Aims of Science Education in Light of Ideological Resistance and Epistemic Dissensus

Anjan Chakravartty University of Miami

Abstract

Science education, like most education, has multiple aims: instilling an appreciation for and an understanding of the subject matter; developing skills of thinking and analysis; and so on. Science education in particular seems especially contentious, though, regarding *epistemic* aims: the sciences are both commonly associated with matters of fact, and viewed with significant skepticism. Some of the latter stems from cultural phenomena including group identity commitments, inculcated by authority figures and communities that are antipathetic to science. Additionally, however, and less widely appreciated, there is often no consensus among philosophers, historians, and other scholars of the sciences – including scientists themselves – concerning the precise epistemic status of science. In light of this, and considerations of epistemic paternalism, epistemic autonomy, and the limits of persuasion, I argue that while allowing for belief, acceptance, not belief, should be viewed as the primary (epistemic) aim of a general science education.

Keywords

science education, science denialism, pseudoscience, scientific realism, scientific antirealism, epistemic paternalism, epistemic autonomy, limits of persuasion, belief, acceptance

---

What do we aim to achieve – or rather, what *should* we aim to achieve – in teaching science? It would be overly ambitious here to attempt to provide a thoroughly grounded, comprehensive answer to this question, given that science education, like most education, is something we might reasonably hope to serve a number of different ends; and furthermore, because the way we think about and prioritize some of these ends may vary substantially depending on the extent and depth of the scientific education at issue. With this in mind, let me be begin by being more specific about the scope of the discussion to follow.

For present purposes, I will focus on a specific pedagogical context, one that is sometimes (loosely) identified with a "general science education" – the sort of basic, introductory exposure to the sciences that for many people will run its course in secondary school, or perhaps in the earlier stages of a post-secondary education (not excluding, of course, later adult learning or continuing education). A general science education may serve as a foundation for subsequent, deeper and more detailed education of the sort that has the potential to yield varying degrees of specialist expertise, but for most people, exposure to science by means of formal education will end sooner rather than later: a general science education is all that most people will ever have by way of a rigorous or systematic training. The fact that a majority of the adult members of our many societies will have at

most a general science education suggests that this sort of education in particular has a considerable role to play in shaping what we think of as the public understanding of science, and this, in turn, is a formative influence on levels of public support for incorporating our best science into policy and action, both governmental and otherwise, for tackling many of the challenges that face us and our planet. Thus, it turns out that what we achieve in general science education is hugely impactful for us all, which brings me now to the question of its aims.

I will argue in what follows that the primary epistemic aim of a general science education is best thought of in terms of the doxastic attitude of *acceptance* of the content of scientific theories and models, in contrast to the attitude of *belief*. That said, I will build up to this conclusion in stages. In section 1, elaborating briefly on the motivation for thinking about general science education in particular, indicated above, I will invoke a weighty desideratum for epistemic aims in this context, concerning the prospect of scientific contributions to our well-being. Next, in section 2, I will describe two families of skepticism in relation to the sciences – what I will call 'ideological resistance' and 'epistemic dissensus' – both of which complicate the project of specifying epistemic aims that would help to satisfy this desideratum. In light of this, in section 3, I reflect on worries about epistemic paternalism and indoctrination that threaten to undermine the very idea of epistemic aims for general science education, and argue that some (but not all) of these concerns should be taken seriously. Finally, in conclusion, I contend in section 4 that, while not precluding belief in our best science, acceptance is better equipped both to facilitate the desideratum of greater uptake of science in society, and to respect the complexities of commitments associated with ideological resistance and epistemic dissensus. Thus, acceptance should be viewed as the primary epistemic aim of a general science education.

1. Science education, public understanding, and the roles of science in society

Thinking about aims constitutes a significant part of the philosophy of education. Much of this, however, is not especially pressing here. For example, I am less concerned presently with the aims of education *simpliciter*, if there are such things, than I am with the specific aims of teaching science – appreciating, of course, that if there are indeed aims properly associated with the genus Education, they will thereby apply to its species, including science education. Also, while there are many aims one might reasonably associate with *science* education, my concern here is with epistemic aims, and more specifically, aims concerning the doxastic attitudes students ultimately manifest toward the content of whatever is presented to and otherwise experienced by them in a

pedagogical setting, such as belief, disbelief, and suspension of judgment (agnosticism). This is to leave aside many other, undoubtedly important aims, such as inculcating an appreciation of the wonders of the natural and social worlds in which we live, facilitating understanding of the nature of observation and experimentation, and developing formal and informal skills of data analysis, modeling, and reasoning, none of which is disconnected, to be sure, from doxastic attitudes, but none of which is my primary focus in what follows. And finally, as mentioned above, this focus on doxastic attitudes will concern general science education in particular.

A focus on epistemic aims in this context directs our attention, appropriately if somewhat narrowly, to those products of the sciences that are susceptible to doxastic attitudes, namely and most prominently, the descriptive content of our best scientific theories and models. This is why, above, I was able to tie the question of the aims of general science education so easily to serious consequences for the public understanding of science, policy, and action: how people view the epistemic status of the content of science is a significant factor in determining whether science will guide our actions in pivotal ways. From agriculture and nutrition to healthcare and medicines to existential crises in the form of pandemics and climate change, our best science is crucial to fashioning better outcomes than we might end up with otherwise.[1] What I would now like to suggest is that this connection between the perceived epistemic status of scientific descriptions on the one hand, and outcomes for people, other life, and planet Earth on the other, yields a strong desideratum regarding the epistemic aims of a general science education: that these aims (or, at least, the primary aim) may help to facilitate the promotion of the uptake of science in society, especially in public policy and action, since the consequences of failing to encourage doxastic attitudes that allow for this are so grave.

