Science education on the tightrope between scientism & relativism: a Wittgensteinian balancing act

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Abstract

Mentalities like scientism and relativism idealise or belittle science respectively, and thus hurt science education and our literacy. However, it seems very hard to avoid the former mentality without sliding to the latter, and vise versa. I will suggest that part of what makes balancing between the two so difficult, is a representational account of meaning that science educators, like most of us really, usually endorse. Scientism then, arises from the assumption that *there is such a thing called science*. Relativism, on the other hand, assumes that *there is no such thing called science,* there is no real meaning attached to the term. Wittgenstein's remarks on rule-following then, could help us escape this twofold danger. Addressing scientism, Wittgensteinian writings remind us that, in order to understand the sciences, we do not need to point to some mental referendum of what science is. We rather need to grasp a matrix of overlapping, often implicit, always evolving rules that govern scientific practices. Addressing relativism, Wittgenstein's comments help us realise that there are always certain criteria about what kinds of things we call by a name; there are rules governing scientific practices, rules that even though they may be context dependent or evolving, are always in play.

Keywords: science education, scientism, relativism, Wittgenstein, rule-following, represantationalism

Introduction

In education, in philosophy and history of science, in science education theory and research, in epistemology, in culture, even in our everyday dispositions and declarations, we constantly have to battle with our lurking tendencies to accept either scientism or/and relativism. Neither mentality does justice to the sciences. Some of us may be prone to the one more than the other; however, as I will suggest, scientism invites relativism and vice versa. They are, in many ways, two sides of the same coin. Part of their allure is that they both share a representational account of meaning, an account of meaning that comes to us all too *naturally*, so to speak, i.e. *easily, obviously*, as if we have grown into it from the beginning of time. Such an account of meaning can and has been addressed by Wittgenstein's remarks in his *Philosophical Investigations* (thereafter *PI*), and the rest of his later work.

In this paper, I will first explain my use of the terms *scientism* and *relativism*. I will try to explore their meaning while resisting the temptation to provide a definition of either term; I will rather rely on examples from popular culture and our educational practices, including science education. Then, I will suggest that at least part of our tendency to slide to either or both such mentalities comes from a representational account of meaning that science educators, science education researchers, and most of us really, share. Finally, I will suggest a remedy following the later Wittgenstein's remarks on rule-following.

The slippery slope to scientism

Scientism is a mentality or even a cluster of mentalities of idealizing the sciences and their methods. It probably starts as an innocent habit of convenience: we often speak of *science* in the singular term, often without defining which science we refer to, or which particular study or method we have in mind. So we might say that we have read a scientific study that suggest, for example, that married men are happier than unmarried, or that drinking might lead to cancer or that a new orbit of some planet has been discovered; or we might say that we heard a *scientist* talking about how low calorie drinks are not healthy. Speaking vaguely, in the affirmative, and in the singular term about *science* is an attitude that science education silently promotes whenever schools teach physics, biology, chemistry, geography or geology under the *science class* strand; or whenever a science educator asks students only questions they already have the answers to; or whenever they get students to apply a theory to similar problems over and over again; or whenever they experiment in class with recipe-like protocols. Such teaching habits reinforce an excessive trust in science; moreover, they imply a mythology about how straightforwardly science works (Gasparatou, 2017b; Gasparatou, 2018b). The mythology is further cultivated in many social sciences classes that often try to emphasise their credibility by overclaiming their hard-sciences methodologies and trying very hard to mimic the quantitative approaches even when asking qualitative questions. In popular culture such an attitude is behind many TED-talks, popular science books, articles and podcasts that claim that science will help us be happy, moral, find the right relationship, better our friendships, and usually accompany their claims with incomprehensive brain-scan pictures and vague statistics (eg. Harris, 2011; Fisher, 2008).

