levels of education (“Education for All Goals”) and a lack of focus on higher and tertiary level education crucial to the progress of a nation. This can be especially alarming given that the average gross enrollment in higher education for most countries within the Caribbean is less than 10% (it is 11% for Trinidad which already enjoys free universal primary and free universal secondary education): Compare this with the high average rate of 55.6% enjoyed in Europe (Tewarie, n.d.). Arguably, there are many developing countries which do not yet enjoy the universal primary education aimed at by the EFA. Nonetheless, divorcing primary education goals from higher education goals can undermine overall national development, especially given that thinkers are needed for educational and technological development, and to grow and sustain the knowledge driven economies predominant to this century thus far. The focus of globalized agencies on primary education over higher education is also seen in the World Bank’s lendings from 1963–2005 (Psacharopoulos, 2006). However, “making home right” to the exclusion of participation in international economic networks can put a developing nation at real threat of exclusion from global technological advancement (Castells, 1999, as cited in Robertson et al., 2007). There seems to be a need then to create initiatives in which the participation of developing countries in global or international programs enhance, rather than threaten, their own national growth and development. Possibly, a worldwide network permeable to the free sharing of knowledge and technologies for the betterment of humankind can help to even a globalized playing field, and to promote technological development (Castells, 1999, as cited in Robertson et al., 2007). As used here, the term *global* is considered altruistic and represents a community of people working toward the betterment of humankind; unequivocally, “globalization” has hegemonic connotations. For instance, inspection of the EFA’s goals might generally reveal altruistic aims. However, to reduce the EFA’s tendencies toward “globalization” might necessitate its “global” enactment which consciously seeks to balance power relationships. This can be achieved through the ethical practice and accountability of power-brokers which includes their willingness to seek and listen to the voices of the target populations as they work together to develop and promote clear, national educational agendas suited to the targeted nation’s developmental needs.

Postcolonial Science

Trinidad was colonized first by the Spanish in 1498. Later on, in the early 19th century, we were colonized by the British from whom we gained independence in 1962. In 1976, we became a Republic. Postcolonialism for us and other colonized does not simply represent the time after the

end of colonial rule, nor does it innocently indicate our power to now govern ourselves and to choose our heads of state from among our own people. Postcolonial “does not suggest that the values and practices that were inherent during the colonial era are now gone. Nor does a postcolonial lens define a radical new historical era, where the ills of the past have been cured” (Ndimande, 2004, p. 202).

Instead, postcolonialism is necessarily anticolonial, anti-oppressive, and anti-imperialistic in its efforts to *decolonize*—a resistance movement that seeks out, seeks to deconstruct, and seeks to challenge historic movements of political, social, geographic, religious, cultural, and economic subjugation and dominance, and their ongoing impact. As a discourse, postcolonialism “in part involves the challenge to colonial ways of knowing, ‘writing back’ in opposition to such views” (McLeod, 2000, p. 32), and might be located within broader goals of self-determination (Tuihawai Smith, 2012).

Trinidad is the larger of the Caribbean twin-island independent, republic of Trinidad and Tobago. The two islands were separate political entities before 1889 and up to today each has its own particular sociocultural ways of being, knowing, and doing. I was born, and have lived my entire life thus far on the larger island of Trinidad, and will focus my discussion on my experiences therein.

I guess that I might be considered as an indigenous person to Trinidad, but I have often wondered what this means exactly for I am a Creole. A racial and ethnic product of the original First Nations Nepuyo and Garifuna of the Caribbean region, as well as the people who came or were forcibly brought to Trinidad: African slaves, European colonizers, and Far East indentured laborers. I am of mixed racial origin and was raised by parents of mixed religious persuasions. Out of this, I feel no allegiance to any race, ethnicity, or religion. People are just people to me. My ambivalence toward these matters is never questioned by me or my country-people once I firmly describe myself as a Trinidadian—that rainbow multicultural, multiethnic, multireligious Carnival country where there is harmony in diversity (or at least a very good pretense at it). Sometimes it all coalesces as an idea in my mind, uncertain what it means to be indigenous in this Trini-Caribbean place of my birth that holds the allegiance of my heart. It is from this space that I write about science.

