



# Myths and matters of science education: a critical discourse on science and standards

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## Abstract

In this forum paper, I grapple with critical questions about our understanding of science as a discipline and the education standards formulated within that framing. My exploration is contextualized in our current socio-political climate and is presented in discourse with Charity Winburn's *Meeting the needs of the individual student in the post-pandemic era: an analysis of the next generation science standards*. I draw on Winburn's astute observations about the narratives and epistemologies that shape our current science standards as a springboard for diving deeper into questions about the ways of knowing and types of knowledge traditions that are uplifted in US science education. Through a dialogic process, I outline a critical analysis of the myth of neutrality, the prioritization of epistemologies, and the standardization of learning ingrained in traditional science curricula. I conclude by building on Winburn's hopes for science education with my own aspirations for bringing joy into our collective science learning experiences.

**Keywords** Science · Pandemic · Neutrality · Epistemology · Critical analysis

At the height of the COVID-19 pandemic, when many of us were struggling to make sense of the devastation laid bare in the wake of a virulent virus, author and political activist Arundhati Roy (2020) shared words of wisdom to help us grapple with the significance of that moment in time.

“[The pandemic] is a portal, a gateway between one world and the next. We can choose to walk through it, dragging the carcasses of our prejudice and hatred, our avarice, our data banks and dead ideas, our dead rivers and smoky skies behind us. Or we can walk through lightly, with little luggage, ready to imagine another world. And ready to fight for it.” ~ Arundhati Roy (2020)

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The pandemic was a stark reminder of how vulnerable we all are to illness and also clearly demonstrated that the fates of our fellow people across the globe are tied to our own. Roy (2020) urged us to respond to our shared grief and fear by embracing different ways of being, in harmony with each other and our environment. However, what emerged during the last three years within the US socio-political context seems far from harmonious. Sandro Galea and Salma Abdalla (2020) describe the multiple crises we concurrently experienced in addition to the COVID-19 pandemic, namely the widespread unemployment and civil unrest. Not only were we wrestling with significant anxiety about our health, we were also contending with the deep fissures in our society across race, class, and gender most notably and also across other intersections of our identities. Consequently, instead of viewing each other as connected, we grew increasingly suspicious of one another. Instead of confronting injustices in our society, we doubled down on false narratives to protect the myths of meritocracy and US exceptionalism. Instead of banding together with others around the world, we dug deeper boundaries to separate the “us” from the “them.” This fractured landscape eventually etched all fabrics of our society, and was prominently displayed within the sphere of education, which was targeted as both the cause and solution of our broader problems. There is historical precedent to this scapegoating of education; as Adam Laats describes, “At moments when American culture has taken some progressive turn, conservatives have consistently blamed a single culprit for indoctrinating vulnerable youth with radical ideas: public schools” (Talbot 2021). Our most recent experience with this backlash was epitomized in school board meetings, which became spectacles of great theater, animating the ideological as intellectual, the hysterical as logical, and the prejudicial as moral. This is the atmosphere in which our students enter school today and are expected to learn—amidst the lingering turmoil from a global pandemic, deep-rooted injustices, and increasing gun violence. My examination of the scientific discipline and science standards is contextualized within the backdrop of this present-day, tumultuous educational experience. I build my analysis for this forum article in dialogue with Charity Winburn’s paper entitled: *Meeting the needs of the individual student in the post-pandemic era: an analysis of the next generation science standards*.

Arundhati Roy (2020) offered us clarity in a time of chaotic disorientation, courage in a time of mass hysteria, and, perhaps most notably, hope in a time of catastrophic despair. Surrounded by the ruins of the pandemic, she imagined what could be built for more hopeful, future possibilities. Hope is a powerful analgesic in moments of strife; at times it is all we have to cling to. Charity Winburn (2023) remembers a form of hope that sprung from that same well of viral destruction—that is, the hope we placed in science during the COVID-19 pandemic. She examined the pandemic’s impact on student motivation to engage with science, noting that current Next Generation Science Standards (NGSS) fall short of accounting for the socio-cultural climate and individual students’ needs in a post-pandemic world. Applying a framework based on self-determination theory, she identified key components of scientific standards that are currently missing in the NGSS. Winburn (2023) argued that in order for us to fully realize the hope of science through K-12 education, we need to adapt the NGSS to: (1) allow for multiple paths toward achieving learning goals; (2) value diverse learners through individualized assessments; and (3) include more voices (including students’) in shaping the standards themselves. I extend Winburn’s (2023) discussion by exploring science education from a broader vantage point, through Roy’s (2020) socio-political framework for contextualizing the pandemic.