The scientistic rationale thus, is being cultivated slowly, often implicitly; and is not without merit. It goes somewhat like the following:

- the sciences have solved many puzzles, and given us many tools
- the sciences try to employ good methods
- the scientific method works
- it is the one & only valid method of inquiry
- it will answer all questions
- if the method doesn't work, then the question is bogus

Many of the above premisses then, are not wrong. The sciences have indeed advanced our knowledge about the world and have benefited us in many ways; their successes relate to the fact that scientists do worry about their methods: they try to ask comprehensive questions, employ valid methodologies, develop technologies that further their discoveries, make accurate predictions, etc. The slippery slope begins when we go from the plural to the singular term and assume that there is one method that all sciences employ. Assume that is, that there is a super-calculus of some sort that if we feed it raw input, will automatically provide us with scientific knowledge. However, there is no raw input to be fed, as any philosopher of science would admit in the post-positivism era. As to the calculus, it rather seems that scientists work in many different ways and employ many different methodologies, depending on the technology at hand, their mentalities, their cultural and institutional setting, and, more importantly, the questions they struggle with (Thurs, 2015). Even within the same discipline, say *zoology*, someone who studies the reproductive system of mammals will probably employ different methods than someone who studies the feeding habits of spiders. Such an assumption is in many ways the root cause of our tendency to apply this method to all questions (Haack, 2007; Rowbottom, 2006). And furthermore imply that if a question does not seem accessible by the method, it must be a pseudo-question.

The scientistic narrative today is often implicit, even unconscious. Nevertheless, it builds a mythology around the sciences which works against our scientific literacy (Delfino, 2014; De Ridder, 2014; Stanford, 2016). It makes science mysterious: it seems comes down to a method, yet no one can break down this method once and for all, for all of us to practice in our everyday quests. It promotes an attitude of admiration instead of critical thinking and it reinforces our impatience with history (Haack, 2007; Kidd, 2014; Kitcher, 2012). We blindly rely on what a scientist tells us about some matter or other today, even though they themselves might change their minds tomorrow, due to new evidence or new methodological advances. We are inclined to turn down questions that cannot be explored scientifically today, or turn to pseudo-science for answers that have not yet been scientifically articulated; for all we know, certain questions about morality, love or happiness, for example, might indeed be answered by the sciences; or, again, they might *not* be answered by any science. Even the most science-optimistic among us will have to wait and see.

Being over-optimistic can be dangerous: science might be expected to save the day no matter what we do; even if we make earth an inhabitable place, science can take us to other planets. Being overconfident in the advances of science can have surprising results too. If we build a narrative in which science is the ultimate arbiter of things, we may feel very disappointed when we notice, for example, that scientists very often disagree pretty much about everything; or when they change their minds; or when they cannot offer us comfort about some specific problem we face. In some ways then, scientism may open up the way to relativism, as well as to pseudoscience or anti-science movements.

The slippery slope to relativism

On the other end of the spectrum lies *relativism*. The term is used to refer to an overall mentality, or a cluster of mentalities of belittling the sciences and their methods (Nola & Irzik, 2006; Haack, 2007). Such an attitude lies behind alternative treatments, anti-vaccination trends, global warming opponents, flat-earth proponents, cult enthusiasts, astrology advocates and so many other pseudo-scientific or anti-scientific trends. The implication here is that science is a conspiracy; and at the same time, that we can have a science of everything. So, astrologists may claim to be scientists, as well as homeopaths, reiki instructors, feng shui consultants and the like. Education seem to fail to address such a mentality, even though it does not explicitly reinforces it. Yet, at times, while trying to address scientism, humanities, social sciences, and even natural sciences teachers may put a bit too much emphasis to a relativistic reading of the history of science, which pictures the history of mankind as a random, even irrational, shift from a cultural paradigm to another cultural paradigm. Slowly, implicitly, even unconsciously at times, the relativistic narrative is thus built. It goes somewhat like that:

- *what science is* may differ from one context to another
- depending on the context, power-plays, etc, some questions, answers and/or methods get to be called *scientific*
- *science* is whatever has worked in a historical circumstance and/or community

Just like the scientistic, the relativistic rationale is not without merit either. The sciences are indeed parts of human endeavours, and, as thus, they are subject to all human limitations, historical, cultural, and personal; moreover, not only their suggestions, but their overall status may be fallible and subject to change. However, just like in other endeavour, fallibility and change is not necessarily irrational; in fact, it is *because* they are subject to fallibility, due to a constant demand for verification and falsification, that scientific theories get their credibility. Thus, our thinking that some treatment or method or discipline is valid, or working, does not make this treatment, method, or discipline valid, nor working. So, it is not true that science is whatever was thought to be so. Phrenology is not a science; it never was, no matter what people thought about it. Aether does not exist; it never did; not even when scientist used this concept to explain the traveling of light or gravity. Its existence was disproved and the theory that supported it was amended.

