Examining the Alberta K-6 Draft Science Curriculum for Markers of Colonial Influence

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Abstract

Education systems are increasingly attempting to “include” Indigenous science in new frameworks, materials, and teaching practices. These practices can be harmful and/or misleading if Indigenous science is, implicitly or explicitly, subjugated to Western science. In this article, I use feminist standpoint theory and anticolonial analysis frameworks to analyze the extent to which the curriculum refutes or reinforces Western science hegemony and (de)legitimizes Indigenous epistemes. Results indicate that the curriculum reproduces Western cultural notions of what science is/should be, thereby perpetuating colonial practices and the exploitation of Indigenous Ways of Knowing.

Keywords: episteme, standpoint, anticolonialism, hegemony, science education, Western science, Indigenous Ways of Knowing

Introduction

Recent discourses question the objectivity and ubiquity of the scientific methods of the West (Elliott, 2009; Yadav, 2018). The presumption that Western science takes place absent of societal influence is challenged by examination of the power dynamics through which it was built and continues to operate. These societal relations are woven into each aspect of Western science: its experimentation methods, its approach to analysis, and ultimately its findings (Harding, 2002). Placing science in context - that is, considering how an interplay of societal factors influences it - opens it up to scrutiny on many fronts, some more immediately obvious than others. Some areas of analysis include sexism, racism, colonialism, heteronormativity, ableism, and neurotypicality; multi-axis analysis of the intersections between these factors is doubly revealing (Crenshaw, 1989; Archer et al., 2019). Analysis in this manner peels back the veil of ubiquity and espoused objectivity touted by Western science to reveal its basis in often-discriminatory societal values (Archer et al., 2019).

As a fourth-generation settler on Treaty 6 territory and an aspiring scientist, I often wonder how scientific discourses advantage some modes of thinking over others. I ask why we look back on historical societies' scientific methods through critical eyes but glorify 21st century Western science as if it were faultless. I think about how the unquestioned hegemony of Western science benefits me, a European settler. As a high school student, I wonder the same about science education.

The fallibility of Western science is not confined to research settings; as noted by Brickhouse (1994), it is also a factor in Western science education environments and materials. In classrooms, science is viewed as an elite pursuit most suited to dominant personalities that fit the historically-crafted mould for scientists: male, white, English-speaking, cisgender, heterosexual, and traditionally masculine (Brickhouse, 1994; Letts 2001). The sole suitability of this type of student is reinforced constantly; in classroom discussions, masculine traits that assert dominance[1] are recognized as legitimate and intelligent ways to express science. These performances are rewarded, while quieter, feminine, and alternative ways of expressing science are diminished (in

[1] Archer et al. (2019) describe "competition; dominating and controlling class science talk; and policing the science talk of others" as the most prevalent assertions of classroom dominance

many instances by the more dominant personalities in the classroom) (Archer at al., 2019). This masculine environment is not created by any conscious fault of individual educators; rather, it is a product of Western science itself, which was built on exclusivity and the glorification of the dominant male (Criado-Perez, 2019). The Archer study is illustrative of a trend of exclusivity within Western science extending beyond solely the masculine/feminine dichotomy. When legitimate expressions of science in classrooms are those that are the most in line with the historical stereotype, the more deviant a method of expressing science is from the masculine, European, cisgender, heterosexual norm, the less likely it is to be labelled as legitimate.

As discussed by Ahenakew (2016), Indigenous methods of expressing knowledge tend towards the more abstract, including metaphor and poetry. These methods of communication are very distinct from Western methods, and are thus less likely to be accepted as legitimate ways of expressing science in Western circles; in this manner, Indigeneity may be cast off as unscientific within Western science and Western science education. The enforcement of this clear distinction between what is (not) science reasserts the sole legitimacy - and therefore the dominance - of Western science (M. Higgins, personal communication, August 10, 2021). All other epistemes are left fighting for second place, with those the least distinguishable from Western science occupying higher rungs on the epistemological hierarchy of the West.

Due less to recognition of the fallibilities of Western science and more to social change and cultural movements, educational boards are moving to “integrate” Indigenous Ways of Knowing into their educational materials and curricula (Schaefli et al., 2018). In Alberta, the Teaching Quality Standard (TQS) is the set of guidelines to which teachers are held throughout their careers, based on “the teacher’s decisions about which pedagogical knowledge and abilities to apply” resulting in “optimum learning for all students” (2018, p. 3). In 2018, the TQS was re-written to include a new fifth section, which mandates the application of “foundational knowledge about First Nations, Metis, and Inuit for the benefit of all students” (Alberta Education, p. 6). Concurrently, Alberta Education developed an entirely new draft K-6 curriculum, which was unveiled in early 2021; it is set to be piloted in some classrooms in the 2021-2022

school year, and mandated across all classrooms and school boards the following year (Alberta Education 2021a).

The new curriculum, which contains many references to Indigenous lives and Ways of Knowing, contains more non-Western knowledge than previous curricula and represents a departure from previous policy in that teaching Indigenous content is now mandated by the TQS (Alberta Education, 1996; Alberta Education, 2018). New content and new requirements for the implementation of Indigenous content have the potential to incite large-scale impacts for educational staff and students (Matewos et al. 2019).

Many would argue that change is necessary in science education. Research shows that about 90% of students feel alienated from school science to some degree, demonstrating that it is currently badly out of step with students' needs (Aikenhead and Elliot, 2010). While the addition of content about Indigenous Ways of Knowing to Western educational materials has been adopted as a method to make science education more inclusive, it is by no means a quick fix. The manner in which learning occurs is shaped by how Indigenous and Western epistemes are portrayed in educational materials: the context in which they are presented, the content itself (i.e. what is included/excluded), the way in which they are communicated, and the portrayal of the relation between them.

My analysis of the draft K-6 science curriculum is shaped by the aforementioned factors. I ask (1) how are Indigenous and Western epistemes portrayed independently and in relation to each other? And, (2) (how) are power and privilege dynamics between scientific epistemes addressed? My analysis is used to address the extent to which the pilot K-6 science curriculum provides the material necessary for teachers to uphold the expectations of TQS section 5, as well as for the facilitation of "optimum" learning experiences for students. I attempt to address this as holistically as possible through use of standpoint theory and anticolonial analysis.

Feminist Standpoint Theory

Originally a 1970s outgrowth of Marxist feminism, feminist standpoint theory has been greatly developed by feminist scholars like Nancy Hartstock, Patricia Hill Collins, and Sandra Harding (Hekman, 1997). Harding's work is specifically tailored to science

and research methodologies, and as such I draw the basis of my analytical theory from her writings.