As I write, I’m trying to find my voice. It’s not like it’s lost or silenced; it’s as if I have been mute all my life. Especially in this writing space where I’ve been told that my experiences needed to be validated against the scholarly literature—much of which does not speak to who I am as a Creole person, or to the indigenous ways of being, knowing, and doing of my home in the Caribbean. I have recently had opportunity to hear Wanda Chesney speak on “Groundings” (see Chesney, 2011), and Laurel Bristol on “Plantation Pedagogy” (see Bristol, 2012) as decolonizing methodologies appropriate to Caribbean spaces. These women spoke of a need to “re-engineer” or “re-format” Caribbean classrooms—an on the ground revolution

for pedagogy and research that embraces and honors our identity, and needs as a society and people. With Chesney and Bristol's words resonating I went to the grocery store to find the local sweets of my land, sugarcake and fudge, stuck almost out of sight behind the cashier's register while the foreign candy enjoyed premium display, and it made me so very angry. Listening to Chesney and Bristol leads me to wonder too about "legacy" and "heritage." My people's culture is oral. Few who have seen my countryman, Peter Minshall's 16-foot puppets of Tan Tan and Saga Boy dance (illustrated at <http://www.youtube.com/watch?v=NCOwmeSHL0>) might disagree that our Carnival Masquerade (Mas) can be a scientific and technological innovation. Indeed, at their debut some 25 odd years ago, Tan Tan and Saga Boy were considered by many as a world novelty. But you cannot hang the three dimensional hedonism of color, sound, and exuberance that is our Carnival on a museum wall. And it deepens my wonderings at the way that academe and the world records and documents science and scientific innovation, and how none of these methods cater to the artifacts of my culture as are Minshall's creations. I join Chesney and Bristol then in the call for a re-imagining and an innovation of the methodological. I call further for a re-imagining of intellectual spaces and displays that allow peoples like mine to leave authentic trails of our legacy so that our young people too can proudly share their scientific heritages with the world. I admit too, that this journey into a recognition of our idiosyncratic ways of being, knowing, and doing within science still needs greater representation within Trinidadian science education policy documents.

The lower secondary (ages 12-14) science curriculum of Trinidad proposes the following:

Science is the study of the biological and physical environment. It is a method of problem solving which requires that all the necessary resources and skills be used to gather objective evidence, analyse and synthesize that evidence, then make inferences and draw conclusions. These activities require specific skills and habits of mind, such as accuracy, discipline, and integrity in the application of scientific principles, which are fundamental to scientific activity. (Government of the Republic of Trinidad and Tobago [GORTT], 2008, p. 22)

Definitions of this type betray ideologies within Trinidadian science educational policy documents which propose science as "purely objective, solely empirical, immaculately rational, and thus, singularly truth confirming" (Aikenhead, 2001, p. 337). Such definitions of science also suggest that reality is discrete and stagnant; immune to its observer's subjectivity, including their cultural suasions; and dismountable into its component parts whose functioning can then be ascertained through verificationist means (Stanley & Brickhouse, 1994). These means hold Karl Popper's hypo-deductive method in high esteem: indeed, science actively utilizes Popper's falsification to test the value of knowledge. That is, in science, empirical evidence about the world around us (curiously limited to collection through

the experiences of the five senses in my opinion) is logically induced into representable laws and theories. Peer review is then repeatedly and rigorously used to try to falsify such knowledge and so ascertain its worth (Monk & Dillon, 2000).

The view of science described in the previous paragraph is often termed as the standard account of science or Western modern science (WMS) which reflects foundational elements of empiricism according to Francis Bacon, positivism as conceptualized by Comte, and neo-positivism as suggested by the School of Vienna in the early 1900s (Thésée, 2006).