Roy (2020) employs the imagery of a space-time portal as an analytic tool to interrogate the ways our past has shaped our present-day conditions, and how our choices of today can lead to possibilities for our futures. This process serves to dispel myths and delusions,

unveil entrenched systemic inequities, and raise critical questions about our shared humanity. I utilize Roy's approach to examine the historical, contemporary, and prospective dimensions of science as a disciplinary practice. My dialogic inquiry offers critical insights about the scientific canon in order to unveil possibilities for more just and equitable science education futures. More specifically, I look beyond the post-pandemic timeline to examine the ways science and science pedagogy have historically upheld and continue to perpetuate, dominant knowledge traditions and ways of knowing. Confronting and addressing inequities in science education will impact all students, and our society, more broadly. My hope is to elucidate that contextualizing learning can help us develop a foundation of science education that better supports students to navigate challenges and excavate possibilities in our evolving world. My critical analysis encompasses three key themes, which I outline as the core contributions of this forum paper: (1) the myth of neutrality implicated in the science discipline; (2) the prioritization of epistemologies in science canon; and (3) the standardization of learning ingrained in traditional science curricula. In the following sections I delve into each of these core concepts, and conclude on a note of hope, as conceptualized by both Roy (2020) and Winburn (2023), imagining possibilities for justice and joy in science.

## The myth of neutrality implicated in the science discipline

The scientific discipline is predominantly viewed as rational, objective, and ideologically neutral. However, science does not take place in a social vacuum. Historically, we have witnessed many atrocities conducted with the support of science, including eugenics doctrines (Kevles 1999), the Tuskegee experiments (Fairchild and Bayer 1999), and the creation (and eventual detonation) of the atomic bomb (Hughes 2003). The dominant narratives of the times shaped the lenses through which each of those scientific explorations took place. This is exemplified by the dynamics of race, ethnicity and imperialism implicated in the aforementioned examples. In the wake of such abuses, maintaining that science is a neutral discipline seems, at a minimum, misguided and simplistic. The allures of neutrality are the presumed trustworthiness that objectivity and logic inspire, along with the implied nonpartisanship of not taking any one political or values-based stance. Many philosophical debates about scientific neutrality center on its dichotomous aspects (*e.g.*, objective vs. subjective), but these are not mutually exclusive stations. As Edward Rykiel Jr. (2001) posits, "Scientists can be guided by the standard of objectivity even if absolute objectivity is unattainable... However, they bear a special responsibility to make a distinction between scientific statements and the values they associate with those statements" (p. 435). So, science could perhaps adopt a form of subjective objectivity and, more critically, must explicitly confront the socio-political context of scientific exploration.

Neutrality within an inequitable and unjust society simply perpetuates the status quo by refusing to acknowledge disparity and by allowing dominant narratives to flourish. Winburn (2023) recognizes consequences of an uncritical adherence to the myth of scientific neutrality as they appear in education science standards. She notes the work of Alberto Rodriguez (2015), Matthew Weinstein (2017), and Ian Hardy and Todd Campbell (2020) in articulating that "Through a discourse of politeness, the standards and their supporting documents rarely mention an explicit stance on diversity and equity,... [including] conversations associated with power in society as it relates to science... Instead, proponents of NGSS focus on the content and classroom level implementation of the standards without

analyzing the socio-cultural climate in which they are implemented.” (pp. 14 & 7). Such a decontextualized approach to science learning, Winburn (2023) argues, will maintain barriers to entry into science for students with identities on the margins of socio-political power. If history is our guide, we might predict how the lack of diverse voices in the field of science could continue to produce a legacy of harmful practices. Demystifying the myth of neutrality in science can help us engage in richer discourse about science and embrace the complexity of scientific exploration as interconnected and interdependent human beings.

In our current social climate, recognizing fact from fiction and trusting in shared truths has become exceedingly challenging with numerous seeds of doubt sown through online misinformation (Rodríguez-Ferrándiz 2023). The confusion and emotions embroiled in the COVID-19 pandemic along with the isolation we all experienced, exacerbated the mistrust in information, especially scientific data. As a society, we were not equipped to contend with the unknown. We did not have the patience and fortitude to live with uncertainty. Additionally, the pandemic unveiled already existing disparities and made them more visible to us all. As Roy (2020) noted, “The lockdown worked like a chemical experiment that suddenly illuminated hidden things.” We were unprepared to confront uncomfortable truths as a society. Within this context, the neutrality of science did not assuage our anxieties nor inspire confidence. An apolitical, dispassionate stance in any discipline seemed even more unfathomable in this atmosphere. Students today are grappling with these complex issues as well as school safety concerns, all while trying to make sense of learning. Winburn (2023) cites Thomas Chiu (2022) in identifying that students “...need flexibility and adaptability in their educational systems to consider cultural, socioeconomic status, accessibility, and technological skills” (p. 6). This moment calls on us to reconsider neutrality in the contextual framing of science, so we might better prepare the next generation to be more discerning in wrestling with uncertainty and the unknown, with a healthy curiosity and a robust understanding of the socio-political environment they live in.