In its application to science, feminist standpoint theory recognizes the culturally-situated nature of Western science by questioning the legitimacy of scientific claims to complete objectivity. It states that all knowledge - including scientific knowledge - has its basis in local interests, needs, and cultures (Harding, 2002). Different areas of inquiry, approaches to experimentation, and methods of recording results are shaped through varying societal interests; these interests are embedded in the questions that researchers ask, which projects get funding, and how results are interpreted (Harding, 2003). Additionally, the physical location of a community leads to varying needs, which direct scientific priorities for the area, unique conditions for experimentation, and different influences on the plausibility of certain outcomes (Harding, 2002). Thus, different societies produce different bodies of knowledge, with their own respective areas of strength and weakness.

Shielded by Western science's claim to neutrality that refutes critical inquiry, Western cultural values within science - including Western norms that frame Indigeneity as a binary negative to settler science - remain largely unchallenged (M. Higgins, personal communication, August 10, 2021; Letts 2001). Within Western science education, curricular materials play a role in the covert integration of societal norms into what is taught. These materials have a powerful position in classrooms, regarded as authoritative sources of accurate and unbiased education. However, a 2010 study found that an Ontario biology textbook reinforced unsubstantiated societal norms of heteronormativity and the gender binary, selectively omitting scientific facts that challenged these values (Bazzul and Sykes). The textbook's subversion of legitimate science as a means to perpetuate cultural values underscores the extent to which Western science materials are societally-ingrained. Feminist standpoint theory peels back the layers of societal influence to reveal that these materials are based in, and reproduce, a white, masculine settler standpoint. In this article I use it in an effort to bring to attention the cultural values and assumptions that are reproduced in the K-6 science curriculum, and I use anticolonial frameworks in tandem to specifically address

the standpoint with which the curriculum approaches the Indigene-colonizer relationship.

Anticolonial Frameworks

Anticolonial analysis identifies misrepresentations of Indigenous life, worldviews, and culture, and ways in which colonialism is (overtly or covertly) perpetuated. Much of this colonial perpetuation comes through evasion of colonial responsibility; Tuck and Yang's (2012) six settler moves to innocence,[2] detail how settlers absolve themselves of responsibility for past and continuing colonialism by attempting to 'become' native themselves, to equate other types of oppression with colonialism, to view decolonization as solely an act of personal learning, and/or to view land as a personal right of all. These acts can play out implicitly or explicitly, and either way misrepresent both Indigenous cultures and the act of decolonization (Tuck and Yang, 2012). In fact, misrepresentation occurs in even the most well-intentioned of settler literature. Integration of Indigenous cultural material into Western literature often takes it out of context, and as such cannot communicate it exactly as it is meant to be understood. As this loss cannot be wholly remediated, it must be recognized and discussed; what is absent must be acknowledged as missing so that readers are made aware of its absence (Ahenakew, 2016). This prevents further oversimplification and erasure of Indigenous culture, which is the cornerstone of anticolonial analysis: Indigenous worldviews and Indigenous lives must not be erased (Jones and Jenkins, 2014). As such, the most accurate way to discuss Indigenous and Western concepts in tandem is to focus on the differences between the concepts and identify power imbalances, history, and important contrasts to place distinction at the forefront and avoid erasure as much as possible (Jones and Jenkins, 2014). My analysis examines the extent to which these anticolonial guidelines are taken into account in the curriculum and provides suggestions for improvement that are based in anticolonialism.

[2] Settler nativism, adoption (into native culture) fantasies, colonial equivocation, free your mind and the rest will follow, A(s)t(e)risk peoples, reoccupation and urban homesteading (Tuck and Yang, 2012)

Another critical piece of my analysis is the indelible connection between anticolonial analysis, feminist standpoint theory and Western science, which I discuss in the forthcoming section.

Feminist Standpoint theory and Anticolonialism in the context of Western Modern Science

Western science developed as a locally-European practice, based in Enlightenment values of objectivity, rationality, and determinism that were of importance to European society at the time. Expansionism and colonialism forced the spread of European science across the globe, marginalizing Indigenous epistemes in a continuing hegemonic mission. However, the result was not and has not been a one-way flow of knowledge from Europe to its colonies; settlers exploited and continue to exploit the local knowledge of Indigenous peoples for the benefit of European science. The land, resources, and ways of life of local peoples globally were and have been used for the progress of European science, aiming to solve local-to-Europe problems, to benefit European people (Harding, 2002). In this way, colonial extractionism feeds the progress of Western science and of Western societies.

Thus, European science is local in that it solves problems whose solutions are most pertinent to Europe. It is also local in the values it propagates. Skepticism, rationality, neutrality, abstractness, universality, and objectivity; these European Enlightenment values make up the basis of European science (Letts, 2001). However, the valuation of objectivity does not create a value-free episteme; it and all of the Western[3] science values feature prominently because of their cultural importance in Europe, and they are thus indicators of the inseparability of culture and science (Harding, 2003).

Just as with every other episteme, the cultural values that shape Western science also shape its research focuses, creating areas of scientific strength and weakness. As with every episteme, it is also not stagnant. Changing Western culture and interests continually influence what is studied by every discipline of Western

[3] What originated as European science is now referred to as Western science because it was adopted and subsequently imposed on colonies and Indigenous people (in actions parallel to those of Europe) by the non-European countries of the global West (Tyson, 2006)

science (Harding, 2002). These influences on Western science are reflected in what is deemed important and relevant enough to be taught to students, trickling down to impact science education; however, there is also an additional value-based dimension to science education that is revealed through its development process, which shapes how science is represented in educational materials.

Representations of Science in Education

Overview

Along with the cultural values imbued within Western science, educational materials add an additional dimension of social influence through the inclusion/exclusion and generalization processes. When educational materials and curricula are created, politicians, academics, and researchers systematically decide what is included (and therefore taught) and what is left out. This process at its core is guided by personal values that dictate what material gets priority and what falls to the side (Bazzul and Sykes, 2010). Additionally, elementary and secondary science necessitates simplification of the material, in which the nuance of complex concepts is whittled away until core material that is understandable to students remains. Designations of what to simplify, the extent to which it should be simplified, and the language used to represent the remaining material are all driven by personal and cultural values that have their basis in what is (not) perceived as relevant at a certain time in a certain locale (Lemke, 2011). Thus, science educational materials are imbued with cultural values at three points, the first being the values that direct the formulation of scientific knowledge, the second during inclusion/exclusion of material, and the third when included material is simplified. As such, it is imperative that learners have sufficient opportunity to think critically about science, ask challenging questions, and draw their own conclusions (Lemke, 2011). In order to ask critical questions about science itself, students must be introduced to the historical context of Western science, they must understand that it is only one of many valid approaches to science, and they must be aware that it is, like all epistemes, culture-based (Harding, 1993, as cited in Lemke, 2011). Through this critical approach to science education, students can criticize, challenge, and begin to dismantle Western science hegemony.