The relativistic mentality also relies on misconceptions of the sciences and the scientific methods. For it shows a total disregard for ideals and discussions about truth, validity, method, verification, falsification, criteria, which are very much parts of our scientific processes (Nola & Irzik, 2006). And in doing so, it encourages numbness instead of critical thinking. Furthermore, just like scientism, it makes us impatience with history: not whatever we think as scientific today is scientific today; the test of time is essential for any theory.

Relativism comes in many varieties and versions. It is a rather simplistic view about the sciences, yet it is very much real. Living in a world of fake news, conspiracy theories, and science opponents it is hard to miss it or grasp the dangers it invites. And scientism, is surprisingly among the dangers relativism invites; many prominent philosophers, scientists and theorist in fact are driven to more and more extreme scientistic stances *because* of the growing anti-science movements that take place today: teaching creationism, refusing medicine or vaccination, refusing environmental crises and so on, drive intelligent people into the opposite extreme (e.g. Rosenberg, 2011).

Science education on the tightrope

Philosophers of science have long warned us against the slippery slopes of the scientistic and the relativistic mentality (Nola & Irzik, 2006; Haack, 2007); and science education researchers have been trying very hard to address the twofold problems in order to promote scientific literacy. However, they also see that, when in the actual classroom, things rarely work as they should (e.g. Lederman, 2006; Erduran & Jiménez-Aleixandre 2008; Duschl, 2008; Kuhn & Crowell, 2011). For it is extremely easy for a teacher to let the door open into either simplistic mentality.

Throughout the 20th century science education research, Inquiry-Based Science Education (IBSE) is the most prominent proposal of science education research (e.g. Driver et al., 1994; Friesen, 2012; Ergazaki & Zogza, 2013; Dagys, 2017). Its historical roots go all the way back to J.J. Rousseau, J. Dewey and J.J. Piaget, who emphasised that we authentically learn only by doing stuff that interests us. IBSE suggests we include *hands-on / minds-on* activities in order to teach science; that we actually get students to practice with scientific projects on topics that concern them. However good the suggestions and the material however, it is very easy to pass on the wrong message anyway. Sometimes, a science educator provides strict, recipe-like instructions which students should follow to get to the correct result very straightforwardly; thus inviting a scientistic attitude towards the sciences (Gasparatou, 2017c). Or, it could be that a science educator allows students to randomly explore the environment around them and play with stuff; not enough guidance is given, not enough questions are asked, no conclusions are reached; each student in fact may reach their own conclusions and be left happy with them, thus endorsing a relativistic stance towards the sciences. One very promising version of IBSE is ARG: teaching through argumentation (Ergazaki & Zogza, 2005; Erduran & Jiménez-Aleixandre 2008; Van Dijk, 2011). Real-life based dilemmas are be given to the students. For example, it is suggested they have a patient with disease-A, and the patient wants to have offspring; students are asked to discuss what they should advise the patient to do. Students have to study, explore options, discuss with their peers and make up a collective strategy about what to propose. ARG allows students to work through all kinds of factors (data, interpretations, community's values, habits and correction strategies etc.) that may influence scientific decision-making. But again, ARG-strategies require great mastery in choosing dilemmas, facilitating the discussions and connecting them to what is taught (Erduran & Jiménez-Aleixandre 2008). If a science educator chooses an easy case, in which the data points straightforwardly to one option, there is no real need for discussion; thus, implying a scientistic view that data plus science point to the answer. If a science educator picks a fully ambivalent case, that opens up too many interpretations or solutions, they may end up inviting a relativistic view that it is all just a matter of perspective and opinion. Even slight nuances in the way a teacher speaks, may open the door to either mentality (Gasparatou, 2016; Gasparatou 2018a).

Now, I am not suggesting that science educators cannot get it right; they can and they often do. My question is rather *what is it that makes it so easy to fall into either trap?*; and more importantly, *why is it that the moment one tries to escape one of these mentalities, they find themselves already committed to the opposite one?*

The Wittgensteinian act

I think part of the problem is representationalism. We are obsessed with questions like *what is this thing called science*. We would very much like it if one could point to an actual object and show us 'Science'; but since we cannot do that, we would gladly settle for the next best thing: a mental representation in the form of a definition. Scientism implies there is a definition. That *there is such a thing we call science*. It is implied every time we talk about *science education* or *science class,* it is implied whenever we suggest that *science* will answer, or has already answered, all meaningful questions, it is implied whenever we talk about the superiority of the *scientific* method. But, whenever we press for a definition, we cannot come up with an adequate, or even a useful one. And yet, we are too deeply entrenched in this tradition to quit it: there must be a definition of some sort for a term to have a meaning. But then, lacking a definition, the term must be meaningless. *Science* is whatever. *Science* is relative. *Science* is totally context-dependent. Relativism treats science as a meaningless term. *There is no such thing called science.*