## The prioritization of epistemologies in science canon

Along with neutrality, most prominent science is grounded in a specific approach to research and inquiry. Winburn (2023) notes, “The standards tend to focus on specific versions of scientific thought and have a large emphasis on certain types of scientific reasoning over others, continuously supporting the idea that there is an acceptable way to think scientifically and do science” (p. 15). Historically, the “acceptable” scientific method has been grounded in Eurocentric knowledge traditions, which are still foundational to the science canon across education. Monica Miles and ReAnna Roby (2022) identify the role of a supposed race-neutral color-blindness implicated in the dominant curricular framing for science education. Once again, we encounter the illusion of fairness professed through an approach that essentially dismisses or refuses to engage with issues of identity and power in scientific discourse. Consequently, we find that science education, as well as other disciplinary standards, prioritizes epistemologies rooted in Western or European cultures, while devaluing or overlooking other knowledge traditions. As Winburn (2023) articulates, “The practice of displaying only one type of scientific thought is problematic for the standard’s impact... They are actively working against their commitment to historically disadvantaged populations by implicitly assimilating all children to the dominant scientific culture at hand” (pp. 16–17). Assimilation stems from an implicit belief that there is a “correct” way to think and act, which is often framed in ways that conflict with non-dominant cultural

and racial identities; thus, the dominant is equated with being “right” while the non-dominant is deemed “wrong.” These discriminatory logics also feed into schools’ behavioral policies that disproportionately penalize Black and Brown students (Miles and Roby 2022). Cumulatively, such education policies and standards work to ostracize students from marginalized backgrounds through an essential erasure of epistemologies and representations from their social and cultural heritages.

In addition to disengaging students from non-dominant backgrounds, which furthers narratives of performance gaps, the prioritization of Eurocentric epistemologies in science also diminishes the richness of scientific discourse. What ideas, perspectives and conversations are we missing out on by focusing on one approach to “doing science”? Whose contributions to science are we ignorant of in the dominant historical account? How are our perceptions of the world hampered through a narrow epistemological lens? These are questions we should grapple with in critically examining the foundations of science education. Bryan Brayboy and Emma Maughan (2009) offer us insights about how scientific exploration might be enhanced through engagement with indigenous knowledge traditions. In their *Story of the Bean*, they outline the ways indigenous wisdom about and in connection to the land enhanced the collective understanding of how plants grow and are related to our lives. Ikehukwu Kanu (2018) draws on Igwebuiké philosophy from the Igbo peoples to engage in more expansive and interdisciplinary discourse in science, with the recognition that scientific knowledge is not superior to learnings from any other field of study. Miles and Roby (2022) discuss possibilities for intentionally drawing on Black knowledge traditions and more accurately representing Black contributions to science, as pathways to enhance student engagement and humanize the discipline. These varied approaches all point to opportunities for us to view science in more expansive and interconnected ways and bring students into the discussion as knowledge holders themselves, collectively struggling to make sense of an increasingly incomprehensible world. We need to provide “students with space to grapple with unanswered questions that do not [necessarily] conform to a previously devised right or wrong way of problem-solving..., because there is no evidence to suggest that problems of the future do not need new ways to solve them” (Winburn 2023, p. 9). This was true long before the COVID-19 pandemic, but is ever more critical in our current climate of distrust, hateful rhetoric, violence and ever-widening inequity. Together, we need to address what Roy (2020) described as a tragedy that is “the wreckage of a train that has been careening down the tracks for years.”

## The standardization of learning ingrained in traditional science curricula

“While standards are meant to be seen as guides, most states that have adopted the NGSS use the standards as a perfect goal, which imperfect beings and environments must attain to be deemed proficient in science” (Winburn 2023, pp. 11–12). Here, Winburn (2023) is describing the unreasonable and illogical foundation of science education standards, which are tied to both neutrality and epistemological prioritization and promote a dominant framing of scientific study. Standardization is widely seen as a tool for building accountability into our system of education. However, the context of such accountability is defined by punitive measures that reward compliance while punishing deviance. When these benchmarks are created in a decontextualized, purely academic vacuum with just the voices of a few who are deemed “expert” by these same measures, what results is a relatively

