

How to reconcile the multiculturalist and universalist approaches to science education

Sven Ove Hansson¹ 

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Abstract The “multiculturalist” and “universalist” approaches to science education both fail to recognize the strong continuities between modern science and its forerunners in traditional societies. Various fact-finding practices in indigenous cultures exhibit the hallmarks of scientific investigations, such as collectively achieved rationality, a careful distinction between facts and values, a search for shared, well-founded judgments in empirical matters, and strivings for continuous improvement of these judgments. Prominent examples are hunters’ discussions when tracking a prey, systematic agricultural experiments performed by indigenous farmers, and remarkably advanced experiments performed by craftspeople long before the advent of modern science. When the continuities between science and these prescientific practices are taken into account, it becomes obvious that the traditional forms of both multiculturalism and universalism should be replaced by a new approach that dissolves the alleged conflict between adherence to modern science and respect for traditional cultures.

Keywords Multiculturalism · Universalism · Indigenous science · Fact-finding practices · Directly action-guiding experiments

Yeung Chung Lee (2017) does a good job in showing how attention to technology can contribute to the development of culturally relevant curricula for science education in non-Western and indigenous cultures. My contribution will take the form of an extension rather than a criticism of his argument.

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This review essay addresses issues raised in Yeung Chung Lee’s paper entitled: *When technology, science and culture meet: Insights from ancient Chinese technology*. doi:[10.1007/s11422-017-9805-5](https://doi.org/10.1007/s11422-017-9805-5).

✉ Sven Ove Hansson
soh@kth.se

¹ Department of Philosophy and History, Royal Institute of Technology, Brinellvägen 32, 10044 Stockholm, Sweden

As Lee points out, discussions in this field have been dominated by conflicts between two major approaches to science education. The “multiculturalist” approach treats popular and indigenous views on nature as alternatives to modern science that differ from it in fundamental ways, but should nevertheless be incorporated into the science curriculum. The “universalist” approach agrees that these traditions are fundamentally different from modern science, but it assigns to modern science a unique and superior role, and therefore it excludes these other approaches from the science curriculum.

In what follows I will argue that this is a misconceived conflict. Both approaches fail to see the strong continuities between modern science and its forerunners in traditional societies. As soon as these continuities are understood, a third approach becomes possible that dissolves the alleged conflict between adherence to modern science and respect for traditional cultures.

Unfair comparisons

The discussion is often couched in terms of comparisons between “indigenous belief systems” and modern science. This is a misguided and unfair comparison. In particular, the common comparison between modern science and the magical and religious thinking in indigenous societies is remarkably misconceived. Religious and spiritual thinking in traditional societies should be compared to religious and spiritual thinking in modern societies. Similarly, modern science should be compared to those elements in traditional societies that are most similar to modern science.

Furthermore, any comparison between small-scale and modern societies will have to take into account the differences in scale and degrees of specialization. This is what we usually do when comparing other cultural elements than science. For instance, there is a huge difference between cooking over an open fire in a traditional Nigerian village and cooking in a modern restaurant kitchen in Lagos. In spite of these differences, we do not hesitate to use the same word, “cooking”, about both activities, and we have no difficulty in finding similarities in what is going on in the two places. Similarly, we apply the term “music” both to the performances of a traditional didgeridoo player and to those of the Sydney symphony orchestra, and we use the word “mathematics” both about the arithmetic operations performed by a jungle dweller who never went to school and the activities at a university department in mathematics. In contrast, we tend to use the word “science” exclusively about ways to develop and systematize knowledge that are only possible in large-scale, literate societies like our own. This linguistic practice tends to obscure the continuities between (scientific) knowledge production in modern societies and its forerunners in other types of societies.

As soon as we go beyond the conceptual limitations imposed by linguistic conventions, it will be easy to see that modern science has important precursors in indigenous and traditional societies, just as modern cooking, music, mathematics, literature, law, textile production, etc. have such progenitors. They are important for science education, since they can provide the material that connects science with the students’ experiences and with traditions that they are already acquainted with. In order to find these precursors we should look primarily at the methodologies rather than the knowledge (or knowledge claims) of these belief systems.

Science as a fact-finding practice

A scientific discussion is not like any other discussion. Its form and contents are largely shaped by its basic purpose, which is to find out *how things are*, in contradistinction for instance to how we wish them to be or how they should or could be.

In order to achieve this purpose, science has to satisfy three basic characteristics. First, it makes a *distinction between facts and values*. It seems to be a basic feature of human reasoning that we are capable of distinguishing our factual beliefs from our other attitudes and reactions to what is happening around us. We do this all the time in our daily lives—more or less perfectly—but in science we attempt to do it to a much higher degree than in most other contexts.

Secondly, science strives for *shared, well-founded judgments* about how things are. Science is radically non-sectarian, aiming at nothing less than a common factual ground for all of humanity. It relies on the assumptions that we all live in the same empirical reality and that the facts about it are common to us all. (These are of course assumptions that science shares with our mundane everyday interactions.) In order to achieve shared judgments we need to engage in orderly discussions and joint deliberations that are characterized by rational argumentation, mutual respect, and willingness to learn from each other.

