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FORUM

Hawks and baby chickens: cultivating the sources of indigenous science education

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Kome ya ke cikin aikin ɗan tsako, shaho ya daɗe da saninshi.
(Hausa proverb: Niger/Nigeria)
Whatever concerns the habits of baby chickens, you can be sure the hawk learned it long ago.

Abstract In this response to Hewson and Ogunniyi's paper on indigenous knowledge (IK) and science teaching in South Africa, I seek to broaden the debate by setting the enterprise of integrating IK into science education in its cultural and socio-political context. I begin by exploring the multiple meanings of indigenous knowledge in Africa, next consider the sources available for accurately apprehending those different varieties of IK and then raise three issues of procedure that the Hewson and Ogunniyi approach seems largely to overlook: the varying meanings and styles of argumentation in African culture; the relevance of more participatory and discovery-based modes of inquiry to their topic; and the critical importance of grasping the socio-political terrain on which IK must operate. I conclude that, while their initiative opens valuable new paths of inquiry and practice, the proposed methodology would benefit from more solid grounding in discovery learning, African styles of debate and a clear mapping of stakes and stakeholders.

Keywords Indigenous knowledge · Science education · Discovery learning · Sociology of science · Action research

This review essay addresses issues raised in Mariana Hewson's and Meschach Ogunniyi's paper entitled: *Argumentation-teaching as a method to introduce indigenous knowledge into science classrooms: opportunities and challenges*, doi:10.1007/s11422-010-9303-5.

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Executive summary

A cikin wannan lambar ta mujami'ar, Hewson da Ogunniyi sun yi sharhi kan buɗi da sabon tsarin ilimantarwa, da aka jaraba shekaru goma da suka wuce a ƙasar Afirika ta Kudu, za ya bayar a fannin amfani da sanin gargajiya domin koyar da kimiya da kuma haɓaka koyo gun ɗalibai da suka fito daga yare dabam-dabam. A cikin tawa ansar, na nemi faɗaɗa mahawarar ta hanyar shimfiɗa aiki da sanin gargajiya domin horo kan kimiya cikin yanayinsa na adabi, zamantakewa da siyasa. Na fara ne da iyakance tarin manufofin sanin gargajiya a Afirika, sannan na tanadi hujjoji da ke akwai domin tantance kowace manufar kalmar sosai kahin da ƙarshe in ɗaga batu uku kan jerin matakai da husa'ar Hewson da Ogunniyi ta ma kamun sakainar kashi, wato: bambancin manufa da salon magana a Afirika; mahimmancin sa-baki da ji-da-gani cikin hanyoyin bincike kan jigon mahawarar tasu; sannan da tsananin mahimmancin fahintar yanayin zamantakewa da siyasa inda za a amfani da sanin gargajiyar. Na kamala da cewa, watakan niyyarsu ta buɗa sabin hanyoyi bincike da aiwatarwa masu daraja, shimfiɗar tsari da suka gabatar na iya ƙarfafa idan an dogara ta ga koyon ji-da-gani, salon mahawara na Afirika da ƙayyade romo da masu faɗa aji firifalo.

Saboda an yi amfani da kalmar "sanin gargajiya" a fanni dayawa na bincike da aiwatarwa cikin shekarun baya, ya cancanta a iyakance koko a fayyace manufa ko da yaushe. Lalle ne, a Afirika ta Kudu da ma sauran sassa na nahiyar akwai yawancin sanin gargajiya, daidaicin musulmunci da na iyalai yan isilin turai kamar Afirikanar. Ta ƙaƙa ake iya kai ga waɗannan ma'adinai na sani, shi ma wani batu ne da Hewson da Ogunniyi ba su zanta ba sosai a kai cikin sharhin nasu: har ila yau, malamai da ɗalibai da suke karantarwa ba su issasar masaniya gami da waɗannan al'adu domin tsofaffi a cikin al'ummomi kaɗai suka mallake su. Kenan, shimfiɗar matakai ta bincike mai baiwa al'umma kafar sa-baki na ɗaya daga cikin dataccen guzurin manazarci.