Representations of Indigenous epistemes in science education

The ways in which alternative epistemes to Western science are approached in curricular materials can position them as equal to or lesser than Western science, challenging or contributing to Western hegemony. Cash Ahenakew (2016) explores how Indigenous ways of being can easily become a "colourful (but insignificant) alternative" to Western science, or "perceived as something that is already integral to the dominant logic and therefore also insignificant, given that it offers nothing new" in research (p. 336). I believe that these potential pitfalls in research run parallel to those in educational materials. Tokenistic portrayals of Indigenous epistemes as primitive or solely historical run the risk of infantilizing them and/or impressing upon students that they are not legitimate means of conducting modern science. These portrayals reinforce Western science hegemony by implicitly indicating that it is superior to "less developed" Indigenous epistemes. Jones and Jenkins' (2014) framework of the Indigene-colonizer hyphen can be used to demonstrate how the second pitfall may be present in curricula that integrate Indigenous ways of being. Overemphasis on similarities between Indigenous Ways of Knowing and Western science, or content centered around mutual understanding/collaboration inevitably softens or erases the gap, thereby leaving behind vital differences between Indigenous cultures and Western science, as well as the exploitative, colonial history of Western science. Attempting to highlight only similarities between epistemes serves to reassert Western science hegemony by construing all ways of knowing as indistinguishable from Western science itself. It also does further damage by erasing the colonial and exploitative past of Western science and the power imbalance between Western science and Indigenous epistemes. Better curricular approaches explore not facts about the other culture's science in order to make connections, but focus on the differences between the two cultures' ways of doing science (Jones and Jenkins, 2014).

Methods

I selected the Alberta draft K-6 science curriculum for analysis due to its timely relevance, potential for future impact, and deviance from previous educational policy in

its approach (and the approach of the concurrently-developed TQS) to including Indigenous Ways of Knowing. I annotated the whole of the curriculum, using standpoint theory and anticolonial analysis to note the ways in which Western and Indigenous epistemes are portrayed in the text. Both implicit and explicit[4] references were documented, and context - the curricular material surrounding these references - was also taken into account. Overall, 68 notable passages were catalogued.

I organized my findings into three broad categories: misrepresentation of Indigenous Ways of Knowing, erasure of Indigenous Ways of Knowing, and assertion of Western hegemony; and six subcategories: facts out-of-context about Indigenous Ways of Knowing, poor/misleading in-context comparisons, Indigenous sidekicks to Western authorities, violent omission of Indigenous perspectives, policing scientific communication, and Western scientific methods as objective truth.

Within the category misrepresentation of Indigenous life, the facts out-of-context subcategory looks at aspects of Indigenous life, Ways of Knowing, or technology given as tokenistic examples illustrating aspects of Western science; the poor/misleading in-context comparisons between Western and Indigenous science are generally incomplete, inaccurate, or lead to slanted conclusions in favour of Western science. In the erasure of Indigenous Ways of Knowing category, the subcategory Indigenous sidekicks to Western authorities contains passages that represent “collaboration” between Western science and Indigenous people, which in itself is a form of violence through erasure. And, the violent omission of Indigenous perspectives subcategory explores areas where Indigenous voices are conspicuously absent from the discourse. Lastly, within the assertion of Western hegemony category, the policing scientific communication subcategory discusses instances in which students’ expressions of science are forced into the Western mold; the subcategory Western scientific methods as objective truth examines instances in which the cultural basis of Western science is obscured or implicitly refuted.

My analysis is organized by category, with discussion of each subcategory within. Frequency of appearance of passages belonging to each subcategory is discussed

[4] Throughout the analysis, I indicate whether each subcategory draws mainly explicit or implicit conclusions; this is in recognition that implicitly-drawn conclusions require greater amounts of my own interpretation

within the analysis and quantitative data (Appendix A) is presented in tandem with qualitative analysis findings.

In keeping with feminist standpoint theory, I would like to acknowledge the value-based nature of my own work within this analysis. While I have taken care to come to valid conclusions in line with anticolonial and standpoint literature, I recognize that I cannot remove myself or my cultural background from this work. As such, I have documented all of the passages that I analyzed, which can be perused for alternate interpretations (Appendix B).

I discuss methods for amelioration of the curriculum within my analysis of each subcategory. These methods are in line with standpoint, anticolonial, and educational research, but I would also like to state that they are general strategies that may begin the improvement process (not complete it) and the voices of Indigenous individuals who wish to comment on this curriculum must take precedence over all else.

Analysis: Misrepresentation of Indigenous Ways of Knowing

The first category is misrepresentation of Indigenous Ways of Knowing; its subcategories are facts out-of-context about Indigenous Ways of Knowing and poor/misleading in-context comparisons of Western and Indigenous life. Passages in this category require context to be understood and analysis is generally of implicit conclusions. Notably, subcategories within this category tend to contain the least homogenous sets of passages; misrepresentation is expressed in a wise variety of ways, and my discussion spans many different forms of misrepresentation in this category.

Distinction between this category and the next, erasure of Indigenous Ways of Knowing, is made mostly over concerns of visibility; passages in this category make visible inaccurate portrayals of Indigenous life, while those in the next category minimize Indigenous ways of living that are incongruent with Western ways. Within this category, Indigenous Ways of Knowing are misrepresented so as to portray them as so similar to Western science that the two fit together, or to portray them as underdeveloped and thus lesser than Western knowledge. In both instances, Indigenous Ways of Knowing are irreconcilably distorted.

Facts out-of-context about Indigenous Ways of Knowing

My findings show 9 passages exemplifying the first subcategory, facts-out-of-context, representing 13.24% of the 68 total passages. Examples are present in every grade (including kindergarten), except Grade 4. They come from a wide variety of focus areas, including units discussing ecosystems, space, and technology. Most examples follow a format in which a Western science topic is explained and then content about Indigenous life is used to illustrate the concept; this is demonstrated clearly by a passage from Grade 3:

> Events that can change Earth's surface in a short period of time can include
> - volcanic eruptions
> - earthquakes
> - landslides
> - tsunamis
> - flooding
> - melting and freezing
>
> Changes to Earth's surface can be shared by First Nations, Métis, and Inuit through
> - stories
> - traditional knowledge
> - language
>
> (Alberta Education, 2021b)

The content of these passages is contrary to the consensus within anticolonial and education studies that the best way to induce multi-episteme learning is through learning about difference; as it is put by Jones and Jenkins (2014), "[w]hat I learn is not about you, but I learn from you about *difference*" (p. 15). Instead, these passages point out no cultural contrast, but meld together Indigenous and Western science through inclusion of tokenistic examples taken from various Indigenous (First Nations, Métis, and Inuit) cultures. Further indicating the tokenistic nature of these examples is the lack of contextualizing information surrounding these examples. In some instances, "First Nations, Métis, and Inuit" is the only information given about the origins or cultural context of these examples, and if there is further information, it doesn't go beyond indicating examples that are specifically Inuit or Métis. Specific uses, cultural importance, and historical context is never given.