In proposing a 'desideratum', here, I mean to suggest that aiming to produce doxastic attitudes that may help to promote the uptake of science in society would be immensely desirable – in some cases, existentially so, such are the stakes – but not to suggest that this is in some sense an *a priori* or necessary condition on doxastic aims. The idea that the aim of education, generally speaking, is constitutively or necessarily tied to well-being may well be associated with the view that human flourishing is properly considered the primary, fundamental, or overarching aim of education (see Curren et al. 2024). This widespread view is not uncontroversial, however. Inspired by an Aristotelian conception of education on which its proper function is to help prepare

[1] This leaves ample room for cases in which, at some (often earlier) stages of inquiry, the sciences are less epistemically potent than we would like, or incorporate biases (hidden or transparent) that lead us astray, but in general and with all the caveats that 'best' may suggest in the expression 'our best science', I will take the impressive (though clearly fallible) epistemic credentials of our best science for granted here.

individuals and collectives to flourish, this particular proposal has been conceived mainly in terms of developing the intellectual and ethical virtues required to do just that, which is, of course, contestable. In any case, while at a certain level of abstraction it seems credible that there may be close connections between plausible concepts of education and flourishing, broadly construed – it is uncontroversial, for instance, in ethology and evolutionary biology that teaching and learning are highly adaptive, increasing fitness – the plausibility of anything resembling a strict, conceptual connection (in neo-Aristotelian garb or otherwise) is not what I am asserting here.

Important connections between general science education, the public understanding of science, and the roles that science may play in society to further well-being are plain, whatever one's considered opinion regarding the question of whether flourishing is the primary or fundamental goal of education. Given the plainness of these connections in contexts of science and society, it would be highly desirable if the doxastic attitudes manifested by students as a consequence of a general science education were to help facilitate the uptake of science in public policy-making and private decision-making, for the good of us all. It is thus reasonable and appropriate that we should care a great deal about whether defensible epistemic aims for this sort of education are favorable to this sort of uptake. Having thus elaborated on and clarified my motivation for the present focus on general science education, in terms of a defeasible but nonetheless consequential desideratum concerning epistemic aims, let me turn now to what I take to be the two most challenging obstacles to satisfying it.

2. Science and skepticism: science denialism versus epistemologies of science

In some domains of education, the epistemic status of the relevant content is uncontroversial. Whatever difficulties one may have in grasping the content of arithmetic, algebra, geometry, or calculus, the mathematical facts of the matter are not really up for grabs. In domains where interpreting evidence requires non-deductive or non-algorithmic inferences in order to generate conclusions, however, the status of those conclusions is inevitably less secure. All by itself, this is often unproblematic. Competing interpretations of works of art, music, or literature, for example, are simply part of the celebrated richness of those disciplines. Likewise, it is well understood that some historical contentions are supported by large amounts of probative evidence, and others less so, rendering them more speculative. When it comes to at least some areas of the sciences, however, the situation is less clear. Scientific investigation is often touted as our preeminent mode of inquiry into facts about the natural and social worlds; this is commonly

associated with an attitude of deep respect for the epistemic credentials of these forms of inquiry. And yet, in our era, the sciences are also subject to significant and in some cases widespread forms of skepticism, which is not uncommonly associated with an attitude of deep suspicion regarding their epistemic credentials, sometimes manifesting as a rejection of science altogether.

It may be tempting to diagnose these latter, negative forms of assessment of the epistemic status of scientific descriptions in terms of simple failures to distinguish between more speculative conclusions drawn at relatively early stages of investigation or in cutting-edge science, and more secure findings based on further study and stronger evidence in the fulness of time. (This might, for example, explain *some* of the backlash against health advisories concerning vaccines at the early stages of the global Covid-19 pandemic in the early 2020s, when researchers worldwide were scrambling to explore the nature of the virus at issue, SARS-CoV-2.) Such confusions may well occur, but the sorts of skepticism about science I have in mind here are not obviously matters of simple confusion as such. Rather, they are more principled and, as a result, not amenable to being easily dismissed or dissolved. These more principled forms of skepticism thus present, each in their own way, strong challenges to the hope of satisfying the desideratum relating to epistemic aims of general science education outlined above – that such aims may be conducive to the use of science in ways that promote our welfare.

Turning a spotlight, then, on these forms of skepticism about the content of science, let me start by dividing them into two broad camps. I will refer to the first as comprising versions of *ideological resistance* to science: skepticism that is frequently identified with the phenomenon of science denialism, but whose forms have quite different profiles otherwise, which I will consider momentarily. The second camp, which I will refer to as exemplifying an *epistemic dissensus* regarding our best science, is crucially different in the sense that the views comprising it are *not* properly understood – at least, not in any straightforward way – as denialist about the epistemic status of scientific descriptions. On the contrary, each of them identifies the outputs of our best scientific theorizing and modeling with some or other positive epistemic status, though in rather different ways, collectively. Given their positive epistemic dimensions, the label 'skepticism' may initially give the wrong impression of the dissensus, even if it is appropriate here as a technical (philosophical) term, given that these views do not endorse what may be taken as face-value, unqualified, or uncritical interpretations of scientific models and theories. They are epistemologies of science that couch the positive epistemic status of our best science in qualifications or deflations of the literal truth of at least some scientific claims.

Before digging into these two broad categories of skepticism in relation to science in more detail, let me say something to clarify further what it is that they have in common, in virtue of which it is reasonable to think of them as affording a joint challenge to the desideratum I have outlined relating to the epistemic aims of a general science education. Ideological resistance and forms of epistemic dissensus, though very different sorts of things, share a striking feature: both may be regarded as oppositional to strong or naively conceived variants of scientism, by which I mean especially forceful commitments to the epistemic authority and/or the expansive epistemic jurisdiction of the sciences. Scientism is commonly viewed as a bad thing when the strength of these commitments is judged excessive, amounting to a kind of hubris regarding the certainty of scientific claims, or the notion that everything is (in principle) susceptible to an exhaustively scientific analysis or description. A rejection of this sort of hardcore scientism with respect to the epistemic authority or the authoritative scope of the sciences is common to both ideological resistance and the epistemic dissensus – a point to which I will return later. This, however, as will now suggest, is where the commonalities end.