Batutuwan shimfiɗar matakai da ya kamata a kiyaye sun ƙumshi batun gudanar da mahawara kan matanai a Afirika, da kuma bambancin salon afirikawa da na turawa da suka gabatar. A cikin haka, amfani sosai da husa'ar koyo ta ji-da-gani da ke ba ɗalibai kafar warware sigogin ilikin gargajiya a fannin kimiya da kowace al'umma ta mallaka, wani babban ciko ne ga shimfiɗar tsarin. A ƙarshe, ya kamata a tuna cewa, sanin gargajiya na iya kasancewa matanin gardama domin ya saba ma tushen ilimi da jami'o'i ko gwamnatoci ke bayarwa, sannan, kuma saboda a wani fannin, kamar sanin magungunna da itace magani na kowace karkara, shi kansa ya zama babbar kadara wadda kowa ke da hanyarsa ta cin moriya.

Bayar da daraja ga waɗannan matanai masu halaka da yanayi na iya ƙarfafa shimfiɗa da ingancin mahimmiyar niyyar da Hewson da Ogunniyi suka sa gaba.

In their article in this same issue, Hewson and Ogunniyi emphasize the opportunity that the new curriculum inaugurated in South African schools over the last decade offers for taking fuller account of indigenous knowledge (IK) in the teaching of science and so conceivably promoting lagging achievement among the country's distinctly multicultural student body. They endorse the threefold agenda for the introduction of IK into the school curriculum earlier proposed by Ray Barnhart and Angayuqaq Kawagley (2005) on the basis of Alaskan

experience—first, documentation of indigenous knowledge; then identification of the epistemologies underlying it; and finally, research and development on teaching strategies designed to introduce it. They concentrate their own remarks on the third category: the development of teaching strategies for introducing IK into the school curriculum. While the topic is undeniably important and their initiative clearly helpful, a few issues stand out right away.

Definitional matters

The first concerns the essential question of what is meant by "indigenous knowledge" in the particular case at hand. The term has been used to cover such a variety of things in different areas of research and practice over recent years that some delimitation or clarification is always called for. As Bill Derman (2003) has remarked, IK easily becomes a sort of residual category including everything that is outside what the author deems to represent formal Western science and philosophy. The issue is further complicated in situations—the more frequent the broader one's focus—where in fact several different cultures and related knowledge systems, with varying levels of coverage, articulation and power, interact in the same political space; and it is endowed with additional nuance by the inevitable positional jockeying and hybridization among them (Roth 2008).

In addition, Helen Tilley (2010) reminds us that the identification of indigenous knowledge and "vernacular science" as entities fundamentally different from the Western scientific canon is at the same time in good part the result of movements for the globalization of science born out of colonial expansion and of the confrontation of European technologies with the arts of the East and the South. It was an encounter in which the European working classes played little role and of which they understood still less, but one that they were schooled over time, John Willinsky (1998) points out, to see as their own cause and conquest. The African situation bears the imprint of this same encounter and of the hybrid influences it created. In the South African case, Hewson and Ogunniyi therefore note, "indigenous knowledge" includes several non-Western knowledge systems—variably developed, preserved and expressed—and the proto-scientific habitus of westerners with little technical training of their own. They thus evoke varieties of traditional African lore (Xhosa, Zulu.), Afrikaner household knowledge, the Islamic perspectives of Pakistani and Indian immigrants and still other epistemologies.

But the relation that these particular cultural viewpoints bear to western scientific norms is a bit equivocal. Take the Islamic case, for example, instantiated by one of Hewson and Ogunniyi's teachers and—to judge by the most recent estimates (Pew Research Center 2010)—about 730,000 other South Africans or 1.5% of the overall population as well, including a good segment of those most educated. Historically speaking, one can argue both that the western scientific tradition was preserved by Islamic civilizations over the Middle Ages and that its modern form subsequently grew from those roots as much as from the earlier Greek ones (e.g., Bibbs 1999). As a consequence, we would seem to be talking about a different species rather than a different genus—and about evolutionary siblings that have a long history of interaction.

As for Afrikaner folklore, it represents a mix of popular western cultural baggage filtered through and formed by the experience of living on the African continent and with African peoples (van der Merwe 2009)—and it serves to highlight the fact that being of European extraction does not necessarily mean understanding the ethos of western science, any more than belonging to the Muslim *ummah* automatically confers appreciation of the

historical achievements of Islamic scholars and scientists. In fact, there are throughout the West, as D.W. Livingstone and Peter Sawchuk (2005) remind us, multiple forms of folk science developed by working class people who have little access to or trust in the benefits of academe.