In many of the passages in this category, a lack of historical situation also leads to the misrepresentation of examples from the past. This is exemplified through a passage from Grade 3:

> Many First Nations, Métis, and Inuit have designed, tested, and continue to use simple machines that decrease effort, which can include
> - antler wedge
> - paddle
> - Inuit scraping tools such as an ulu
> - Métis travois
>
> (Alberta Education, 2021b)

The use of these technological examples, all of which were developed by Indigenous peoples in the distant past, without sufficient historical explanation, “places the thoughts, culture, knowledges, and traditions of Indigenous peoples in the past and makes them seem irrelevant to the current day” (B. Fraser, personal communication, August 9, 2021). Contrasted with progressive portrayals of Western science, it shrinks Indigenous epistemes to a static aspect of history that has - as is strongly implied in the curriculum - been eclipsed by the success of the West. This portrayal, of Western science as a “natural” successor to Indigenous Ways of Knowing is misrepresentative of the historical factors (i.e. colonization and exploitation) at play, and it also paints an image of Indigenous societies today as “backwards” or “primitive,” a wholly false conclusion that perpetuates the legitimization of modern Indigenous science.

In fact, there is violence even at the base level of the “integration” of this tokenistic content into a Western curriculum. Reading through, I was reminded of two of Tuck and Yang’s (2012) settler moves to innocence: settler nativism and adoption fantasies, in which the settler attempts to “become” Indigenous in an attempt to evade colonial responsibility. The use of (any, historical or modern) Indigenous examples to illustrate Western science misrepresents Indigenous science as completely compatible with (although subordinate to or surpassed by) Western science. This implication, that Indigenous science fits into Western science, is grafting not only unacknowledged but violently integrated (Ahenakew, 2016). It suggests that Indigenous societies and settler societies can - or even should - be combined without distinction, which is more accurately described as assimilation of the Indigene. It absolves settlers of colonial responsibility by implying that Indigenous and Western science are completely mutually

compatible and that distinctions can be smoothed away, everything (or everyone) melted together into one. Thus, the settler does not become Indigenous in the manner described by Tuck and Yang (2012), but in a similar way the dissolution of distinctions between the colonizer and the Indigene removes much of the meaning from these titles, and the weight of colonial responsibility is lifted - though the power and privilege dynamics remain (and are indeed further empowered through this obscuring of roles).

Poor/misleading in-context comparisons

This subcategory contains statements made about Indigenous life that are either contradicted or substantially altered in meaning by context found elsewhere in the curriculum. They make up 13 of the statements analyzed, or 19.12%, and are present in Grades 2 to 6, appearing most often in Grades 2 and 4 (4 ea.). They are found in a wide variety of units, including many present in, or contradicted by, information in scientific methods units.

The stated information in many of these passages is altered by directly-preceding information. In these instances, the Western societal norm is stated and then followed up with a statement illustrating how Indigenous societies diverge from this norm. Note these examples, from grades 4 and 5 respectively:

> Most of society follows the Western (Gregorian) calendar in daily life.
> Indigenous peoples traditionally use a lunar calendar to measure time. (Alberta Education, 2021)

> Websites and weather apps improve access to reliable weather information.
> First Nations, Métis, and Inuit communities continue to rely on traditional knowledge to interpret and predict weather patterns. (Alberta Education, 2021)

These statements do not weigh the two calendars or methods of predicting weather equally. In the first passage, “[m]ost of society” centers the Western perspective, affirming its position of power over the Indigenous lunar calendar, which is cast as an outlier. In the second statement the language, “improve access,” “reliable,” and “continue to rely,” also casts the Western method as the favoured and the Indigenous way as a lesser method. These portrayals affirm the preeminent position of the Western perspective in science, placing Indigenous technologies at the (implicitly less-developed) margins.

Additionally, the lack of historical context given ensures erasure of the power dynamics between cultures and their technologies. An alternate framework could educate students about the origins of both Western and Indigenous methods, teach the differences in standpoint that led to the development of different technologies, and also recognize that Western methods dominate because of colonialism and exploitation. Any placement of Indigenous and Western ways side-by-side cannot be understood fully without knowing this historical context. In the above comparisons, the Western-biased language compounds the lack of historical context to ensure the misrepresentation of Indigenous ways and worldviews.

Other comparisons are not side-by-side but contradictions found in other areas of the curriculum. In many instances, a statement is made in favour of Indigenous science, but in a different area there is a clear discontinuity in this sentiment. These appear most often in scientific method units, such as this one from Grade 6:

> Ways to share explanations of natural events include
> - written texts
> - traditional knowledge
> - visual forms
> - verbal presentations
> - stories and legends
>
> (Alberta Education, 2021b)

In this statement, Indigenous science is recognized as legitimate. However, other statements in the unit implicitly contradict it:

> Scientists communicate data, evidence, and explanations to the scientific community through
> - research papers
> - conferences
> - graphs, tables, flow charts, diagrams
> - formulas
> - models
> - maps
>
> (Alberta Education, 2021b)

This second statement lists only Western methods of communicating science, implying that the “scientific community” is solely Western and that traditional knowledge, stories, and legends are not legitimate ways of communicating within a scientific community.

Although multiple epistemes are recognized in the initial statement, this can be recognized as a superficial transplant due to the lack of continuity in the rest of the unit. Inclusive content present in some passages is subverted by other passages that discuss the same topics from a Western standpoint, subtly reasserting exclusivity and rendering inclusive passages outliers from the (Western) norm. This recentering of Western perspectives obscures the validity of Indigenous science by portraying it in an incomplete manner and implying through exclusion that it is not a suitable medium for many aspects of science (i.e. it can be used to "share explanations of natural events" but not to "communicate[5] [...] to the scientific community"). Through this portrayal the supremacy of settler science over Indigenous science is asserted: it is impossible to holistically teach the legitimacy of a variety of epistemes without consistently addressing all epistemes equally.

