Trading zones, peripheral science and contributory expertise: a framework for exploring science outside the Western contexts

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This article is a contribution to the problem of how a small peripheral scientific community enters in contact with another larger scientific group, first, in order to establish its own independent existence, but then also to found a new ongoing practice. Before such a new scientific community could be recognized as an independent contributing member however, it must go through some intermediate stages, and those stages could be illuminated by a philosophical analysis. This paper, a short research communication about our collaborative work on how to understand scientific practices outside the standard Western contexts, seeks to capture those intermediate stages in the form of a trading zone framework.

Keywords: Contributory expertise, peripheral science, trading zone.

PICK-UP any philosophy of science journal or a history of science textbook, or any conference programmes in the philosophy of science, you will see that the episode of science being analysed or discussed is most likely a piece of scientific activity undertaken by some European or North American scientific community. Why is it so routinely that way? Do no other communities outside these contexts practice any modern science? Clearly, this is not true! After all, there exist several scientific communities of fairly long standing in quite a few non-Western countries – Japan, India, China, South Korea and Latin America, among other communities. The number of patents and publications issuing from these scientific communities is no longer insignificant in volume. Furthermore, in the 21st century, the actual practice of science is often very transnational in character – for example, one might find a group of Japanese scientists designing a public transportation system in collaboration with their Indian counterparts and so on. Why then is it that our philosophical analysis of science lags so far behind the actual practice of science? This happens, we think, for two main reasons. First, by default, those Euro-American scientific communities are considered to be the true bearers of scientific temper, i.e. that typical mindset which one needs to produce modern science. Furthermore, they are also viewed as the seat of all novel ideas and most major discoveries, indeed as the very centre of scientific practices. It therefore becomes natural to think that since all interesting science emerges from this central spot, it is here that we should concentrate our philosophical efforts. This mental association is so strong and the image so overpowering that it is hard to imagine that there could be any other type of analysis of a scientific practice, especially an analysis designed to suit the contexts of peripheral science, i.e. those people who contribute to the sciences, but contribute to it from outside of this charmed central circle. This sounds somewhat strange and yet necessary, and this, precisely, is the goal of our research efforts.

We propose therefore to develop a model for analysing scientific practices in their peripheral contexts first by taking this kind of science very seriously. This means that we focus (mainly) on the people who are otherwise not very well-known in the history of science, such as some first-generation scientists or a group of newcomers within a scientific discipline (sometimes this could be just one person), or even a deliberately oppositional group. Such people often are quickly forgotten after making a few early contributions to science. Of course, he or she could also enjoy some success, and then lose his/her place, perhaps having lost a scientific controversy. However, we consider such people as important epistemic agents who bring something to the scientific practice. This view leads us to consider the early stages through which such individuals or communities must pass when they enter a scientific practice in order to create some contributory expertise for themselves within that practice. We then ask if and how they get to train new practitioners (when they are able to leave behind a new indigenous scientific community). One aspect of this process is cognitive – involving reasoning, mental models and so on – but the other is clearly social. Our goal therefore is to capture these two elements in their close interaction. Our approach thus cuts across many other existing approaches

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in understanding science, e.g. sociology of scientific knowledge (SSK), social epistemology, cultural and cognitive studies of science and so on. As no other analysis of science is currently designed to think about science's peripheral contexts, but since all approaches could give us some useful tools in developing an account of such a science, we select our tools from many diverse contexts.

We begin by asking the following types of questions: (1) What is peripheral science? What is a peripheral scientific community? In what contexts do we encounter them? (2) What makes a scientific community peripheral? Is it because of some asymmetry that is purely cultural or social, or is it – as we prefer to call it – epistemic asymmetry? (see note 1). (3) How does a peripheral scientific community enter in interaction with another established community – what goals does it seek during that process, how does it choose its research problems (keeping those goals in mind), how does it develop a concrete research programme, produce a research outcome, and so on.

It is here that we introduce the notion of the trading zone as our main overarching theoretical framework, which we think can show how scientific knowledge could be made in the contexts of peripheral interactions. The notion of a trading zone was first formulated by Peter Galison[1] to deal with the problem of incommensurability between two scientific paradigms. A trading zone, originally a concept borrowed from anthropology, shows us how two groups or tribes could begin an interaction in the midst of their otherwise very deep differences. Such trades can often scale up to optimal outcomes. Ever since Galison's work, this notion has taken on a life of its own, explaining, among other things, how science acquires new members from diverse social and cultural contexts, and how it responds (appropriately) to the concerns and the needs of the wider community. Following Galison, Collins and Evans[2,3] have labelled these two problems as the problem of extension and the problem of legitimacy. We find their insights and approach to be analogous in spirit with our own interest in peripheral science, and thus, it is with the help of their revised notion of a trading zone that we set up our own theoretical framework (see note 2). Collins and Evans, and later Michael Gorman[4], call this revised notion the study of experiences and expertise (SEE). SEE is a way of thinking about how unusual, even non-egalitarian, collaborations could begin in the domain of scientific and technological expertise, and how such interactions could (eventually) create the outcomes of introducing new people or new groups into the practice. Peripheral science, we claim, is the case of another such extension of SEE.

Put briefly, SEE looks at scientific practices by noting the dynamics among different groups when they enter a new trading zone, and how each group interacts with the others in multiply different ways, sharing their expertise. Indeed, trading zones are those places where a member of a scientific community displays his or her contributory expertise[3], and it is here that a newcomer acquires his or her first track record of contributory expertise in the practice of science. This allows the newcomer to form his or her (first) connections with a more dominant community (see note 3). Trading zones are therefore those places where a new research interface first emerges between two unequal communities, finally creating an epistemic loop between them.