Empiricism stressed the reality and foundation of the experimental process, which underpins the scaffolding of theoretical knowledge . . . positivism placed facts at its centre, invalidating the quest for primary causal relations, final causes and significant meaning . . . neo-positivism required that any assumption must ensue logically from facts. (Thésée, 2006, p. 25)

This WMS might be more accurately termed *Western European science* as it emerged from Italy, France, England, the Netherlands, Germany, Austria, and the Scandinavian countries during the 16th and 17th centuries. WMS spread to the world outside of these countries "through military conquest, colonization, imperial influence, commercial and political relations, and missionary activity" (Basalla, 1967, p. 611). Decades after the end of colonialism, this creep of a colonial brand of science seems to continue in the form of neocolonial activity.

The colonial enterprise and the natural sciences, mutually, have shaped and controlled the deployment of one another. Although new forms—more subtle, global and diffuse—of this dynamic have taken place, they cannot over-shadow the on-going oppression and exclusion of the same nations plagued by the neo-colonization enterprise. This is neither accidental, nor coincidental. While the old colonial power advanced unheeded, the neo-colonial power proceeds more cautiously, hidden under polymorphic masks. The most powerful of these masks frames an epistemological figure which implies knowledge. (Thésée, 2006, p. 25)

I suggest further that the standard account of science is not just Western and modern but also secular in its disposition as it continues to negate the impact/role of Spirit or God in any form in its activities. It is suggested that Western knowledge (as is WMS) might be flawed on two counts. First, it tries to make sense of the nature of the world through reason (only). Second, it feels itself to be the trustee of all knowledge, entitled "to authenticate and invalidate other knowledge (when it gets around to it)" (Doxtater, 2004, p. 618). This is scientific fundamentalism or "scientism" which claims that WMS is the only valid way of coming to know. By locating global initiatives of "science for all" within scientism, WMS becomes a gatekeeper (Snively &

Corsiglia, 2001), and so by default gets to decide what scientific knowledge is valued as epistemologically rigorous. Ironically, the original people of the West who were here before the European colonizers, and those who have been able to survive this global colonialism of Europeans, still are both relational and metaphysical in their scientific practices. For example, see a description of the epistemological practices of the Inuit of Far North America (Bielawski, 1995) and the Hopi Indians of North America (Wall & Masayeva, 2004).

First Nations people like the Inuit and Hopi of North America, and the Nepuyo of Trinidad practice a relational science in comparison with WMS which is reductionist, secular, and objective/substantivist. A relational ontology, in comparison with an objective/substantivist one, connects entities within a system so that parts or members are not enjoying objective existences, but instead exist within a series of valued relations and processes (Nelson, 2009). Complexity theory, which supports the functioning of complex adaptive systems, can help to explain a relational ontology. A complex adaptive system is non-reductive: that is, it is bigger than the sum of the function of all of its parts as the relations between parts also add texture to the system. A complex adaptive system in 3D might look like a network, with parts of the system represented by points or entities in the network that are interacting with each other. Anytime a change or bifurcation enters the network's matrix, parts/members/entities adapt by changing the relations between themselves to emerge new properties that are usually more complex, and which allow the system to evolve, grow, and thrive (Fleener, 2008; Goldstone & Sakamoto, 2003; Morrison, 2008). On the contrary, within a substantivist (objective) ontology, "entities are ontologically primary and relations ontologically derivative" (Wildman, 2010, p. 55). Objectivism aligns with a substantivist ontology and relegates relations as amoral, supports Western modern thought systems (Nelson, 2009), and "by reducing the world to a collection of things places the knower in a field of mute and inert objects that passively succumb to his or her definitions of them" (Palmer, 1983, p. 56). Like indigenous research (as opposed to Western scientific research), a relational ontology respects "the interconnectedness of physical, mental, emotional, and spiritual aspects of individuals with all living things and with the star world, and the universe" (Lavalley, 2009, p. 23). Such interconnectedness might be thought to yield the communal energy of All That Is, from within which any one of us, can come to know about the rest of us through intuition because we are separate yet the same. For the Inuit (Bielawski, 1995), the Hopi (Wall & Masayeva, 2004), and the Nepuyo of Trinidad, Spiritual ways of coming to know about the land, the water, the sky, the wind, and its occupant sentient beings are valid ways of doing scientific inquiry and deriving sound scientific epistemology. The Western Eurocentric voice, compensation arrangements, and cultural setting dominate the academy, stifle spiritual voices, and this might be considered as "a [*sic*] act of violence against us and those like us whose cultural norms dictate the centrality of