Analysis: Erasure of Indigenous Ways of Knowing

This category includes subcategories Indigenous sidekicks to Western authorities and violent omission of Indigenous perspectives. In the first subcategory, the portrayal of Indigenous people as "helpers" or "collaborators" to Western powers erases independent Indigenous worldviews through minimization to a subordinate aspect of Western society. In the next subcategory, the omission of Indigenous perspectives is evident when necessary distinctions and power dynamics between Indigenous and Western ways of knowing and being remain unaddressed. In passages that fall into this subcategory, explicit reference to Indigenous lives and Ways of Knowing may or may not be made, but a common lack of discussion of separating aspects leads to erasure in all instances[6]. This category contains a mix of implicit and explicit conclusions from the curriculum.

Indigenous sidekicks to Western authorities

5 passages (7.35%) in Grades 4-6 fit this subcategory, with all examples present in climate and living systems sections of the curriculum. While this was the least frequently-documented subcategory, these passages exemplify some of the clearest

[5] Exclusion of Indigenous methods of communicating science is an underlying theme of the curriculum and a recurrent topic of my analysis; see subsection Policing Scientific Communication
[6] See Appendix B

insights into the curriculum's portrayal of the Indigene-colonizer relationship; these are some of the only passages in which the Indigene-colonizer relations are referred to explicitly. This subcategory is also one of the most uniform, with all of the passages discussing collaboration between Indigenous people and Western authorities. This is illustrated by two passages from this subcategory, the first from Grade 4 and the second from Grade 5:

> Research and discuss how Indigenous communities work alongside Parks Canada to further understand multisystem impacts.
>
> First Nations, Métis, and Inuit can bring long-term observations of climate for local context. (Alberta Education, 2021b)

Once again, the language used in these passages centers the settler perspective by portraying Indigenous communities as outsiders coming into the mainstream to "work alongside" or "bring" their knowledge to the Western authority. This portrayal of Indigenous people as "helpers" or implicitly lesser-than collaborators to Western authorities, results in "inclusion into empire," which Max Liboiron describes, from the viewpoint of the settler, as "bring[ing] you into structures to help you know what we know and that will liberate you" (Smiles, 2021). It's erasure by way of white saviorism, aided by a dash of Western (white) supremacy. Remediation of this erasure necessitates the unsettling of the standpoint presented in the curriculum; power dynamics must be examined closely and presented visibly, along with an exploration of relational history and lasting group dynamics. A crucially important aspect of the historical and continuing Indigene-colonizer relationship is the Western practice of taking what Indigenous land, resources, or knowledge, is deemed valuable to the West and leaving the rest behind. "Collaborative" relationships also follow this pattern, as "two-way sharing" between oppressor and oppressed continues to be a resource relationship, wherein only the oppressor gains insight (there is nothing to be gained by the oppressed through conversation with the oppressor) (Smiles, 2021). The lack of acknowledgement of this dynamic signals implicit approval of settler exploitation.

Violent Omission of Indigenous Perspectives

This subcategory contains 9 passages (13.24%), present in all grades (including

kindergarten) except Grades 2 and 4. This subcategory contains a wide range of passages, with many related to the environment and living systems. However, they all lack a valuable Indigenous perspective that is pertinent to what is being taught, and propagate colonial violence through this refusal to recognize the legitimacy and importance of Indigenous epistemes. Formats vary within this subcategory, but many portray an incomplete or oversimplified image of a concept through exclusion of Indigenous culture, life, and worldviews:

> Human activities that can impact the land in positive and negative ways include
> - living on the land
> - building towns and cities
> - getting and using resources
> - farming
> - pollution
> - stewardship
>
> (Alberta Education, 2021b)

The above passage fails to address the important distinction between Indigenous and Western societies: actions that negatively impact the land (building towns and cities, using resources irresponsibly, and pollution) are disproportionately undertaken by Western societies, and actions beneficial to the land (living on the land, using resources responsibly, stewardship) are undertaken by Indigenous societies. The terminology “human activities” universalizes responsibility for all human impacts on the land, absolving Western society of a proportionate burden of responsibility. And, the use of generalizations and emphasis on similarity is an act of violence on the part of the West as it presents the Western standpoint as the human standpoint. It also produces inaccuracies - pollution is not a “[h]uman activity,” it is primarily a Western one - and obfuscates the way towards cross-cultural scientific progress by implying that all human societies are homogenous in their scientific knowledge, strengths, and weaknesses.

Another way the curriculum perpetuates erasure through omission can be found in the areas that the curriculum focuses or the manner in which knowledge is presented, as demonstrated through this passage from Grade 1:

> Ways that plants and animals or their parts can be used include
> - food
> - clothing

- shelter
- tools
- art
- medicine
- social/emotional connection

(Alberta Education, 2021b)

The emphasis placed on the use of the natural world by humans is a distinctly androcentric, Western perspective that centers around environmental exploitation. The omission of Indigenous perspectives that focus on reciprocity represents not only an incomplete portrayal, but one that implicitly reasserts Western hegemony; as I discussed in the introduction, the inclusion/exclusion process in educational materials is one that is drive by societal values, and statements within this subcategory elucidate the Western values driving that process.

Omissions resulting in erasure of Indigenous Ways of Knowing likely come as a result of an overabundance of Western perspectives in the simplification and inclusion/exclusion processes of the creation of this curriculum. Deference to Indigenous voices offering input to the material, pre- and post-creation, could broaden its scope and minimize violent omission (to undertake this action responsibly means doing it on the terms of the Indigene).

Analysis: Assertion of Western Hegemony

The last category is assertion of Western hegemony, containing subcategories policing scientific communication and Western scientific methods as objective truth. Scientific language is policed through statements of what is (not) proper scientific communication, which privilege Western methods of communicating science. Western scientific methods are presented as absolute truth when they are presented as the only scientific methods that produce valid science. The portrayal of Western methods as uniquely valid leads to the presumption that they must be uniquely accurate, which is not only an inaccuracy but also an assertion of Western power. In this category, conclusions are both implicit and explicit, but many are made abundantly clear through the language used to describe them and the clear interpretive meanings of the content.

Policing Scientific Communication

12 examples of policing scientific communication were identified, making up 17.65% of the total. These were concentrated in Grades 4-6, with the exception of two in Grade 2. Passages in this subcategory are characterized by overt instruction regarding the communication methods that are (and others that implicitly aren't) science. These mostly come from scientific methods units and may dictate how students themselves should communicate science or how the "scientific community" shares science. An example from Grade 4 demonstrates both of these methods of policing communication:

> A common system of measurement and symbols gives the scientific community a way to communicate data and evidence.
>
> Interpret representations of data and evidence that use SI units. (Alberta Education, 2021b)

By indicating that the only valid way for scientists to communicate their data is through the use of Western empirical SI units, the first statement asserts Western hegemony within the scientific community. Implicitly, all other ways of communicating and interpreting science are invalidated - including the primarily qualitative and sensory modes of communication of Indigenous communities (Ahenakew, 2016). And, the second statement tells students that they, too, must develop their skills in Western science communication; that those are the methods worth learning and that interpretations must be in-line with the methods (and, implicity, goals) of the West.