Unlike the views comprising the epistemic dissensus about science, views subscribing to ideological resistance are not merely skeptical about *scientism*. They are skeptical about *science itself*. They do not recognize the sciences as generating epistemic returns at all, as the term 'science denialism' suggests. Ideological resistance fosters an antipathy toward science, often driven by group identity commitments championed by authority figures (parents, religious leaders, influential promoters of special interests, etc.) and communities. These commitments are inculcated in the members of these groups – including, of course, students at formative stages of education. It goes without saying that commitments like these complicate the context of science pedagogy in ways that escalate the more deeply entrenched such commitments become. Conversely, the opposition to scientism exemplified by positions comprising the epistemic dissensus is not at all connected to a denial of the epistemic status of science. It is rooted instead in an appreciation of the carefully considered ways that scientific claims, theories, and models must be interpreted, or so these positions contend, in order to reveal their epistemic status. These positions give positive assessments of the epistemic credit science is due, but framed in terms of serious epistemological reflections on the precise nature and extent of this credit.

With this distinction between ideological resistance and epistemic dissensus in hand, let me now concretize the discussion by sketching a number of approaches to thinking about science that fall into one camp or the other, or that could go either way other depending on the more precise details of how they are fleshed out. Table 1, below, lists (arguably) the most common categories of

these views. While it would require too much of a digression from my present purpose to say much in detail about them here, a quick overview may serve to illustrate their basic features and how they differ, thereby lending credence to the challenges they pose, individually and collectively, to thinking about what the epistemic aim or aims of a general science education should be.

Ideological Resistance	Epistemic Dissensus
• pseudoscience • anti-science • resistance to facts	• selective realism • empiricism and instrumentalism • neo-Kantian constructivism
	• pragmatism • social constructivism • local knowledge • Indigenous knowledge

Table 1: Forms of ideological resistance to and dissensus about the epistemic status of science

Let us begin with the broad category of ideological resistance. Pseudosciences, such as astrology and creationism, are generally described as non-scientific doctrines or practices masquerading as science on the basis of misleading characterizations of their investigative and analytic methods. While there is ongoing debate concerning whether science and pseudoscience can be neatly demarcated in terms of their general features, or whether demarcations are typically, idiosyncratically contextual, there is widespread agreement regarding which doctrines and practices are, in fact, pseudoscientific (see Hansson 2021/2008). 'Anti-science' (as I have labelled it in Table 1) is a catch-all for trenchant opposition to science, sometimes but not always involving the vigorous promotion of pseudoscience. The hallmark of anti-science is the pursuit of non-epistemic ends, such as social or economic ends, that may be hindered by scientific findings. Homeopathists, for example, may seek to profit at the expense of genuinely efficacious treatments (leaving placebo effects aside here); likewise, the tobacco and fossil fuel industries have famously promoted misleading 'research' to undermine facts about the harms of second-hand smoke and climate change, respectively, established by the relevant sciences. Rounding out this side of Table 1, 'resistance to facts' is a term that has recently come to denote the fascinating social phenomenon of

generic disinclinations, for whatever reason, to accept evidentially well-supported facts – consider, for instance, the anti-vaccination movement.

Turning now to the dissensus of more credible accounts of the epistemic upshot of our best science, we find a variety of positions reflecting evaluations of scientific practice and scientific claims by philosophers, historians, sociologists, and other scholars of the sciences, not to mention scientists themselves. These positions offer interpretive proposals for how best to understand the factual content of our best science. As in the case of ideological resistance, there is overlap between these positions, but their core proposals vary substantially. A common way of framing these differences is in terms of an overarching discussion of scientific *realism*: the view that scientific inquiry yields mind-independently true (or approximately true) descriptions of both observable and unobservable aspects of the world; that is, descriptions that are literally true of their targets independently of how we might think about them.[2] Without getting into the weeds of a voluminous literature, let me note that this idea has proven controversial, which is perhaps not surprising; after all, the history of the sciences is littered with descriptions that were once accepted as true but subsequently rejected, and even our best theories and models routinely abstract from and idealize their targets systems in the world. The controversies rage both among realists, who have elaborated different and conflicting proposals for how to explicate realism, and among antirealists, who have elaborated different and conflicting worries about its plausibility.

Thus, turning to the right-hand side of Table 1, proposals for 'selective realism' suggest that while some parts of our best scientific theories and models may be apt for skepticism, others may be justifiably believed – but advocates of these views disagree about what qualifies for skepticism and what for belief. Various forms of empiricism and instrumentalism limit what they take to be belief-worthy scientific claims to those describing observable things, maintaining that strictly unobservable entities are beyond our epistemic reach, but they sometimes disagree about where, precisely, the line should be drawn between what is observable and what is not, and about whether, under certain conditions, claims about some strictly unobservable entities may qualify for belief after all. Neo-Kantian views (some of which are empiricist), inspired by Immanuel Kant's contention that our knowledge of the world is unavoidably permeated with specifically human concepts and categories, take many scientific claims to be in various ways conventional, and thus not descriptive of a mind-independent world *per se*.

[2] Debates about scientific realism are central to (or in the background of) much of the philosophy of science and science studies more generally. For comprehensive overviews, see Chakravartty 2017/2011, Saatsi 2018, and Rowbottom 2019.

Finally, in the remainder of Table 1 we find positions that may, depending on how they are specified, fall on either side of the divide between ideological resistance and epistemic dissensus. Pragmatists, for instance, articulate the notion of having justified beliefs in terms of their utility, and are typically skeptical of the idea of mind-independent truth. In some incarnations this is compatible with realism about at least some scientific claims, but it is also compatible with a rather different sort of rendering, as a strong form of conventionalism on which science itself may be regarded as something akin to an ideology. Social constructivism is also a broad tent, ranging from versions that simply consider the ways in which social, economic, and political relations shape scientific beliefs, to versions that go further, deflating the epistemic status of scientific descriptions entirely into social statuses, thus affording them no epistemic privilege as such. Turning to the last two entries in this zone of Table 1, beliefs held by those with considerable local or contextual expertise, including (for example) Indigenous peoples, are often attuned to natural and social phenomena in ways that professional science is not, sometimes resulting in conflict between the two, which may play out as part of a dissensus regarding the interpretive content of science, or as a rejection of science altogether.