spirituality in our lives" (Dilliard, Abdur-Rashid, & Tyson, 2000, p. 449).

By implication then, different ways of knowing how the world works are fashioned from the cosmology of the observer, and provides opportunities for the development of many sciences. Even WMS has itself developed from a particular *weltanschauung*: its situatedness in Western philosophy and paradigms. However, "its epistemological robustness, reliability of status of knowledge produced . . . has ensured its universal acceptance as a powerful way of understanding our world" (Carter, 2008, p. 175); allowed it to make large contributions to human advancement (Brown-Acquaye, 2001); and has so helped to promote its wide acceptance. Still, WMS's enmeshment within a global, capitalist, progressive agenda has facilitated hegemonic interests and led to many unplanned outcomes, including numerous varieties of imperialism and threat to life on the planet (Carter, 2008). Certainly, there are charges that the environmental ruin that the earth presently faces has been precipitated by the practices of a substantive Western science disbelieving that the physicality of the earth and its sentient beings exist relationally. There are those who believe that a symbiotic, relational science (as indigenous sciences tend to be), cognizant that threat to *either* man *or* Earth ultimately threatens both, might save life on the planet from decimation (Snively & Corsiglia, 2001).

Our unique Trinidadian science is itself a Creole of the scientific practices of our multiculturalism; though not included in our national policy documents, there is evidence of a few attempts (e.g., see Coard, 2013; Herbert, 2003; Herbert, 2008; Simon, 2013; Wong, 2007) on a school and classroom level to do so. Even so, the realm of the metaphysical or Spiritual (as is represented by the contribution of our First Nations Nepuyo people, for instance) is unrepresented.

Within postcolonial Trinidad, to navigate our particular world space, there is evidence (see the taxonomy below) that our unique science invokes both the WMS of our colonizers and intermingled these in varying degrees and combinations, with our own indigenous science.

CATEGORY 1 The indigenous practice can be explained in conventional science terms. For example, the indigenous practice of using a mixture of lime juice and salt to remove rust stains from clothes, can be explained in conventional science in terms of acid/oxide reactions.

CATEGORY 2 A conventional science explanation for the indigenous knowledge seems likely, but is not yet available. For example, a brew made from the plant "vervine" (*Stachytarpheta*) is used in the treatment of worms in children. This plant is considered in conventional science circles to have pharmacological properties, but appropriate usage has not been verified [by conventional science].

CATEGORY 3 A conventional science link can be established with the indigenous knowledge, but the underlying principles

are different. For example, the indigenous admonition that eating sweet foods causes diabetes links diabetes with sugars, as does conventional science. However, whereas the indigenous system claims that sugars cause diabetes, conventional science claims that when one is diabetic, the ingestion of sugars can worsen one's condition.

CATEGORY 4 The indigenous knowledge cannot be explained in conventional science terms. For example, there is no conventional science explanation for the indigenous knowledge claim that if one cuts one's hair when the moon is full, the hair will grow back to an increased length. (George, 1986, as cited in George, 2011, p. 85)

The mixing of Western (colonial) and indigenous practices to form a hybrid, in this case, of Western science and Trinidad's indigenous science is discussed by Homi Bhabha in his 1994 work "Location of Cultures." Rizvi, Lingard, and Lavia (2006), in analyzing Bhabha's work, discuss as follows:

Bhabha shows how postcoloniality always involves the "liminal" negotiation of cultural identity across differences of race, class, gender and cultural traditions [and I suggest scientific practice]. He argues that cultural identities cannot be ascribed to pre-given, irreducible, scripted, ahistorical cultural traits. Nor can "colonizer" and "colonized" be viewed as separate entities that define themselves independently . . . Instead, Bhabha suggests that the negotiation of cultural [scientific] identity involves the continual interface and exchange of cultural [scientific] performances that in turn produce a mutual and mutable recognition of cultural difference. (p. 253)

The reclaiming of our identities (of which our sciences is part) is occurring within a previously colonized space: Who we were before and after the experience of colonization is not the same nor are they mutually exclusive—the experience of colonization is forever intermingled with us and within us. Understanding the nature of postcolonial activities, such as science in countries like Trinidad, is about a struggle for self-determination (Tuhiwai Smith, 2012). A communally aware science education and practice might ensure that doing and making science, science policy, and science education policy emanate from the needs of the people whom such articles are supposed to serve. These articles might then be appropriate to the developmental needs of communities and countries (Psacharopoulos, 2006). Indeed, such activity can help countries "to develop post-industrial educational paradigms and structures that would achieve culturally sensitive educational change appropriate for the challenges of the new global age" (Hickling-Hudson, 2002, p. 576).

Considerations for a Postcolonial Science Education

Today, education serves as the garden in which the seeds of the neocolonial process are sowed in the minds of girls and boys, thereby assuring future Western domination and exclusion of marginalised nations. (Thésée, 2006, p. 25)

Postcolonialism attempts to account for and describe the aftermath of colonialism. Indeed, every instance of colonialism is individualistic in many ways (e.g., my experience as a Creole), and it has been argued that postcolonialism exhibits a "reluctance to differentiate adequately between experiences of colonialism" (Rizvi et al., 2006, p. 254). The strength of any theory attempting to capture postcolonialism is such that "whatever the controversy surrounding the theory, its value must be judged in terms of its adequacy to conceptualise the complex condition which attends the aftermath of colonial experience" (Gandhi, 1998, p. 4).

It can be suggested from Gandhi's musings that all sites of postcolonialism should be dealt with on a case by case basis. This position can also be related to science. Science has always been about humankind's wonder of the world and learning about that world so that he or she can navigate, and hence survive and triumph within the elements: especially those of the natural and physical world of his or her particular world space. It might be reasonable then to suggest that "science education is successful only to the extent that science can find a niche in the cognitive and socio-cultural milieu of students" (Cobern, 1994, p. 7). So the suggested considerations toward a postcolonial science education that have been made below are based on the importance of place, space, and context. Simply put, localization is suggested here as one possible antidote to the deleterious effects of globalization. The considerations for science and science education that are discussed below within such an antidote are an inclusion of indigenous science; an indigenous definition of scientific literacy; an indigenous innovation agenda; and a community focus or a place-based practice.

Inclusion of Indigenous Science(s)

The colonization that spawned Creoles like myself seems to have reformatted the term *indigenous* to describe the people who existed before the colonizer and seems to hold no thought of people like me. And in so doing continues to colonize me in so many ways, through a lack of delineation of the Creole in terms of ethnicity, race, culture, or place. I have always wondered too at the similarity in the words *indigenous* and *indigent*, with the latter betraying many long-standing beliefs about "indigenous" peoples, and echoing a vocabulary historically used to describe things "outside" of the colonial mother country (Tuhiwai Smith, 2012).

I must confess though my lack of fondness for the term *indigenous*; it seems to me to be a dirty word, a brand offered to conquered peoples. It is rare, and not mainstream practice to refer to the Britons, or the Frenchmen say, as being "indigenous" to their respective lands. It is very confusing to me what this term *indigenous* means. Regardless of my feelings, "indigenous" deals with being here; with a situatedness from where one sits, and knows, and does. It seems that "indigenous" is though, capable of offering "Creole" a defining identity through a place-based delineation and so becomes the antithesis of colonial by opening up a postcolonial space.