Methods of communicating science shape the perception of what is being communicated; the same evidence or observation can lead to a myriad of different conclusions depending on how it is presented. The science communication methods favoured by different cultures are, like the rest of their scientific frameworks, shaped by cultural values to highlight culturally-important aspects of science and to produce conclusions in line with societal values. Thus, this teaching of the superiority of Western methods is also an indication of the centering of Western perspectives and interests present in this passage.

Additionally, there are ramifications to teaching solely Western methods for students' learning on a personal level. Students are more likely to understand concepts that they are familiar with, and the teaching of distinctly Western methods advantages

Western students. Additionally, students that learn in distinctly non-Western ways in their community may feel pulled in two directions, between the ways of knowing and sharing present in their cultures and the very different Western methods that they are taught at school. For Indigenous students whose at-home learning may be contradicted by school learning, this is likely to be especially pronounced as school learning essentially invalidates methods of learning in the community. In addition to cultural invalidation, this may lead to a lack of understanding of school science, and in the long term, lower levels of attrition in STEM fields for non-Western students.

Allowing student choice in terms of methods of communicating science would allow students to employ methods that they understand fully and that are consistent with their cultures, removing confusing home-school dichotomies and limiting privilege of Western students in science classes, while also fostering an atmosphere in which more students feel equipped to enter into science and challenge Western norms of communicating science in the long term.

Western Scientific Methods as Objective Truth

29.41% of the total, or 20 passages fit into this subcategory, making it the most broadly represented in the curriculum. These passages were present in all grades except kindergarten, and were most prevalent in Grades 2 (4) and 4 (6). They were overwhelmingly represented in scientific methods units, with outliers coming from computer science and living systems units. These statements generally address what science is, what its goals are, and how it is done in a manner that frames Western science and its values of objectivity, empiricism, and determinism as free from cultural influence. This is exemplified through a passage from Grade 3:

> Scientific attitudes and values are based on objectivity and include accuracy in recording data and honesty in communicating data.
>
> Objectivity in science is an attempt to learn about the world using methods that remove the influence of personal thoughts, feelings, and expectations. (Alberta Education, 2021b)

This passage and most others in this subcategory frame Western science as the only valid scientific method by universalizing objectivity and empirical methods, thereby obscuring their Western value-based origins. When the definition of science is defined

so narrowly so as to include only Western methods, science is by definition solely Western, and the methods of the West no longer “Western science” but simply “science.” The hegemony of Western science does not, however, remove its local origins; it remains firmly rooted in the interests and goals of the West. Gatekeeping what science is (and isn’t) so as to maintain Western hegemony is therefore a continuing form of colonialism; it forces the global scientific community to adopt Western methods in order to gain recognition as legitimate practitioners of science, ensuring the ongoing global presence of Western interests, practices, and ultimately Western power.

In addition to the definition of science as Western, the perpetuation of Western scientific hegemony is perpetuated in this passage through the statement that Western science is objective and therefore free of “personal thoughts, feelings, and expectations.” This distancing from culturally-ingrained personal values encourages complacency with regards to scientific standpoints and the hegemonic nature of Western science; if science is purportedly unbiased, how could it be culturally influenced? Thus, critical thinking with regards to scientific methods falls to the wayside, protecting the dominance of Western methods and the ubiquity of Western interests.

It’s a confounding paradox, that science on the surface level is built on critical thinking but this manner of science education stifles it. To open the definition of science to critical examination by students would allow them to consider how Western hegemony was constructed, where it falls short, and ultimately what can be done to disrupt it.

Discussion

My analysis of the draft K-6 Alberta science curriculum continuously reminded me of the colonial ethos of extraction: taking what is deemed to be “of value” to the settler and leaving the rest. In this case, it may be more aptly described as taking only what can be made “innocent” from Indigenous cultures; what can be presented without disrupting Western hegemony, or what can be (mis)represented in such a way that supports Western dominance. Material is presented as innocent through oversimplification, removal from context, and lack of acknowledgement of missing

pieces; it is fragmented and stripped down until it can be succinctly enveloped into the blanket of Western hegemony, packaged within it but never challenging it.

As Tuck and Yang (2012) describe, the ethos of incommensurability guides moves that unsettle innocence. Indigenous knowledge cannot be faithfully "integrated" into Western frameworks as it is into this curriculum; to attempt to reconcile the two ways of seeing the world is to lose necessary power and privilege dynamics, differences in communication methods, and methods of pursuing knowledge, ultimately resettling knowledge. The resettling of scientific knowledge is all too evident in this curriculum; passages from category three, assertion of Western hegemony, create the framework for assimilation of Indigenous Ways of Knowing, which is accomplished by passages in categories 1 and 2, which remove all that is incommensurable by way of misrepresentation and erasure, resettling science through portrayal of only the "innocent."

Ultimately, a settled framework for science education cannot faithfully portray Western or Indigenous ways of knowing. Disruption of Western hegemony requires that necessary distinctions between Indigenous and Western sciences be explored within cultural and historical contexts that reveal the interplay of power, privilege, colonialism, and exploitation within science. What is meant to appear as "innocent" at first glance is decidedly not so; at its core is violence rooted in the perpetuation of ignorance to the aforementioned factors that continues the cycle of epistemological oppression of Indigenous Ways of Knowing at the hands of the West.

Conclusion

The portrayal of Indigenous epistemes in the Alberta draft K-6 science curriculum is tokenistic, misleading, and underdeveloped. Indigenous Ways of Knowing are consistently made to be lesser than Western epistemes, through which Western hegemony is asserted and perpetuated. Because of the poor manner in which Indigenous Ways of Knowing and their relation to Western science is presented, it is my conclusion that the material in the draft curriculum is not of the quality necessary for teachers drawing from it to adequately fulfill the requirements of TQS section 5. The curriculum does not, as mandated by TQS section 5, "accurately reflect and

demonstrate the strength and diversity" of Canada's Indigenous population; it is misrepresentative and minimizing. Additionally, the knowledge present in the curriculum cannot be applied "for the benefit of all students," as by its very nature it privileges Western perspectives and therefore places Western students in a place of power and privilege. In the long-term, this power dynamic is damaging to all students as it maintains the homogenous, single-perspective paradigm that hampers cross-cultural scientific progress. Thus, the curriculum requires modification in accordance with Indigenous perspectives, feminist standpoint theory and anticolonialism before it can be employed in a manner that fulfils the requirements of TQS section 5.