Clearly, much more could be said to spell out the subtleties of the various forms of ideological resistance to and epistemic dissensus regarding the epistemic status of our best science. While I have only scratched the surface here, I hope nonetheless to have clarified how each of these camps of skeptical concern are relevant to, and how they may complicate, any attempt to determine what the primary epistemic aim of a general science education should be. Arguably, a serious (primary) aim is one that is achievable, even if only to some appreciable degree; at a minimum, such an aim should serve as a regulative ideal which, in guiding action, has some significant potential to make an intended difference to what is achieved. If we are to take seriously the desideratum of teaching science in ways that may serve human and planetary welfare, it should now (I hope) seem concomitantly obvious that we will have to take seriously, in general science education, epistemic aims targeting doxastic attitudes toward the content of science that are responsive to these forms of skepticism. Before turning to what this entails for the question of aims, however, it is crucial that we first remove a potentially worrying obstacle in our path. Let me turn to this now.

3. Apprehensions about epistemic paternalism and scientific indoctrination

Thus far, I have argued in favor of a desideratum for science education – epistemic aims that help to facilitate the use of scientific findings in pursuit of our well-being – and have discussed two

families of skeptical reaction to the outputs of scientific work, one (ideological resistance) comprising forms of science denial, and the other (an epistemic dissensus) comprising epistemologies of science that furnish different interpretations of what we are warranted to believe given the content of our best theories and models. These two families of views could not be more different: the first is skeptical not only of strong forms of scientism, but of science *simpliciter*; the second is likewise skeptical of scientism, but all of *these* assessments of science champion the epistemic credentials of our best science *in some form*, albeit in different and conflicting ways. Neither can be dismissed in the context of a general science education. Ideological resistance is present in our societies whether we like it or not; and we cannot pretend that our leading expert analyses of the epistemic upshot of scientific inquiry form a consensus. (It goes without saying that this community of experts includes scientists themselves, who are well represented, historically, across the epistemic dissensus sketched above).

Given these skeptical considerations, is it even appropriate or defensible to advocate for the sort of positive epistemic assessments of science that would be required to satisfy the desideratum outlined above? Some may well think it inappropriate or perhaps even indefensible, all things considered: as we will see momentarily, one might hold that certain plausible, pedagogical norms (explored below) militate against such aspirations to influence the doxastic attitudes of students in this sphere. If this judgment were correct, it would rightly preclude any further, normative discussion of these kinds of epistemic aims for science education. Before I proceed, then, to argue that there *is*, in fact, a compelling answer to the question of what the primary epistemic aim of a general science should be, let me clear the ground by disposing of the contention that it would be wrong to say so. Contentions like these stem most obviously from worries about the possibility of epistemic paternalism and, in its most severe form, indoctrination, which stand opposed to the arguably virtuous principle of epistemic autonomy, all of which I consider next.

Generally, paternalism is identified with systems or practices in which those with authority restrict the freedom of others, without their consent and purportedly in their best interests. Autonomy, conversely, is identified with a state of freedom from the control of others, or as it is commonly described, a state of 'self-governance'. In cases where being subject to paternalism is not merely purportedly but actually beneficial, paternalism and autonomy may both be associated with certain goods: the promotion of an agent's welfare in the case of paternalism, and a respect for their agency in the case of autonomy. *Prima facie*, however, given that to act paternalistically is to violate an agent's autonomy, and that to be autonomous is to resist paternalism, even in cases where both are desirable for an agent, the goods associated with them would seem to be in competition. In such

cases, we must consider what is preferable on balance. Now, what is of special interest here are specific forms of these general notions, namely, *epistemic* paternalism, and *epistemic* autonomy.[3] At stake here specifically is what is in one's best epistemic interests, in the former case, and one's freedom regarding the formation of one's beliefs, in the latter. Putting all of this together, epistemic paternalism is a system or practice in which those in authority interfere with the inquiry of others, without their consent and for their epistemic good. Epistemic autonomy is freedom from the control of others or self-governance with respect to the formation of one's beliefs.

In science education, the condition (for epistemic paternalism) of 'interference' in another's inquiry is almost trivially satisfied. Teaching science, for instance, involves presenting evidence that students likely do not have or would not easily acquire otherwise. That said, the 'without consent' condition, though something of a gray area, is probably not satisfied. Whether students explicitly consent to general science education may vary, but their presence in the classroom provides at least some evidence of an implicit consent to being taught, presented with evidence, and so on. Some ambiguity here is fueled no doubt by questions whose answers differ across jurisdictions – for example, at what age are students free to choose whether or how they are educated? Adding to this ambiguity is Thaddeus Pope's (2004) distinction between hard and soft epistemic paternalism: the former confronted by those whose decisions about their own inquiry *should* be respected, and the latter by those judged to have lesser agency in this regard. Sadly, it is beyond the capacity of this essay to discuss how these matters are best adjudicated. But we may proceed with the plausible assumption that, to the extent that legal and other norms governing such adjudications in any given jurisdiction are, in fact, *norms*, they will thereby define what counts as consent in education, and who is able to give it – whether explicitly or implicitly and by students or caregivers responsible for them. Being educated will typically involve consent in the form of an acceptance of these norms.

The interim conclusion here is that although teaching *simpliciter* may amount to interference in the epistemic lives of those taught, this does not entail that educating all by itself is a form of epistemic paternalism, for typically, in one sense or another, there is (at least tacit) consent. This, however, takes us only so far. The fact that teaching need not be epistemically paternalistic leaves open the possibility that under certain conditions – ones that are epistemically pernicious in ways that make consent unlikely or unreasonable – it may be epistemically paternalistic after all. The most pressing concern of this sort, in the realm of education, involves conditions associated with the possibility of indoctrination: in its negative connotation, 'indoctrination' is routinely

[3] Recent discussions of epistemic paternalism often take inspiration from Goldman 1991, which is concerned primarily with legal practices of allowing access to and withholding information. For a more general discussion, see Ahlstrom-Vij 2013, and for a focus on education specifically, see Giesinger 2019.

associated with situations in which there is a lack of consent, or in which it would be difficult to maintain that consent is in the best interests of an agent. It seems to me that science teaching is *not* properly thought of as systematically indoctrinating, but as I will now clarify, subtleties regarding the epistemic status of science may well give the impression that it is.

