

Is physics the hardest of them all?

New research suggests that the sciences can be ranked based on how “hard” they are. But **Philip Ball** argues that such a hierarchy is deeply misguided

The 19th-century French philosopher Auguste Comte believed that all authoritative knowledge derives from an objective, data-driven, scientific study of the world – a doctrine known as positivism. In the 1830s he developed his idea by postulating a hierarchy in the sciences based on the level of complexity involved; the greater the complexity, the less the degree of exactness (what we now tend to call “hardness”). According to Comte’s scheme, mathematics was the “hardest” subject, followed by physics, chemistry, biology, with “softer” sciences such as psychology and sociology bringing up the rear.

New research claims to supply “bibliometric evidence” that such a hierarchy exists: that there are objective reasons to consider maths and physics the “hardest” and most solidly grounded of the sciences (*PLOS ONE* 8 e66938). Bibliometrics experts Daniele Fanelli of the University of Edinburgh and Wolfgang Glänzel of the Catholic University of Leuven carried out the study involving an analysis of 29 000 papers on the Thomson Reuters Web of Science database, categorized into disciplines such as physics, chemistry, psychology, plant and animal sciences.

They propose that a defining characteristic of a “hard” science is the ability to reach a shared interpretation of phenomena. This, they say, should manifest itself in several general features in a scientific paper. For example, such articles tend to be shorter – because there is less need to justify and explain a study – and the references will tend to be fewer, less diverse and more recent because key questions are resolved faster. The paper’s title may also be longer because the issues addressed will be defined more precisely.

The work tells us something well worth knowing: that there are real and fundamental differences in style, approach and content across the sciences, so that it might be a mistake to evaluate and manage all of the sciences in the same way. Fanelli and Glänzel embrace Comte’s hierarchy and the notion of hard and soft sciences, saying that they “seem to capture an essential feature of science” and that pretending that they do not exist could be a “costly mistake”.



Food for thought Are maths and physics the most solidly grounded of the sciences?

The authors do not deny that all disciplines have cultural and “non-cognitive” components but say that different sciences nevertheless seem shaped “by objective constraints imposed by the subject matter”. They aim to be non-judgemental about that, suggesting – like Comte – that the hierarchy is to be expected because, progressing from physics to sociology, the complexities of the subject matter are increasing – making it hardly surprising that the phenomena become harder to interpret and consensus harder to achieve.

Playing hardball

So what is the problem? Let’s start with semantics: “hard” and “soft” are prejudicial terms. It is difficult to avoid reading them both as “hard-headed/soft-headed”, suggesting that the social sciences are pervaded by woolly thinking, and also as “hard/easy”, suggesting that the physical sciences are more intellectually challenging and reinforcing the snooty conviction that the most brilliant scientists choose physics.

But (most) questions in physics are arguably the easiest to answer securely because they tend to be the easiest to isolate and interrogate experimentally. Economics is failing to answer our real-world questions not because economists are less able but because economics is so complex, with few if any universal laws and patchy data. (It has another problem too, which I’ll come to.)

Even more invidious than the “hard/soft” terminology is the whole notion of a hierarchy. By definition, this can’t help but imply a judgement of status: there’s a top and a bottom. At best it invokes condescension towards those disciplines unlucky enough not to be physics; at worst, we’re invited to feel impatient that these “softer” sciences have not yet got themselves physics-ified.

Comte certainly felt that all sciences aspire to the condition of physics and he looked forward to the time when the social sciences reached this stage of higher evolution.

It was in Comte’s time that historians of science began to construct the narrative in which the mathematization of nature, as displayed in Newton’s *Principia*, was the defining achievement of the scientific revolution, ignoring that this approach was of no value at that point in, say, zoology, botany or chemistry. When the German philosopher Immanuel Kant declared that the chemistry of his day was “not science” as it was insufficiently mathematical, he was exposing his limited understanding of what chemistry was about – both then and now.

Not only is mathematization, with its consequent opportunities for reductive subdivision of problems, of limited value in some sciences, but they – the life and social sciences, particularly – have a dependence on context and history that offers scant purchase for physics-style universal rules. Different data sets, in other words, may tell different stories. When those dependencies are neglected for the sake of simplification, as in mainstream neoclassical economic theory, the result is a model so abstracted and simplistic that no amount of empirical input – not even the near-collapse of the global economy – can make much impression on the ramparts of its ivory towers.

I believe that many sciences, from biology to sociology, can benefit from physics-based ideas. But placing physics at the top of the tree does not help because it blurs the view of where “physics thinking” is and is not appropriate. And presenting science in terms of “consensus deficit” is not just misguided but potentially dangerous. A quest for consensus tacitly accepts Comte’s assumption that all questions can be given a single, scientifically based answer. But many cannot, not just in the humanities but also in history, politics, ethics, the social sciences, economics and beyond.

Even in the so-called “hard” sciences, the value of having complementary but not entirely compatible models is under-rated. And when it comes to questions about humanity, we may often be better served by a diversity of views – including old ones – than by a doomed dream of consensus.



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