As long as we accept this view of language, our options are limited: We can choose sides and settle for some version of scientism or relativism; or we get trapped in a moving circle, falling from one simplistic extreme to the other. To put it in Wittgensteinian terms, we are trapped all too deep in representational mythology. It is with this mythological picture of language and understanding that he opens the *Philosophical Investigations*:

> When they (my elders) named some object, and accordingly moved towards something, I saw this and I grasped that the thing was called by the sound they uttered when they meant to point it out. […] Thus, as I heard words repeatedly used in their proper places in various sentences, I gradually learnt to understand what objects they signified; and after I had trained my mouth to form these signs, I used them to express my own desires.
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> These words, it seems to me, give us a particular picture of the essence of human language. It is this: the individual words in language name objects [...] In this picture of language we find the roots of the following idea: Every word has a meaning. The meaning is correlated with the word. It is the object for which the word stands (Wittgenstein, 1953, §1).

Wittgenstein treats this picture of language as a *mythology*: it is very old, at least as old as Plato; it is powerful, since we have all grown up with it and it is so much a part of us that it is truly hard to resist; and it is false, like most mythologies. In all his later work, he tries hard to uproot this picture of language because he thinks that seeing language as representation oversimplifies what the meaning of a term amounts to; and thus prohibits our understanding (Wittgenstein, 1953, §1-38; Baker & Hacker, 2009; McGinn, 2013). And *science* is a term; and the ways we usually talk about *science* too, also comply with this deeply rooted habit of ours to think of understanding as *giving definitions.* We keep looking for a referendum for the term; we keep failing to find one; and we either hang on to the idea that there must be one; or think that the term is, by itself, meaningless.

In philosophy of science and in science education research a Wittgensteinian alternative has already, and up to a point, been explored. Namely, it has been proposed we treat science as a *family resemblance* term. Wittgenstein talks about family resemblance when talking about games (PI, 67): I understand the term *game* because I can grasp the *family resemblance*, the sometimes obvious, and sometimes vague, overlapping similarities, between all the practices we call *games*. The *family resemblance* idea resists the idea that we need a definition in order to understand something, or even that we can give an explicit, complete list of all the similarities. However, it also suggests that *there are* such similarities, and that we are in a position to grasp them. The suggestion then, is to treat *science* as a family resemblance term and help students grasp the similarities among the different sciences (Erduran & Dagher 2014; Irzik & Nola, 2011 & 2014; Matthews, 2012; Kampourakis, 2016).

Yet, it is important to put the idea of family resemblance within the Wittgensteinian context. Wittgenstein does not propose we make a list of the many similarities that point to our use of a term, just like some science education researches or psychologists suggest (Kampourakis, 2016; Murphy, 2004). Wittgenstein then, does not propose we substitute a strict definition of *necessary and sufficient conditions*, with a more relaxed one, in the form of a *list of key similarities* as sometimes suggested. He rather uses the term of family resemblance, talking about games, so that he slowly guides us into the idea of *language-games*:

> There are … countless different kinds of use of what we call "symbols", "words", "sentences". And this multiplicity is not something fixed, given once and for all; but new types of language, new language-games, as we may say, come into existence, and others become obsolete and get forgotten. … Here the term 'language-game' is meant to bring into prominence the fact that speaking a language is part of an activity […:]
>
> Giving orders, and obeying them— Describing the appearance of an object, or giving its measurements— Constructing an object from a description (a drawing)— Reporting an event— Speculating about an event— Forming and testing a hypothesis— Presenting the results of an experiment in tables and diagrams— Making up a story; and reading it— [...] Asking, thanking, cursing, greeting, praying. (Wittgenstein, 1953, §23)

These are all examples of some of the endless language games we engage in our everyday practices. And since there are endless numbers of games, there can be no definition. To even ask for some type of definition in this case would be to look for some hidden essence of the term game. But there is no such essence; a term gains its meaning by its actual use in actual contexts, i.e. by the many language-games people play with it. Language is intertwined with all human activity. And Wittgenstein's drawing on games when talking about family resemblances, and his introduction of the idea of language games, is to remind us that all human activity has one thing in common: rules!