Thirdly, science aims at *continuous improvement*. New information is always sought or at least welcome. Substantial criticism is taken seriously, and cherished knowledge claims are given up when the evidence gives reason to do so. There is a stark contrast between science and belief systems that are held to be incorrigible and absolute.

We can call a social practice with these three characteristics a *fact-finding practice*. Each of these characteristics can be found in many quotidian contexts, but science differs from most other social practices in satisfying them in a more consistent and systematic way. However, science is not the only fact-finding practice in modern societies. Criminal investigations, the judicial deliberations of a trier of fact (such as a jury), and many forms of journalism are other such practices. Other examples are professionals looking for the defect in a malfunctioning machine, physicians pondering different diagnoses or therapy proposals, and people searching for a lost person or object.

Fact-finding practices can be found in all human societies, including indigenous ones. Unfortunately, anthropologists have usually not paid much attention to these practices, but one case, namely traditional persistence hunting, has been investigated in some detail (Liebenberg 2013).

Hunters using traditional weapons usually cannot kill larger prey immediately, and they must therefore track and follow the prey for many hours before they can kill it. Among the Kalahari hunter-gatherers, tracking is “a process of creative problem-solving in which hypotheses are continually tested against spoor evidence, rejecting those which do not stand up and replacing them with better hypotheses” (Liebenberg 1990, p. 71). This is done collectively in a group of hunters who study the tracks, propose hypotheses, and discuss, criticize and test each other’s hypotheses in a process that has all the above-mentioned characteristics of fact-finding practice. When discussing animal behaviour they take great care to cite the evidence in favour of various claims and to distinguish between facts (for instance tracks that they have seen) and hypotheses. They are willing to admit gaps in their own knowledge, and they are often sceptical against each other’s statements (Blurton-Jones and Konner 1976). All of this corresponds closely to the “unwritten rules” of scientific discussions that today’s young scientists have to learn.

Some indigenous peoples have languages that are exceptionally well suited to honour epistemic distinctions such as that between observations and hypotheses. This can be done eminently in languages whose verbs have grammatical markers (such as suffixes) that mark evidentiality, i.e. what type of evidence one has for a statement. For instance, Quechua, the language once spoken by the Inkas and now by their descendants, has verb forms that indicate whether the speaker has direct evidence of what is claimed, has inferred it, or has it from hearsay (Nuckolls 1993). The Matsés, a hunting people living in the Amazonas, have an unusually elaborate system of evidential verb forms. One of these, called by linguists the experiential form, is only used to refer to “a situation where the speaker detects the occurrence of an event (or state), using any of the five senses, at the time that it transpires. It should be emphasized that the essential condition is that the speaker witnesses the event as the event happens” (Fleck 2007, p. 595). In Tuyuca, another Amazonian language, all forms of verbs carry information about the source of information. Thus the verb in a sentence always notifies “whether the speaker has personally seen the situation, has perceived it by hearing or some other sense, infers it from evidence, has learned it from other people, or deems it reasonable to assume it” (Lazard 2001, p. 360). Since the verbs do not have any forms without evidential markers, there is no simple way to make a claim without indicating what type of evidence you have for it. There does not seem to be much scholarly information available about the sociolinguistic aspects of these elaborate systems of evidential markers. However, it is clear that these linguistic communities have encoded distinctions into the basic structure of their languages that are essential for any fact-finding practice. The obligatory evidential markers in Tuyuca is a feature one might well wish of a language to be spoken at scientific seminars.

Systematic experimentation

Experimentation and experimental method have a long but remarkably neglected history that goes back long before modern science. In investigations of the history of experimentation we need to distinguish between two types of experiments, namely epistemic and directly action-guiding experiments. The purpose of *epistemic experiments* is to find out how nature works, usually by uncovering causes and mechanisms. The purpose of *directly action-guiding experiments* is to find out whether a particular type of human action will have the desired results (Hansson 2015). A large part of the experiments undertaken in present-day science belong to the latter category. Prominent examples are clinical trials and agricultural field trials. Directly action-guiding experiments have an immediate justification not shared by epistemic experiments. For instance, if you want to find out which is the best of two medical treatments of a particular disease, how can there be any better way to find out this than to administer the two treatments to similar groups of afflicted patients and monitor the result?

Epistemic experiments have a relatively short history. A few isolated examples of such experiments are known from Greek antiquity and from medieval Islamic scholarship, but they only became common in the Renaissance. Directly action-guiding experiments have a much longer tradition that goes back to preliterate times. If we take this “forgotten experimental tradition” into account, we will find that the origin of experimentation is neither academic nor curiosity-driven. Instead, it is socially widespread, driven by practical needs, and well entrenched in indigenous and local cultures all over the world.