In older usage and perhaps in some quarters still, the term 'indoctrination' can have neutral or even positive connotations, referring simply to training or education. Today, however, and certainly in the present context, it is generally used negatively to denote a process in which students are taught to believe something in the absence of critical scrutiny of reasons and evidence. In an influential paper, Ivan Snook (1970, 97) offered a critical distillation of earlier views in terms of 'three main candidates for the criterion of indoctrination': *intentions* to inculcate beliefs independently of reasons or evidence; *methods* of teaching that exclude such considerations; and inculcating belief in false *content* (cf. Siegel 1988, 79-80, and Taylor 2017, 39-40, who adds untoward *consequences* for the cognitive states or dispositions of students). Now, since teaching science typically involves explaining techniques of investigation, data gathering, and analysis, there can be no case here for indoctrination based on the criteria of suspect intentions or methods (or, for that matter, untoward consequences linked to being indoctrinated in these senses). And lest this appear to gloss over the fact that younger children are often taught in the absence of evidence they may lack the capacity to understand (e.g., the Earth is "round", i.e., a sphere), let us note that such considerations are commonly part of a general science education in due course. So far, so good.

When it comes to the third criterion of indoctrination, though, concerning the epistemic status of the content presented and inculcated, the issue is murkier. Consider some cases that Snook views as clear examples of indoctrination:[4]

A. Inculcating content the teacher believes to be false.
B. Inculcating content the teacher believes to be uncertain as if it were certain.
C. Inculcating content the teacher believes to be certain but also substantially disputed.

It is difficult to imagine there being much if any dissent from the judgement that A, B, and C describe cases of indoctrination. Granted, there may be disagreement about the relative severity of the indoctrination in each case, but this will not be my concern here. Furthermore, there is room for

[4] I have abridged these cases from the original (A and B from Snook 1970, 97, and C from ibid., 105), but I am retaining what I take to be the author's intentions. The term 'substantially' in C, on which I will comment briefly in a moment, is in the original.

debate fueled by the ambiguity of what, in C, counts as substantial dispute. To the extent that the genuine science of astronomy conflicts with the pseudoscience of astrology, does this count? To foreclose possible confusion on this point and for immediate purposes, let me stipulate here that a substantial dispute about scientific content is one pertaining to expert scientific dissensus; and thus understood, let us consider whether general science education is typically indoctrinating in any of the ways described in A through C.

As mentioned above, I do not believe that science teaching is generally indoctrinating, but the possibility is unsettling nonetheless. Consider the curriculum. Is there an implication, when teaching classical mechanics, that Newton's theory of gravity is true? It is not, and presumably teachers know this; if it were, there would be no need to proceed to Einstein and relativity theory down the road. If there *were* a clear implication, in the classroom, that classical mechanics is true, this would be a clear instance of A, above. Do the subatomic particles constituting atoms and molecules – the protons, neutrons, and electrons of basic chemistry – exist? Well, yes, sort of, in a sense, maybe, but there is substantial uncertainty about them (they are not particles in any ordinary sense) and, indeed, expert dissensus about whether it makes sense to say that there are any such particles at all (as opposed to, say, excitation states of underlying fields, or more exotic possibilities). If there *were* an implication of certainty regarding these entities in the classroom, this would be a clear instance of B, assuming that teachers know better. And since there is often scientific dissensus (what causes cancers? what are the correct diagnostic categories of mental disorders?), and substantial epistemic dissensus viewed through the wider lens of science studies, anyone who is aware of this but teaches what *they* take to be certain would exemplify C.

How might we confirm whether the forms of indoctrination described in A through C above are systematically present in general science education? Perhaps the strongest reason to doubt that they are stems from the fact that the *question* of whether our best science is true or certain is not usually feature of teaching science *qua* science. For the most part, science pedagogy is exhausted by the presentation of, engagement with, and mastery of the content of science. It does not include detailed or extensive forays into substantial, meta-level reflections on whether or in what sense this content is true, or idealized, or a useful fiction, let alone considerations of the fuller range of possibilities collected under the heading of epistemic dissensus in section 2. For good or for ill, and in contrast to many conversations between scientists and other scholars of the sciences, general science education is not ordinarily a locus of these reflections and considerations, nor could it be in

any serious way.[5] It is thus difficult to assess the extent to which inquiry into the precise epistemic status of what is taught may arise in this context if at all, for teachers *or* students. When we add to this the challenge of assessing what teachers in the realm of general science education actually believe, with certainty or otherwise, the prospects for credible assertions of systematic indoctrination are even weaker. There is no basis here on which to conclude that indoctrination is endemic – on the contrary.

I have argued in this section that epistemic paternalism is not intrinsic to teaching, given the likelihood of consent, and that the more specific phenomenon of indoctrination, in which consent is unlikely (and in any case unreasonable), is difficult to pin on a general science education.[6] These conclusions reopen the door to considering what the epistemic aims of a general science education should be, and in a way that illuminates something important about how to take seriously the various forms of skepticism found in ideological resistance to and epistemic dissensus regarding our best science. In seeking to satisfy the desideratum that such aims should, ideally, help to promote the uptake of science in society in order to facilitate our general welfare, I will now suggest that the key to viable epistemic aims, in the face of ideological resistance and epistemic dissensus, is to pay due respect to the sort of epistemic autonomy that is implied in rejecting epistemic paternalism and indoctrination. In the next and final section, I will argue that however daunting this may seem, it is, in fact, possible to thread the needle of these several demands on the epistemic aims of a general science education.