disconnected set of rules for learning. In relation to science standards specifically, Winburn (2023) explains that “The NGSS Diversity and Equity team, while experienced with students with diverse needs, were not of diverse backgrounds themselves. To create policy that is relevant to and supports the relatedness needs of diverse populations of students, voices of diverse populations should be intentionally included from the development phase of the policy” (p. 13). Moreover, the costs of an indiscriminately applied standardization of learning are significant, particularly to those with identities that are not represented, nor accounted for, in its inception. As Linda McNeil (2000) articulates, “The sound bites that seduce policymakers always emphasize claims of benefits, not the actual costs... The costs are great: a decline in the quality of what is taught and a new form of discrimination in the education of poor and minority kids. But perhaps the worst effect is the silencing of two voices most important in understanding the real effects of standardization: the teachers and the children” (pp. xxi-xxii). In the broader context of knowledge creation and acknowledgment, we are forming subclasses of populations whose input and wisdom is completely diminished based on narrowly defined parameters of intellect. During the height of the COVID-19 pandemic, we witnessed what Roy (2020) describes as masses of human beings who will be largely discounted, both literally and figuratively: “People will fall sick and die at home. We may never know their stories. They may not even become statistics.” Ultimately, the cost of standardizing knowledge is our collective loss of the voices that can teach us the most about what it means to be human.

Learning does not take place in a linear nor predetermined timeline. As Winburn (2023) argues, the needs of individual students vary significantly based on their backgrounds and locations in life. Achieving a prescribed level of competence over a wide range of subjects and subtopics is a challenging task for anyone, yet, we hold our children (and their teachers) accountable to accomplishing this within a very delineated and rigid timeframe. Confining all these diverse learners to one standard is a disservice to them and also deprives us, as a society, of the opportunity to engage in different forms of learning and sense-making. The COVID-19 pandemic inspired renewed (but not new) rhetoric about students’ learning loss and achievement gaps. Leigh Patel (2022) deconstructed the underlying sentiment of these claims: “Who is catching up? Who is behind? This preoccupation with timely learning is long-standing. Largely measured by standardized tests that have been researched and proven to be based in eugenics, a pseudoscience created to perpetuate racism, and that continually reinstate white supremacy, test scores and report cards are distractions from learning.” The deficit framing of student learning is so familiar to us that we can only “see” loss and cannot fully appreciate the depth of wisdom our students bring to the world. Standardization then emerges as antithetical to self-determination theory, upon which Winburn (2023) centers her analysis. She identifies competence, autonomy, and relatedness as keys to student learning motivation and outlines ways the NGSS might be reformed to account for these measures. However, as Winburn (2023) also notes, in the absence of any critical exploration of identity, power, and socio-political dynamics, standards alone are relatively meaningless in addressing education inequity. In order to usher in more liberatory forms of education accountability for our students, educators, and society, we need to learn from and through history, explore and value multiple knowledge traditions, and complicate our preconceptions of value-neutral scientific proficiency.

## Conclusions

Scientific discourse has shaped many of the broadly held truths in society, from accepting that the Earth is spherical to believing that our brains control most of our bodily functions. Yet, science is not flawless nor conclusive. Scientific theories often change over time and evolve as new information and insights become available. As the University of California, Berkeley (n.d.) describes, “Science is continually refining and expanding our knowledge of the universe, and as it does, it leads to new questions for future investigation. Science will never be *finished*.” So, science, like scholarship, is fundamentally about living in the questions and pursuing knowledge and truths. Therein lie the hopes of scientific exploration. I believe we will find authentic learning joy when we are free to move at our own pace, engage with who we are and our social context as part of our education, and connect with multiple knowledge traditions and perspectives to grow and deepen our thinking.

Winburn (2023) focused her inquiry of hope on the motivational needs of students in a world forever changed by the COVID-19 pandemic: “What does the post-pandemic student need to be motivated by the hope that comes with science education? The answer could be their perceptions of their abilities to make their own scientific decisions about the world, to feel confident about their understanding of science, and to relate science to their personhood and larger social context” (p. 17). I offer that these needs, while perhaps more identifiably pertinent today, have always existed in education. Most notably, those students whose intersections of identity are completely disconnected from curricular content have long been excluded and devalued as scholarly contributors to our society. Within our current volatile and hostile cultural atmosphere that has once again resorted to draconian measures of banning books and erasing non-dominant voices in education (Harris and Alter 2022), we must stay grounded in our purpose and curiosity. Why do we pursue learning? Why do we teach? Who do education standards truly serve? What does it mean to engage in authentic scientific exploration? Following our questions to uncover new possibilities and inquiries must be a part of the building blocks of a more joyful and hopeful educational experience. In heeding Roy’s (2020) wisdom to view the pandemic as a teacher, we must be courageous and risk being deemed “outcasts” as Alice Walker (2011) describes in her poem “Be Nobody’s Darling,” so that we might realize our potential as a collective society. “In the midst of this terrible despair, [the pandemic] offers us a chance to rethink the doomsday machine we have built for ourselves” (Roy 2020). Let’s take that chance and run toward our liberatory futures.

*But be nobody’s darling;  
Be an outcast.  
Qualified to live  
Among your dead.  
~ Alice Walker.*

**Author contributions** This piece was completed by the sole author, B.D.

## Declarations

**Competing interests** The authors declare no competing interests.

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