We follow rules about how and where to sit, or how and where to brush our teeth, how to greet a friend, how to greet a student or how to greet a colleague, how to carry out an experiment or make a diagram (Wittgenstein, 1953; Sellars, 1956; McDowell, 1996; Brandom, 1998; Derry, 2008; Derry, 2017). And rules point to sets of *criteria*. I do not need to have a definition in mind to know what an apple is. I can easily discriminate between apples and bananas and tomatoes, without a definition about either. I know where to buy them, I can pick out different kinds of apples among apricots, nectarines, cherries, oranges, etc; I can count them; I know they are similar to bananas in some ways, and dissimilar in others; I know they are similar to tomatoes in some ways and dissimilar in others. And yet, if you ask me, I cannot give you an adequate definition off the top of my head. To make a long story short, I *understand* what an apple means without needing to rely on a definition. And you know I understand the term because of all the things I can do around them: buy them, eat them, count them, store them, etc. I have *criteria* about what to call an *apple*, criteria that are more complex and rich than any definition could; and on which I'd rather rely. The complexity of our criteria actually serve me better than any definition. Think about whales. At some point, in the history of humankind, we defined whales as fish. And we were wrong. However, even back in the day, both a fisherman and a biologist could recognise a whale if they saw one, despite the fact they had a wrong definition in mind. People understood what a whale is by means of practical criteria; and this kind of understanding guided us to look for a good working definition for scientific purposes, not the other way around.

Understanding something then, does not amount to having some mental representation, but rather to grasping the rules around the practices it is associated with. The same goes with more abstract concepts that point to sets of practices, like *game* or *ostensive definition.* To understand what *ostensive definition* means requires that you grasp the whole set of rules around the practice of giving ostensive definitions: the gesture of how to point, where to look when one is pointing, where to focus. It is *because* I have grasped the practice of ostensive definition that I understand the link between the term *yellow* and yellow objects (Wittgenstein, 1953, §1-5). And I know I have grasped it because I can follow the rule: actually look at the end of one's finger, right at the yellow colour when I hear the utterance "this is yellow", and then use *yellow* to refer to yellow objects.

Now *science* is a term by which we call a great variety of complex practices. And the only way to have an understanding of the sciences is to engage with as wide a variety of their many practices as possible. The only way to grasp the criteria around scientific practices is to be exposed to them, from an early age, and engage with them in order to deal with real problems. Like any other practice we master, scientific practices require a long initiation process. And like any practice it includes a variety of language-games, each of which is governed by a variety of similar or not so similar rules, explicit or implicit; and all such rules are subject to change. Note however, that to change a rule means to replace it with a different rule; it does not mean there are no rules (Wittgenstein, 1953, §138-242). There are criteria in our use of science, criteria that do not just amount to the whims of any random community (McGinn, 2013).

Addressing scientism, Wittgensteinian writings remind us that, in order to understand something, *i.e.*. the sciences, we do not need to point to some mental referendum of what science is. We rather need to grasp a matrix of overlapping, often implicit, always evolving rules that govern scientific practices. Now, sometimes, the scientific communities may try to articulate such rules; this is definitely part of their game. Even so however, some rules will always remain implicit. Some will change. It is then, difficult, futile, and even unhelpful to insist on making a complete, explicit list of such rules. Addressing relativism, Wittgenstein's comments help us realise that there are always certain criteria about what kinds of things we call by a name; there are rules governing scientific practices, rules that even though they may be context dependent or evolving, they are always at play. And we can grasp a vast variety of complex and very nuanced criteria; if only we engage with the actual practices.

Science education should provide ways of authentically engaging with as many and as various scientific practices as possible. Moreover, it should make it its explicit task to help us resist the representational mythology; guide us away from the idea that in order to understand the sciences I need to have some mental representation of what they amount to, and into their actual, normative habits. Resisting this mythology should be a daily task for each and every one of us. It is a difficult task, because we and our communities have a long tradition of confusing understanding something with providing some sort of definition. Educational practice, instead of reinforcing such a myth, as it does today, should work on dismantling such mythologies (Gasparatou, 2017a). And it is a difficult task. Science education could make a start. The sciences are prominent human practices that our communities and our students invest in. They can be also be an interesting, educational, fruitful playground for students to see that we indeed all learn only by doing. Hands on and minds on.

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