4. The limits of persuasion, autonomy, and epistemic aims of science education

Let us begin by itemizing these demands on epistemic aims arising from the previous sections more precisely. Satisfying the desideratum of a widespread pro-attitude toward science, which lends support to policymaking and action informed by scientific investigation, requires a correspondingly *positive* conception of its epistemic output. Conversely, forms of ideological resistance to science (pseudoscience, anti-science, and resistance to facts), in virtue of their shared

[5] See Chakravartty 2023 for a fully elaborated argument to the effect that the idea of engaging seriously or in depth with such issues in general science education (sometimes associated with proposals to teach 'the nature of science' in science classrooms) is not well conceived – and that to conceive it well would render such efforts impracticable.

[6] It is worth noting that if this is compelling, it obviates – in this context, at least – a widely-shared impulse to argue that while teaching is inherently paternalistic, this is excusable on grounds of legitimate educational authority (cf. Curren 2025, section 5). On the view expressed here, it is a mistake to grant the premise that general science education is inherently paternalistic.

science denialism, incorporate a flatly *negative* conception of the epistemic status of the sciences. Finally, the epistemic dissensus of various more thorough and detailed interpretations of scientific claims, theories, and models, which coalesce into different views regarding scientific realism and antirealism associated with a number of philosophical positions (adopted by humanist scholars of the sciences and scientists, historically, implicitly or explicitly), represents a highly *variegated* set of conceptions of the epistemic upshot of scientific inquiry. Ideally, then, the primary epistemic aim of a general science education should be something that is compatible with *all* of these disparate conceptions of the epistemic status of science – positive, negative, and highly variegated.

No doubt, some will be unhappy with this suggestion. They will insist instead on putting forward their own, personally sanctioned epistemic aim, as supported by whatever interpretation of our best science they judge to be correct, even if it is incompatible with the judgments of others who adopt different positions among the various possibilities mentioned above. But this cannot be the way forward. An aim that is incompatible with the full range of conceptions of the epistemic status of science just canvassed is bound to be substantially suboptimally fulfilled, and as noted earlier, an aim that lacks significant potential for substantial (even if incomplete) realization is not a serious candidate for being the primary aim of something. The context of general scientific education is one in which agents do, in fact, assess the epistemic status of science differently, and with all the evidence and reasoning in the world, there are limits to our powers of persuasion. It is not uncommon, for instance, in cases of ideological resistance, for people to present with deeply entrenched background commitments or belief systems that are incompatible with belief in certain scientific claims or theories (e.g., about climate change; cf. Kahan et. al. 2011, Kahan et. al. 2012). And in the case of epistemic dissensus, fundamental differences of opinion regarding the epistemic status of science are arguably irresolvable (Chakravartty 2017).

If, undaunted by the limits of persuasion, one insists that the primary epistemic aim of a general science education must conform to just one of the conflicting views mentioned above, violations of epistemic autonomy beckon, along with the possibility of indoctrination (e.g., as in C, in section 3). A good science education will surely involve considerations of evidence for scientific claims and theories, but it is dubious that it can or should say anything about whatever contrary, deeply entrenched, non-scientific background commitments some students may have that render them antipathetic to science, or weigh in on debates about forms of scientific realism and antirealism. Strongly held background commitments to people, groups, institutions, and forms of life that are skeptical of science are sometimes central to the self-identities of those who hold them, and this is not something that can be engaged in any direct way, let alone policed, in contexts of

science teaching, not least because it would amount to a major departure from the teaching of science.[7] Likewise, firmly held, conflicting diagnoses of scientific theories and models in the epistemology of science cannot be engaged in any serious or compelling way in a *science* classroom. As a result, and once again, the matter of epistemic autonomy looms large. Beliefs to which one is strongly committed are extremely difficult to change (cf. Mandelbaum 2019), and consent to being taught is not a promise to believe in accordance with epistemic aims that are not one's own.

Let us return, then, to the question of whether there is anything that could serve as a primary epistemic aim for general science education that is compatible with the positive, negative, and intervening assessments of the epistemic status of science we have considered.

This question seems daunting because none of the most commonly discussed doxastic attitudes – belief (taking something to be true), disbelief (taking something to be false), and suspension of judgment (agnosticism concerning truth and falsity) – fit the bill. Taking our most warranted scientific descriptions and theories to be true would clearly serve the desideratum of helping to facilitate the uptake of science in society, but it is incompatible with ideological resistance and many if not all of the positions comprising the epistemic dissensus of epistemologies of science. Taking our best science to be false goes well with ideological resistance, but not with the uptake of science in society, and not with the epistemic dissensus either, all of whose positions contend that there is *something* right about our best theories and models, even if they are not properly, wholly or unqualifiedly described as true. A blanket agnosticism about the epistemic status of science is a poor fit all-around. There are, no doubt, other epistemic achievements one might note here, such as understanding (in contrast to believing or disbelieving in, or being agnostic about the truth of something), and a number of associated skills of thinking and analysis. These may all play a role in the process whereby students form the doxastic attitudes they ultimately manifest toward scientific content, but my focus here is on the primary doxastic attitude that these other epistemic achievements may, ideally, facilitate, and this brings us, finally, to *acceptance*.[8]

As doxastic attitudes go, acceptance may be regarded as weaker than belief and stronger than agnosticism, in the following senses.[9] Belief involves taking something to be true, but

---

[7] *Pace*, e.g., Barnes & Brownell (2017, 4-7), who urge science teachers to explain how non-literal interpretations of certain religious assertions may be compatible with evolutionary theory, it is simply inappropriate, in a science course, to venture into (let alone dwell on) interpretations of religious doctrine.
[8] For discussions of acceptance in related philosophical contexts, see van Fraassen 1980, section 2.1 (philosophy of science), Cohen 1992 (epistemology), and Smith & Siegel 2016 (science education).