Trading zones could go through different stages – they can begin from an early adversarial stage and then scale up to a more egalitarian stage. They can also flip backwards into the original adversarial first stage, or go to a more collaborative third stage where people and their skills are traded fluently, giving rise to shared mental models and (some) shared goals. A trading zone is therefore a dynamic system, always in a state of growth or decay, and it provides the training ground for a new practitioner who needs to gain his or her first round of contributory expertise in science. Naturally, such agents seek to reiterate this process, and if those reiterations are successful, then the new entrants gain their first foothold within the existing practices of science. The SEE approach therefore shows us how a newcomer can turn himself or herself into a contributing member of a scientific practice, creating new outcomes via collaborations with another established community. This process eventually leads to the building of an indigenous scientific community, especially when the newcomers have been able to complete several such cycles of iteration. The efforts of a particular peripheral scientist are often crucial to begin such a cycle, and historically most peripheral scientific interactions have been initiated from the peripheral side (see note 4). The story of peripheral science is often that of some risk-taking mavericks – usually a small group – and how they end up creating a new research interface with another, more established, scientific community, and how by this process they start a new community at home. Once this zone is formed, the peripheral practitioners have the task of keeping it alive by repeated iterations of the epistemic loop that they have just established between the two groups. This entire dynamics could be represented as shown in Table 1.

The consideration of the internal dynamics of trading zones in the peripheral contexts of science allows us to ask questions of the following form.

What are the cognitive and the social mechanisms that allow a peripheral practitioner to produce a piece of normal science? To produce a piece of normal science, the initial stages of lay expertise must develop into a full-fledged, contributory expertise and this transition the peripheral practitioner must achieve often on his or her own, being very meagrely supported by an already existing tradition of scientific expertise. Clearly, this is an uphill task. Furthermore, he or she must develop links with another established scientific community, which, most likely, already has its own trust-network. Such networks give the established community its reliability, speed and power[5].

Table 1. Three types of trading zones and their respective levels of expertise

	State 1	State 2	State 3
Trading zone	Elite control	Approximate parity	Shared mental model
Shared expertise	None	Interactional	Contributing
Communication	Orders	Creole	Shared meanings

Adapted with permission from Gorman[4].

Our approach therefore seeks to show how such peripheral practitioners manage to turn themselves into productive contributors of science through their sheer efforts, notwithstanding the many cognitive asymmetries in the midst of which they are often obliged to work. In this sense they are cultural pioneers, for they endow their own community with a new cultural tool – the tool of modern scientific activity.

Once this notion of a trading zone is accepted as our main framework, our next goal is to cash it out in the form of concrete case studies. Dasgupta[6] has developed two case studies of two early 20th-century Indian scientists – S. N. Bose (of Bose–Einstein statistics) and C. V. Raman, whose discovery, now known as the Raman Effect, is the principle behind today's commercially available Raman spectroscopes. Another study on M. N. Saha and his formulation of the Saha equation is in the process. Working during 1910–1930, these three virtually unknown Indian physicists grasped the light quantum hypothesis of Einstein well ahead of their European peers, and framed their own research projects in terms of that very controversial theory. Thus, a trading zone in physics was formed by these newcomers who became the predecessors of a modern scientific community in India. Novoa and Levine[7] have explored a similar process in the domain of biology in Latin America. They have explored the reception of Darwinism in Argentina, teasing out a set of analogies which were the main vehicles of that theory, and which the Latin American scientists interpreted keeping in tune with their cultural needs, and which were often quite different from those of their European peers. We feel that opportunities for this kind of analysis are abundant once one comes out of the standard Euro-American models of viewing science. Currently, we are seeking to produce a volume on this type of science in *Perspectives on Science*, a journal edited by the Department of Philosophy, University of South Florida, USA.

Lastly, we wish to point out that our theoretical account is not necessarily a story that could only illuminate science in its non-Western contexts. This framework for exploring peripheral science could be used with equal ease in those cases where some historic communities have remained in close proximity with the main scientific community, and yet, have rarely been included in its research efforts. Therein lies the flexibility of this approach. It is, in sum, a way of looking at science from the standpoint of its newcomers and outsiders, who hold less resource, less authority, and yet often create new outcomes in science. This sort of complex activity is historically the point of origin for most scientific communities in Asia, Latin America and Africa, even much of Eastern Europe. It is also the story of some risk-taking mavericks from those contexts, and it tells us that our traditional modes of thinking about science by looking only at its established centres are fraught with serious limitations. Not all new ideas emerge from within a centre. Indeed, in science as well as in other disciplines, the newcomers often serve an important function – they help keeping the practice of science free from rigid stagnation among a few established members, and they introduce diversity at the level of international science. The story of science is therefore much wider than the accomplishments of a central community.

Notes

1. This means that the knowledge of the two parties is unequal for some reason and, therefore, one group must pick up the knowledge of the other. We feel that social (and cultural) inequality is merely a manifestation of this deep-seated epistemic inequality.
2. Collins and Evans are of course not thinking about the peripheries of science, but about interactions within (or around) the main scientific community. But we feel that their analysis could easily be extended to illuminate our special chosen contexts.
3. Of course, this contribution must be acknowledged and accepted by the dominant group.
4. However, this could be different in the future if we possess an appropriately designed science policy.

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