Indigenous knowledge “refers to traditional norms and social values, as well as to mental constructs that guide, organise and regulate the people’s way of living and making sense of their world” (Dei, Hall, & Rosenberg, 2000, p. 6). Indigenous science, a form of indigenous knowledge, “relates to both the science knowledge of long-resident, usually oral culture peoples, as well as the science knowledge of all peoples who as participants in culture are affected by the worldview and relativist interests of their home communities” (Snively & Corsiglia, 2001, p. 6). By expanding the definition of Western science to include practices indigenous to communities, the gate keeping power of WMS through its ability to determine the content and practices of classrooms is derailed (Snively & Corsiglia, 2001).

An Indigenous Definition for Scientific Literacy

Indigenous knowledge comes from the long-term residency of a place; an inclusion of indigenous sciences within classrooms can prepare scientific literates, capable of participating actively in the life of their particular community (Wolff-Michael & Lee, 2004).

Facing a world increasingly ruled by science and scientific ways of thinking and being, scientific literacy has become crucial (Moore, 1995). Scientific literacy gives individuals a “knowledge and understanding of scientific concepts and processes required for personal decision making, participation in civic and cultural affairs, and economic productivity” (National Research Council [NRC], 2014, p. 22). Scientific literacy is hence also contextually driven and place-based so that a housewife, scientist, or school child from different geographies or sociocultural persuasions might all require a special scientific literacy to navigate their particular world space (Moore, 1995; Wolff-Michael & Lee, 2004).

For Trinidad, the terms *scientific literacy* or *science for all* are not directly named in either its national lower secondary (12-14 years) science documents (GORTT, 2008), nor in the regional upper secondary science documents (15-18 years) for chemistry (Caribbean Examinations Council, 2006), physics (Caribbean Examinations Council, 2007b), biology (Caribbean Examinations Council, 2007a), agricultural science (Caribbean Examinations Council, 2013), or environmental science (Caribbean Examinations Council, 2010). Similarly, scientific literacy is not individually described as one of the attributes of The “Ideal Caribbean Person,” who according to The Caribbean Community (CARICOM), expectedly “demonstrates multiple literacies [*sic*] independent and critical thinking, questions the beliefs and practices of past and present and brings this to bear on the innovative application of science and technology to problems [*sic*] solving” (Caribbean Community Secretariat, n.d., “The Ideal Caribbean” section, para 1).

The lack of explicit mention of scientific literacy or science for all within the science curricula documents of Trinidad is not surprising as there is little focus on science in

general within our steering Education Policy Paper (GORTT, 1993). A regional, collective policy position, for example, through the Caribbean Community (CARICOM), can give small states such as Trinidad an opportunity to craft an indigenous agenda for science education amid global initiatives and shifting political alliances (Jules, 2008).

An Indigenous Innovation Agenda

The word *science* comes from the Latin term *scientia* or knowledge, of which Francis Bacon said in his 1597 *Meditationes Sacrae*, “*ipsa scientia potestas est*”: knowledge itself is power. In more recent times, Dean of Harvard’s School of Engineering and Applied Science, Cherry Murray, suggests that in a world attempting to cope with “global challenges such as climate change, population growth concentrated increasingly in megacities, financial crises, and emerging infectious diseases, human society is at a tipping point in the next half century and must find new ways of solving problems” (Lane, 2014). The knottiness of modern global challenges seems to indicate need of innovative, cross-national, and cross-disciplinary solutions (Gijzen, 2013). Science is seen as the solution to many of the world’s pressing issues such as hunger and HIV/AIDS, and a global scientific agenda is likely to continue to expand in the future. Ironically, while national developmental plans and policy play a role, science’s expansion is expected to be primarily fueled by the policy of international developmental organizations (Schoefer, 2004). In fact, just as neo-institutional theory suggests, the growth of science tends to be faster in countries linked to, and supported by global organizations of the world polity (Schoefer, 2004).