[9] It follows that acceptance of *P* is also weaker than disbelief in *P*, rendered as belief in ∼*P*. For ease of explication I will simply frame these comparisons in terms of acceptance and belief here, with the

acceptance involves only the weaker commitment to using something as though it were true for some purpose – for example, the use of a claim or a theory as a means to, or as a premise or basis for, making decisions about how to act. Acceptance and belief are thus compatible doxastic attitudes, because regarding something as true trivially entails that one may regard it as though it were true, to some end; and if one believes something, this plausibly indicates that one should also rely on that something, where relevant, in determining one's actions, just as in acceptance. That said, acceptance does not require belief. One might accept that Newtonian physics is an excellent means by which to calculate how to get a space shuttle from the Earth to the International Space Station, and yet not believe that it is true. In sum, belief entails acceptance, but acceptance does not entail belief.

The sense in which acceptance is stronger than agnosticism, however, must be understood a bit differently. Acceptance involves making a commitment to whatever is under consideration (a description, a theory, a model) such that it may serve as a basis for action, but agnosticism all by itself is weaker in the sense that it involves no such commitment, and thus cannot serve action in this way. Still, acceptance and agnosticism are also compatible doxastic attitudes. If one accepts something but does not believe it, this may well be because one is agnostic about whether it is true or false. That said, agnosticism does not require acceptance. One might be agnostic about Newtonian physics, for instance, and also not accept it. Neither acceptance nor agnosticism entail the other – since acceptance is compatible with belief, in cases where they come together, agnosticism is off the table; and since agnosticism is compatible with having no view at all about whether something may serve as a basis for action-oriented decision-making, in such cases, acceptance is likewise ruled out.

The preceding has all been in the service of clarifying the tripartite distinction between belief, acceptance, and agnosticism, and with this in hand, we are now well equipped to see why acceptance may succeed as the primary doxastic aim for general science education where the others cannot. The key to this is that acceptance is the *only* doxastic attitude that combines *neutrality* with respect to the epistemic status of our best science with a *positive* conception of its utility. Granted, belief in the content of science, unlike disbelief or agnosticism (all by itself), would also support favorable assessments of its utility. This is so even though, unlike acceptance, belief is not constitutively linked to such assessments. But as noted above, none of belief, disbelief, or agnosticism are sufficiently neutral regarding the epistemic status of science to do justice to the

understanding that a comparison of acceptance and disbelief could be elaborated the same way, *mutatis mutandis*.

limits of persuasion and a respect for the epistemic autonomy of agents across the board. In contrast, let us now consider how acceptance satisfies all of the conditions sketched earlier for a viable, primary epistemic aim for general science education.

Recall the desideratum of a doxastic attitude that promotes the use of our best science in shaping policy and action in ways that may improve our well-being and that of the planet. Given that acceptance commits us to using something – in this case, the content of scientific theories and models – as a basis for decision-making about how to act, inculcating acceptance would clearly help to kindle a public understanding of science that is sympathetic to the uptake of science in society. Furthermore, recall the epistemic dissensus of various epistemologies of science. All of these positions hold that the sciences generate warranted beliefs, but they differ profoundly on the question of which beliefs are warranted and to what extent. In the heat of the many debates concerning them, though, it is easy to lose sight of their one point of consensus, namely, the idea that the sciences are stunningly *empirically successful*: they collectively embody our most effective modes of inquiry for making reliable predictions about and for intervening effectively in the world. Indeed, all of these positions can be viewed as attempts to explain, each in their own way, how and why the sciences have proven to be such amazingly successful tools for prediction and intervention.[10] It is the extent of this reliability and effectiveness that marks our best science as part of a judicious basis for decision-making about how to act, which is the essence of acceptance.

This leaves just one further condition to satisfy, and perhaps the hardest one. Unlike the positions comprising the epistemic dissensus, forms of ideological resistance – pseudoscience, anti-science, and resistance to facts – are typified by a fulsome rejection of scientific knowledge. Consequently, the challenge here of identifying something that serves well as an *epistemic* aim for science education may seem formidable. In the case of anti-science in particular this may seem especially forbidding, since the distinctive feature of anti-science is the pursuit of *non-epistemic* ends (social schemes, economic ventures, etc.) that scientific inquiry may undermine. On reflection, however, I suggest that anti-science, while otherwise hugely significant, should be set aside in contemplating epistemic aims for general science education. For one thing, we might reasonably expect that most recipients of such an education are not yet at a stage in life where actively plotting to undermine science to abet social, economic, or political agendas is on the cards. Moreover, anyone for whom such ends are paramount is presumably not open to taking the question of the epistemic status of science seriously in the first place, or at all. Indeed, such people are often in the

[10] For an elaboration of this and the shared conception of empirical success it involves, in the context of how we might best conceive the notions of scientific literacy and the public understanding of science, see Chakravartty 2023.

business of attempting to mislead the public about the very idea. As such, advocates of anti-science are beyond the pale of epistemic aims.

What, then, about pseudoscience, and the general disinclination to accept claims that are well supported by evidence, which we have labelled 'resistance to facts'? Those in the grip of these forms of ideological resistance do, at least, take seriously the question of the epistemic status of science, even if they answer it negatively, or respond to it by suspending judgment. Be that as it may, in these cases, even for those who are deeply committed to their antecedent conceptions of science, an acceptance of scientific claims, theories, and models may yet be a live option. Acceptance, recall, is weaker than belief; it is compatible with belief but does not require it. It is also compatible with disbelief and agnosticism. Thus, acceptance does not require that ideologically resistant students change their minds about the epistemic status of science, while still leaving the door open to them to do so. For this reason, acceptance can be viewed, in line with an acknowledgment of the limits of persuasion and epistemic autonomy, as a propitious way of meeting such students halfway – as an aim of teaching that allows them to get on board with the sciences in ways that really matter, for the good of us all, while nonetheless accommodating their lack of belief in the content of science itself.

It is only natural that some advocates of the sciences will feel ambivalent about this. Commitments to pseudoscience, for instance, have in many cases done substantial harm to people and the planet, and some may feel that the only adequate outcome of a general science education is belief in the content of our best science. But we must also live in the world. A 2023 Gallup Poll (Brenan 2024) found that only 24% of people in the United States believe the theory of evolution; 37% believe creationism (God created humans in essentially their current form in the last 10,000 years), and 34% believe something like intelligent design (the later incarnation of creationism: God guided the process of human evolution). These are striking numbers now well into the twenty-first century, not least for philosophers of education. In this sphere, in recent times, no one has done more to explore the conceptual space and pros and cons of different epistemic aims for science education than Harvey Siegel and his collaborators.[11] If what I have argued in this essay is correct, however, we should resolve any ambivalences now in favor of acceptance.