The patterns reflected in this paper are very likely not limited to this curriculum. Movements to "Indigenize" school science are widespread across Canada, and many school authorities are attempting to alter their materials in response. Further research is required into different curricular materials in different places in order to gain a fuller picture of the epistemological state of curricula across Canada. More focused educational examinations using different critical lenses (e.g. queer and disabled viewpoints) and intersectional viewpoints may also reveal new findings. And, research into other materials (e.g. textbooks, videos, resource banks) may offer new insights into portrayals of epistemological relations across educational resources.

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Appendix A
Quantitative Results

Category	Subcategory	Kinderg-arten	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Total	Percentage
Misrepresent-ations of Indigenous life	Facts out-of-context about Indigenous ways of life	1	1	2	2	0	2	1	9	**13.24%**
	Poor/misleadin g in-context comparisons	0	0	4	2	4	2	1	13	**19.12%**
Erasure of Indigenous Ways of Knowing	Indigenous sidekicks to Western authorities	0	0	0	0	1	1	3	5	**7.35%**
	Violent omission of Indigenous perspectives	1	2	0	2	0	1	3	9	**13.24%**
Assertion of Western Hegemony	Policing scientific communication	0	0	2	0	2	4	4	12	**17.65%**
	Western scientific methods as objective truth	0	2	4	2	6	3	3	20	**29.41%**
	Total	2	5	12	8	13	13	15	**68**	**100%**

Appendix B
Passages Chosen for Analysis

<table>
<tr><td colspan="2">Facts out-of-context</td></tr>
<tr><td>Kindergarten</td><td>Grade 1</td></tr>
<tr><td>Ways First Nations, Métis, and Inuit communities connect with nature can include
hunting
gathering
trapping
fishing
ceremonies
cultural traditions</td><td>The responsibility to care for the environment is fulfilled by showing respect for and protecting all aspects of nature.

The sense of responsibility of many First Nations, Métis, and Inuit can be connected to place, traditional knowledge, and practices for future generations.</td></tr>
<tr><td colspan="2">Grade 2</td></tr>
<tr><td>Some First Nations, Métis, and Inuit have perspectives that consider plants and animals to be equal to human beings.</td><td>Objects created from natural materials by First Nations, Métis, and Inuit can include
Dene birchbark baskets
Métis travois
canoes
Inuit scraping tools such as an ulu</td></tr>
<tr><td colspan="2">Grade 3</td></tr>
<tr><td>Many First Nations, Métis, and Inuit have designed, tested, and continue to use simple machines that decrease effort, which can include
antler wedge
paddle
Inuit scraping tools such as an ulu
Métis travois</td><td>Changes to Earth’s surface can be shared by First Nations, Métis, and Inuit through
stories
traditional knowledge
language</td></tr>
<tr><td colspan="2">Grade 5</td></tr>
<tr><td>For First Nations, Métis, and Inuit, significant events and ways of living are connected to many astronomical phenomena.</td><td>Traditional technologies developed by diverse cultures that reflect understanding of forces of flight include
atlatl
bow and arrow
slingshot
catapult</td></tr>
<tr><td colspan="2">Grade 6</td></tr>
<tr><td colspan="2">Certain plants, such as sage, sweetgrass, cedar, and tobacco, are considered sacred to First Nations and Métis.</td></tr>
</table>

<table>
<tr><td colspan="2">The offering of tobacco signifies
● relationships with the plant
● giving back to the land
● respect for the plant
● a sustainable relationship
Plants play an essential role in an ecosystem.
Plants are used to meet human needs.</td></tr>
<tr><td colspan="2">Poor/Misleading In Context Comparisons</td></tr>
<tr><td colspan="2">Grade 2</td></tr>
<tr><td>First Nations, Métis, and Inuit use of materials is informed by
● traditional knowledge
● time of year
● availability of materials
● practices of sustainability

[notable due to lack of comparison to Western material use]</td><td>In Stoney language, Calgary is Wichispa Oyande, which translated means “elbow town.”

In Cree language, Edmonton is amiskwaciy-wâskahikan, which translated means “beaver hill house.”</td></tr>
<tr><td>Names of places and landforms in an environment can lead to feelings of connection. Identify local landforms and bodies of water in local Indigenous language.

[notable due to appearance following section policing language used to describe natural structures; historical context should also be taught]</td><td>Some First Nations, Métis, and Inuit practise taking only what is needed from the land, which can demonstrate care and consideration for the land and those around us.

[notable due to tense change “they” to “us” and lack of comparison to Western practices]</td></tr>
<tr><td colspan="2">Grade 3</td></tr>
<tr><td>Use of materials for First Nations, Métis, and Inuit traditional knowledge is guided by balance and harmony with the land.

[notable because of missed comparison with Western methods]</td><td>Sources of information or data can include
● experts
● text
● personal observations
● websites
● Elders
● community members
Some sources of information are more trustworthy than others.

[notable because of contradictions elsewhere]</td></tr>
<tr><td colspan="2">Grade 4</td></tr>
<tr><td>First Nations, Métis, and Inuit hold understandings of the interconnectedness of all living things.</td><td>Most of society follows the Western (Gregorian) calendar in daily life.
Indigenous peoples traditionally use a lunar calendar to measure time.</td></tr>
</table>

<table>
<tr><td>[notable due to lack of mention in climate unit]</td><td></td></tr>
<tr><td>For many First Nations, Métis, and Inuit, water is sacred, as it sustains life.

First Nations, Métis, and Inuit hold a sense of responsibility to protect water and sources of water.

Discuss the importance of water to First Nations, Métis, and Inuit and how it sustains life.

[notable due to lack of comparison with Western practices]</td><td>Ways to share scientific evidence include
● written texts
● verbal presentations
● oral traditions
● graphs
● tables
● charts
● diagrams
● simulations
● models
[notable because of passages excluding Indigenous methods elsewhere]</td></tr>
<tr><td colspan="2">Grade 5</td></tr>
<tr><td>Websites and weather apps improve access to reliable weather information.

First Nations, Métis, and Inuit communities continue to rely on traditional knowledge to interpret and predict weather patterns.</td><td>First Nations, Métis, and Inuit practise sustainable harvesting and protocols.