Scientific innovation is part of the solution to the world’s intractable challenges; indeed a rapidly growing new field of innovation studies has arisen out of the global society’s development and need for new knowledge (Fagerberg & Verspagen, 2009). Broad acceptability of the importance of innovation causes the term to be bandied about as if users hold common understandings about it, or demands from it, but in reality its definitions tend to be discipline specific. Analysis across 60 definitions of innovation collected over multiple disciplines for the period 1934 to 2004 suggests that “innovation is the multi-stage process whereby organizations transform ideas into new/improved products, services or processes, in order to advance, compete and differentiate themselves successfully in their marketplace” (Baregheh, Rowley, & Sambrook, 2009, p. 1334). So innovation is considered crucial to the profitability and hegemony of organizations and to the development of countries. Certainly, innovation can help goods and services to remain relevant and in demand even as the sophistication of the tastes and needs of 21st-century consumers increases (Baregheh et al., 2009).

Developing regions such as Trinidad are expected to be innovative enough to compete successfully on a worldwide economic playing field in which developed nations also

participate. Scientific innovation, which has been linked on some fronts to economic development, might have a role. As an example, Pittsburgh in the United States launched an economic recovery through a partnership between industry and research universities (Singh & Allen, 2006). In this initiative, research universities were expected to fulfill their own research missions while also acting as partners in regional and economic development through their technological and technical contributions (Singh & Allen, 2006,).

Indeed, new knowledge is an outcome of innovation, and by 1999, knowledge industries within developed countries already contributed 50% to gross domestic product (GDP; Melo, 2001). National innovation systems deliberate how knowledge, learning, and innovation are organized within modern national economies, and involve stakeholders of technological innovations such as research and development institutions, engineers, and policy makers (Melo, 2001). Generally, nations such as Trinidad, independent since only 1962, are still playing catch-up to developed countries in establishing robust innovation systems. These countries have been affected in different ways through time: for them, import-substitution and trade liberalization have made indigenous technological innovation unnecessary as requisite goods and services are easily accessed from abroad (Melo, 2001). Demonstrably, Trinidad (as well as many territories of the Caribbean) remains a consumer of science and its innovations as technological applications. As a new independent and developing state, we are still learning to recognize and direct our indigenous ways of being, knowing, and doing through sustained and profitable scientific application.

Science teaching that focuses primarily on promoting students' abilities to be innovative and good problem solvers are useful to the drive to solve the world's challenges through scientific innovation. The process of problem solving requires creative and critical thinking to develop solutions or innovations. However, scientific innovation capability might be indicated by critical thinking and intrinsic motivation, more so than creative indicators (Heinzen, Mills, & Cameron, 1993). Within science education, STEM (science, technology, engineering, and mathematics) methodology focuses primarily on scientific innovation as a technological or engineering outcome. That is, STEM is a problem-solving process that applies the principles of science and mathematics to engineer technological solutions to challenges.

STEM stands for science, technology, engineering and mathematics and though STEM initiatives often focus on the relationship between these components or groups of them, they might also focus on the separate elements. Many derivatives have arisen to include, for example, other areas which are problematic (e.g., "R" or reading in STREAM) or areas that might contribute to the creativity of problem solving (e.g., "A" or Arts in STEAM). Admittedly, one commonly accepted definition of STEM is elusive (Breiner, Harkness, & Koehler, 2012).

Actually, there is worry that agendas (e.g., for STEM) in science education are not being shaped by quality research in

science pedagogy but have emanated instead from "global economic restructuring and the imperatives of the supranational institutions that are largely beyond the control of science education" (Carter, 2005, p. 561). These imperatives include a nation's ability to achieve or maintain hegemonic status in the global economy based on its performance in STEM fields (Breiner et al., 2012, and is indicated by the competition between the United States and China and India: see Sanders, 2009). The imperatives may also fuel drives by big multinational companies to keep their human resource departments well supplied with the scientists and technologists necessary to continue their business operations. STEM may therefore be likely to continue to enjoy tremendous funding from rich corporations and governments so that its aims and methods have trickled down and become embedded into science policy, curricula, and pedagogy. Hence, STEM is likely to remain prolific for many years even if it does not necessarily support national and local developmental agendas. Within Trinidad, science education programs do not focus on the training of teachers to be STEM specialists, and the natural sciences are taught separately by pure science (e.g., biology, chemistry, physics) specialists with integration occurring more so at the primary and lower secondary levels up to the age of 13. Moreover, routine block timetabling of subjects generally challenges any personal initiatives to implement STEM teaching by a team of these pure science specialists within the curriculum. This has been a personal experience as a teacher-educator leading such a team in a national science fair (STEMagination, 2013) that involved the training and support of teachers and students in the production of a STEM research project.