Insofar as we want people to *act* on our best science, to take vaccines, to behave in climate-friendly ways, and so on, acceptance is sufficient, because it shares all of the practical virtues of belief. But even if one does not share this motivation, or care very much about it, the moral of the preceding discussion should still ring true. Students bring a diversity of commitments *to* a general

[11] Going from weaker to stronger epistemic aims: Laats & Siegel 2016 suggests that the primary aim should be cultivating an understanding of evolutionary theory and the evidence for it; Smith & Siegel 2004 makes a case for acceptance, and Smith & Siegel 2016 moves in the direction of belief.

science education, some of which they may hold dear and would be loath to give up; and there are many open questions that even proponents of the sciences may reasonably debate about how warrant arises from empirically successful theories and models that are nevertheless imperfect in many ways we can elaborate, and in others we may not know. Whatever other doxastic attitudes students end up manifesting toward science, they should, minimally, end up with firmly committed acceptance. This is the most important and most practicable thing a teacher can instill – and in some cases, it will be the best they can do, not merely realistically speaking but normatively. Acceptance is the primary aim of a general science education.

Acknowledgments

Many thanks to Aleksandra Hernandez, Ben Kotzee, and Chris Martin for comments on a draft of this paper, and to Harvey Siegel, of course, for his illuminating reply. It was Harvey who introduced me to the philosophy of education. Little did I appreciate then the far-reaching extent of his forceful impact on the field, or what a wonderful colleague and mentor he would become. I have been grateful for his support ever since, and for his friendship most of all.

References

Ahlstrom-Vij, K. 2013: *Epistemic Paternalism: A Defence*. Basingstoke: Palgrave Macmillan.

Barnes, M. E., & S. E. Brownell 2017: 'A Call to Use Cultural Competence when Teaching Evolution to Religious College Students: Introducing Religious Cultural Competence in Evolution Education (ReCCEE)', *CBE – Life Sciences Education* 16: es4, 1-10.

Brenan, M. 2024: 'Majority Still Credits God for Humankind, but Not Creationism', *Gallup News* July 2024. news.gallup.com/poll/647594/majority-credits-god-humankind-not-creationism.aspx.

Chakravartty, A. 2017/2011: 'Scientific Realism', in E. N. Zalta (ed.), *The Stanford Encyclopedia of Philosophy*. plato.stanford.edu/entries/scientific-realism/.

Chakravartty, A. 2017: *Scientific Ontology: Integrating Naturalized Metaphysics and Voluntarist Epistemology.* New York: Oxford University Press.

Chakravartty, A. 2023: 'Scientific Knowledge vs. Knowledge of Science: Public Understanding and Science in Society', *Science & Education* 32: 1795-1812.

Cohen, L. J. 1992: *An Essay on Belief and Acceptance*. Oxford: Clarendon.

Curren, R. et al. 2024: 'Finding Consensus on Well-Being in Education', *Theory and Research in Education* 22: 117-157.

Curren, R. 2025: 'Philosophy of Education', in E. N. Zalta (ed.), *The Stanford Encyclopedia of Philosophy*. plato.stanford.edu/entries/education-philosophy/.

Giesinger, J. 2019: 'Paternalism and the Justification of Education', *Philosophical Inquiry in Education* 26: 49-63.

Goldman, A. 1991: 'Epistemic Paternalism: Communication Control in Law and Society', *The Journal of Philosophy* 88: 113-131.

Hansson, S. O. 2021/2008: 'Science and Pseudo-Science', in E. N. Zalta (ed.), *The Stanford Encyclopedia of Philosophy*. plato.stanford.edu/entries/pseudo-science/.

Kahan, D. M., H. Jenkins-Smith, & D. Braman 2011: 'Cultural Cognition of Scientific Consensus', *Journal of Risk Research*, 14: 147-174.

Kahan, D. M., E. Peters, M. Wittlin, P. Slovic, L. L. Ouellette, D. Braman, G. Mandel 2012: 'The Polarizing Impact of Science Literacy and Numeracy on Perceived Climate Change Risks', *Nature Climate Change* 2: 732-735.

Laats, A. & H. Siegel 2016: *Teaching Evolution in a Creation Nation*. Chicago: University of Chicago Press.

Mandelbaum, E. 2019: 'Troubles with Bayesianism: An Introduction to the Psychological Immune System', *Mind & Language* 34: 141-157.

Pope, T. 2004: 'Counting the Dragon's Teeth and Claws: The Definition of Hard Paternalism', *Georgia State University Law Review* 20: 659-722.

Rowbottom, D. P. 2019: 'Scientific Realism: What It Is, the Contemporary Debate, and New Directions', *Synthese* 196: 451-484.

Saatsi, J. (ed.) 2018: *The Routledge Handbook of Scientific Realism*. London: Routledge.

Siegel, H. 1988: *Educating Reason: Rationality, Critical Thinking, and Education*. New York: Routledge.

Smith, M. U. & Siegel, H. 2004: 'Knowing, Believing, and Understanding: What Goals for Science Education?', *Science & Education* 13: 553-582.

Smith, M. U. & Siegel, H. 2016: 'On the Relationship Between Belief and Acceptance of Evolution as Goals of Evolution Education: Twelve Years Later', *Science & Education* 25: 473-496.

Snook, I. A. 1970: 'The Concept of Indoctrination', *Studies in Philosophy and Education* 7: 65-108.

Taylor, R. M. 2017: 'Indoctrination and Social Context: A System-based Approach to Identifying the Threat of Indoctrination and the Responsibilities of Educators', *Journal of Philosophy of Education* 51: 38-58.

van Fraassen, B. C. 1980: *The Scientific Image*. Oxford: Clarendon.