Archaeological studies of ancient agriculture confirm that agriculture was not the result of a few inventions or discoveries but of thousands of years with extensive and continuous experimentation. In pre-colonial Latin America, there was an early period of tropical agriculture in which a wide variety of crops were tried out. The evidence suggests “that people everywhere began by experimenting with the cultivation of plants they were already collecting in the wild” (Bray 2000). Experimentation is still an essential component of traditional Andean farming. As one researcher noted, “[a]gricultural experimentation is virtually universal in the Andes. In every Indian community there are many people who continually experiment with all plants that come their way in special fields (*chacras*) usually located near their houses, but some do so in a certain *chacra* in every production zone where they have fields. They watch how different plants ‘go’ under different climatic conditions” (Earls 1998). Records from other parts of the world confirm that indigenous and traditional farmers do indeed experiment. This is documented for instance from Mexico (Alcorn and Toledo 1998), China (Chandler 1991), and South Sudan (de Schlippe 1956). The Mende people in Sierra Leone have a special word, “*hungoo*”, for experiment. A *hungoo* can consist in planting two seeds in adjacent rows, and then measuring the output in order to determine which seed was best. This was probably an original practice, not one brought to the Mende by visiting Europeans (Richards 1986, pp. 131–146). All over the world, traditional farmers perform experiments (Johnson 1972).

In much the same way, craftspeople of different trades have performed directly action-guiding experiments since long before modern experimental science. For instance, in the early Islamic period, Raqqa (Ar-Raqqah) in eastern Syria was a centre of glass and pottery production. Archaeologists have retrieved debris from eighth to eleventh century glass-making workshops in Raqqa. For one type of glass they found evidence of a so-called chemical dilution line; glass with different proportions of the main ingredients had been systematically tried out in order to find the best composition (Henderson, McLoughlin, McPhail 2004). There are also strong reasons to believe that the compositions of optimal bronze (Malina 1983) and mortar (Moropoulou, Bakolas, and Anagnostopoulou 2005, p. 296) were discovered by systematic experimentation. Studies of Roman buildings give strong indications that builders have experimented with various methods to achieve structural integrity (DeLaine 1990), and the same applies to medieval European cathedrals (Mark 1978). It should therefore be no surprise that craftspeople had important roles in the creation of the modern tradition of epistemic experiments (Zilsel 1942).

Conclusion

Modern science is continuous with other, much older fact-finding practices that share many of its most important distinguishing characteristics. We have evidence of such practices, linking sciences to traditional and indigenous cultures all over the world. They share with each other and with modern science important thought patterns such as the fact-value distinction and the distinction between observations and hypotheses. They also share methodologies such as collegial criticism, hypothesis testing, and experimental investigation. The fact-finding practices of modern science are forerunners of modern science, just as oral story-telling is the origin of modern literature and folk music that of today’s music. The educational implications are obvious. It should be equally self-evident to bring up traditional fact-finding practices in science class as to introduce ancient tales in literature lessons and traditional music in music education. The fact that modern science can

often improve on the accounts of indigenous fact-finders is no reason to belittle their achievements. Modern science can also improve on Galilei's standpoints, but these improvements do not detract from his greatness. Indigenous fact-finders deserve the same respect for their accomplishments.

This perspective opens up a way to overcome the conflict between the "multi-culturalist" and the "universalist" approach to science that were mentioned at the beginning of this contribution. Science is not based on new epistemic traditions that break with those of indigenous and popular cultures. To the contrary, science builds on the age-old traditions of joint fact-finding that we can find in these cultures. By focusing on this common ground we can be at the same time multi-cultural and universalist. We can recognize the unique capabilities and accomplishments of modern science with its unprecedented resources, while at the same time also acknowledging the equally impressive achievements of fact-finders in traditional societies who had no other resources for their inquiries than their own minds and senses.

When traditional Kalahari hunters discussed where the wounded antelope might have gone, they were by no means epistemic relativists. Their discussion started out from the assumption that there must one single truth in this matter. The antelope could not be "far to the east in your world but still close to us in my world". If we want to honour the great tradition of joint fact-finding that they represent, then we have to follow their wisdom in this respect. We should therefore reject all attempts to create epistemic barriers between people when no such barriers are needed.

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Sven Ove Hansson is professor in philosophy at the Department of Philosophy and History, Royal Institute of Technology, Stockholm. He is editor-in-chief of *Theoria* and of the two book series *Philosophy, Technology and Society* (Rowman & Littlefield International) and *Outstanding Contributions to Logic* (Springer). His research areas include philosophy of science and technology, epistemology, logic, fundamental and applied moral theory, value theory, and political philosophy. He is the author of well over 300 articles in international refereed journals. His recent books include *The Ethics of Risk* (Palgrave Macmillan 2013), *Norms in Technology* (Springer 2013, edited with Marc J. de Vries and Anthonie W.M. Meijers), *The Role of Technology in Science: Philosophical Perspectives* (Springer 2015, edited), *The Argumentative Turn in Policy Analysis. Reasoning about Uncertainty* (Springer 2016, edited with Gertrude Hirsch Hadorn) and *The Ethics of Technology* (Rowman and Littlefield 2017, edited). He is Past President of the Society for Philosophy and Technology.