A Community Focus/Place-Based Practice

Science education is critical to producing a constant supply of scientifically literate individuals who understand, support, and can successfully innovate to alleviate the technological demands of the society (Jenkins, 2009). Following a belief that science education results in increased prosperity, and to bridge the gap between "developing" and "developed" countries, developing countries tend to cut and paste from international educational policies and apply these appliqués in *carte blanche* ways. Clear *modus operandi* governing such operations are often not apparent nor are the appliqués usually appropriately contextualized to suit personal needs. Hence, there tends to be a loose coupling between science education policy and practice within developing countries (Driori, 2000). To promote a science education relevant to all students (Barton, 2000), our postcolonial status and the poverty of our innovation systems might also require a science education that is focused on the emancipation of the community.

For example, to teach student-teachers how to promote a science for all agenda within their classrooms, they were engaged within a community-service model that required

them to create and teach an authentic, problem-based science curriculum to students residing in a homeless shelter (Barton, 2000). Such service learning combines “classroom work with social action and service in order to promote development of students’ subject matter, practical skills, social responsibility and civic values” (Checkoway, 1996, as cited in Barton, 2000, p. 801). Within science education, a community-service model may allow students to become aware of the challenges of the communities in which they reside, feel more connected to their communities, and so generate technological innovations that are indigenous to the needs on the ground. This could help to address the loose coupling or “the gap between the general nature of policy statements originating from policy initiatives of IOs [International Organisations] and the particular nature of the curriculum and materials available to teachers” (Driori, 2000, p. 49).

Social, political, and economic integration might be important to achieving aims of a relevant education, especially given tendencies toward loose coupling in the third-world (Knamiller, 1984). Closing the gap between science education policy and practice, especially in poor and weak countries most susceptible to such loose coupling (Driori, 2000), can be helped through the provision of a relevant education. A relevant education should aim to improve the livelihood status of participants as well as of their home communities; indeed, community is an important factor in science education (Driori, 2000; Knamiller, 1984). A place-based science can help teachers and students to do and learn science in ways that engage them in and with the place and community in which they are located: antidote to the neocolonial globalized use of standard texts, examinations, and curricula materials (Grunewald, 2003, as cited in Quigley, 2009).

In Closing

Defining what a “thing” is within postmodern times can be viewed as the creation of an all-encompassing metanarrative that erases designating characteristics given that most “things”—be it a group of people, a culture, or a theory—are nuanced, idiosyncratic, and complex. Definitions of any “thing” in many arenas hence tend to be multiple and contested.

Within a postcolonial space, science education that does and teaches science by including and respecting the community in which it occurs can create opportunities for cultural mediation that can help to craft relevant science curricula in a postcolonial space.

In the context of the postcolonial spaces of curriculum development [as in Trinidad], cultural mediators bring with them understandings related to conciliation. This involves the imperative to bring together people and their stories. Furthermore, cultural mediators understand the need for healing, restoring, and making amends for past neo-colonial activities. (Ryan, 2008, p. 682)

What then does a science education for a postcolonial, sociocultural milieu look like? The essay suggests localization as the postcolonial remedy to colonialism and its new guise in globalization; that is, that primarily people must be taught how to live and build the capacity of where they are. Within science education localization may include a consideration of indigenous definitions of scientific literacy and of indigenous science(s); place-based science; and a drive toward the creation and fulfilment of an indigenous innovation agenda.

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