[notable because there is no mention of Indigenous practices in the climate unit]</td></tr>
<tr><td colspan="2">Grade 6</td></tr>
<tr><td colspan="2">Ways to share explanations of natural events include
● written texts
● traditional knowledge
● visual forms
● verbal presentations
● stories and legends

[notable because of contradictory statements in the scientific unit]</td></tr>
<tr><td colspan="2">Indigenous Sidekicks to Western Authorities</td></tr>
<tr><td>Grade 4</td><td>Grade 5</td></tr>
<tr><td>Research and discuss how Indigenous communities work alongside Parks Canada to further understand multisystem impacts.</td><td>First Nations, Métis, and Inuit can bring long-term observations of climate for local context.</td></tr>
<tr><td colspan="2">Grade 6</td></tr>
<tr><td>Climate change programs continue to foster relations between Indigenous and northern communities to work alongside the government.</td><td>Collaboration between scientists and traditional Knowledge Keepers provides a broader</td></tr>
</table>

	understanding of the effects of weather on people and the environment.
Propose ideas on how local traditional Knowledge Keepers and the scientific community can collaborate to support understanding of local climate and climate change.	
Violent Omission of Indigenous Perspectives	
Kindergarten	Grade 1
Ways to protect the environment include ● reducing waste ● reusing ● recycling ● not littering	Ways that plants and animals or their parts can be used include ● food ● clothing ● shelter ● tools ● art ● medicine ● social/emotional connection
	Investigation includes safety and respect toward ● people ● plants ● animals ● environment Investigation requires safety and respect. Demonstrate safety and respect during investigations.
Grade 3	
Human activities that can impact the land in positive and negative ways include ● living on the land ● building towns and cities ● getting and using resources ● farming ● pollution ● stewardship	Actions that can be taken to protect plants and animals in the local environment include ● respectfully interacting with natural environments ● minimizing disturbance to plants and animals ● being aware of animal crossings ● following fishing and hunting regulations ● counting and tracking populations
Grade 5	Grade 6
Scientific ethics include honesty, openness, respect, fairness, and accountability. Ethics includes minimizing harm to animals, protecting human participants, and informing human participants of any potential risks.	Identify the scientific and economic reasons why fossil fuels, including oil and natural gas, are currently the principal energy resources used in Alberta.

	Discuss the scientific, environmental, and economic considerations around energy distribution and use in the province of Alberta.
	Responsible management of energy resources can include ● minimal disruption of the natural environment ● restoration of areas ● waste management practices
	Traditional ways of living off the land and hunting and gathering practices of First Nations, Métis, and Inuit communities have been impacted by climate change.
Policing Scientific Communication	
Grade 2	
Landforms in Alberta include ● plateaus ● plains ● mountains ● valleys ● hills ● foothills ● canyons ● prairies Apply appropriate vocabulary when describing landforms.	Precise instructions can include ● verbs ● simple language ● clear steps ● a starting point ● a stopping point Describe instructions using precise words, pictures, or diagrams.
Grade 4	
Represent data in graphs, tables, charts, diagrams, simulations, or models.	A common system of measurement and symbols gives the scientific community a way to communicate data and evidence. Interpret representations of data and evidence that use SI units.
Grade 5	
Determine if evidence meets the scientific requirement of describing observable and measurable phenomena.	Choose appropriate measurement methods to record data accurately and honestly.
Defend a conclusion about cause and effect based on evidence gathered in a simple controlled experiment.	Clear, accurate, and honest communication of evidence must ● use correct vocabulary ● include all relevant data ● be free from personal bias ● be understood by the intended audience

Grade 6	
Scientific explanations make sense of natural phenomena by identifying relationships between natural phenomena, including cause and effect.	Compare and contrast multiple forms of text that offer explanations of natural events and phenomena.
Scientists communicate data, evidence, and explanations to the scientific community through ● research papers ● conferences ● graphs, tables, flow charts, diagrams ● formulas ● models ● maps	Background knowledge important to understanding explanations could include scientific vocabulary, methods, concepts, and ideas.
Western Scientific Methods as Objective Truth	
Grade 1	
Tools used to examine properties of objects and materials can include balance scales and magnifying glasses.	Scientists perform investigations to answer questions. Investigation can involve ● asking a question ● making predictions about what the answer will be ● gathering information ● forming conclusions
Grade 2	
Knowledge of the properties of materials and their purpose is important in many occupations, including ● carpenter ● builder ● tailor ● engineer ● designer ● architect	Being objective means not being influenced by personal thoughts, feelings, or expectations. Techniques that scientists use to remain objective can include ● recording accurate observations ● choosing appropriate tools ● carefully measuring ● basing conclusions on facts and data
Procedures scientists use to guide investigations can include ● asking questions ● making predictions ● planning the investigation ● observing and recording data ● analyzing data ● reaching conclusions ● discussing observations and conclusions	Creative scientific processes can include ● asking questions ● connecting to scientific knowledge ● planning ways to problem solve ● designing ● inventing ● trial and error

<table>
<tr><td colspan="2">Grade 3</td></tr>
<tr><td>Scientific attitudes and values are based on objectivity and include accuracy in recording data and honesty in communicating data.

Objectivity in science is an attempt to learn about the world using methods that remove the influence of personal thoughts, feelings, and expectations.</td><td>Observations and results from investigations can be analyzed by
● making connections to previous knowledge
● asking questions
● noticing changes that happen
● discussion
● collaboration
Observations and results from investigations should be analyzed to confirm accuracy and build knowledge.</td></tr>
<tr><td colspan="2">Grade 4</td></tr>
<tr><td>How are organisms designed for survival?</td><td>Ongoing collection of evidence allows the scientific community to attach new learning to what was previously understood.</td></tr>
<tr><td>Ways to classify organisms can include [...]</td><td>Accurate evidence requires the careful use of measuring tools and technology.</td></tr>
<tr><td>Evidence is reliable and valid if objectivity was maintained during data collection and analysis through
● gathering enough data
● performing enough trials
● using appropriate procedures and tools
● recording and representing data accurately
Data gathered during an experimental investigation is used as evidence to determine cause and effect.</td><td></td></tr>
<tr><td>Grade 5</td><td>Grade 6</td></tr>
<tr><td>Scientific methods attempt to remove bias to ensure objectivity.

Science requires evidence and conclusions to be free from bias.

Determine if evidence and conclusions are free from bias.
Choose investigational methods that remove the potential for human biases.</td><td>Abstraction includes
● determining what to keep and what to ignore
● removing unnecessary detail
● identifying important information
● generalizing patterns</td></tr>
<tr><td>Scientific evidence can be collected using controlled experiments to determine cause and effect.</td><td>Scientific explanations make sense of natural phenomena by identifying relationships between natural phenomena, including cause and effect.

Use evidence to evaluate explanations of cause and effect related to natural phenomena.</td></tr>
</table>

Clear, accurate, and honest communication of evidence must ● use correct vocabulary ● include all relevant data ● be free from personal bias ● be understood by the intended audience Identify examples of inaccurate or unclear communication of evidence and evaluate the potential impact.	Only scientific experiments performed with objectivity and a high level of accuracy produce trustworthy evidence to support explanations.