Black African cultures themselves not only have their own traditions of inquiry but have undergone a great deal of change and admixture over the centuries. Ousmane Sembène's classic Senegalese film *Ceddo* (Sembène, Ndiaye, Yade and Diagne 1977), for example, dramatizes the different cultural currents that have criss-crossed, collided and blended for centuries in West Africa. The prototypical triad in *Ceddo* is represented by local African shamans, sea-borne European conquerors and trans-Saharan Islamic clerics. In his scenario, the standoff turns violent, yet results—as it did historically—in forced amalgamation.

This situation of indistinct borders among plural and often stratified bodies of knowledge and custom should come as no surprise. All cultural traditions are arguably hybrids, at least in the sense of having developed in reaction to, if not symbiosis with, the traditions of both proximate and more distant neighbors. I have noted elsewhere (Easton 2011) the large areas of overlap among one of the quintessential cultural artifacts of West African ethnic groups: their proverbs.

At the same time, the difficulty in drawing lines points to deeper issues concerning the nature of culture itself. Over the last century, Margaret Eisenhart (2000) points out, anthropological thought has moved progressively from its foundations in ethnographic investigation of what were taken to be relatively distinct and geographically delimited cultures—often "traditional" or "primitive" ones at a considerable perceived and spatial remove from the ethnographer's own—toward increasing recognition that cultures are in fact quite malleable, that they may be defined by networks and associations at a variety of levels as much as by geographically- or historically-defined groups, and that people may belong in different ways to several at once. If those insights make it easier for us to understand the multicultural settings that are increasingly prevalent in our world, they also make it a bit less likely that inquiry is going to tap directly into stable and pre-defined reservoirs of traditional wisdom. As the meaning and borders of culture change, so do the meaning, nature and dimensions of IK. Indigenous knowledge, after all, is not a thing but a *concept*—one that we have invented in order to frame differences in collective mental dispositions and in order to forestall our own tendency to see the western knowledge tradition as the only show in town.

Meanwhile, of course, another construct is changing meaning as well: the one denoted by the term "science". In their article on traditional ecological knowledge (TEK), Gloria Snively and John Corsiglia (2001) suggest that growing recognition of important TEK insights in non-Western societies makes clear the need for us to broaden our idea of what constitutes science itself. It is a sentiment that has gained support in many quarters and been echoed in an increasing number of articles on topics like "informal science" (McKinley, Brayboy and Castagno 2008), "vernacular science" (Tilley 2010), "creolized science" (Seiler 2011), "citizen science" (Jenkins 2011) and "border epistemologies" (Carter 2010). If the term continues to mean, as the *Merriam-Webster's collegiate dictionary* (1993) declares, "knowledge or a system of knowledge covering general truths or the operation of general laws, especially as tested through [experimentation]", then there are a number of contenders for that label… as long as "experimentation" is interpreted to include the sort that may have been carried out by groups of people over centuries of history.

Sources

A second question concerns the *source* of IK: who is a valid repository of this alternate knowledge tradition, however systematic or hybrid it may be? Who can speak for it or inform us reliably about its current state and accumulated funds of insight? Hewson and Ogunniyi broach this subject toward the end of their article, but their consideration of the matter seems to stop there. It merits further thought.

A first challenge evidently lies in identifying where the knowledge in question "resides" and a second in determining by what (moral, legitimate and effective) means it can be accessed or expressed. There is a long tradition in cultural anthropology of recruiting and relying upon native informants to reconstruct the traits of a culture unknown to the outsider (Lekgoatin 2009). A good informant must be someone intimately familiar with the target culture from an "emic" or insider's perspective. In the case of local knowledge and epistemologies that are being increasingly displaced by outside norms or globalized cultures, that requirement may incline choice toward elder informants who have fuller memories of the hypothetical unadulterated past. In the researcher-informant model, the native party plays the role of possessor of implicit and instinctual, if not systematically organized, cultural knowledge and the anthropologist the role of systematizer (Jackson 2004). In fact, the result is typically not considered communicable data about a cultural system until it has been interpreted and organized in the outsider's frame of reference or at least become an object of articulate and analytical consciousness. It follows, as Richard Bolden and Philip Kirk (2009) remark, that "much of the [related] empirical research… has been conducted by western researchers, through western paradigms for consumption by a western audience" (p. 80).

But if we are concerned with helping African students (or non-Westerners in general) to become more aware of the knowledge traditions of their own cultures and more adept at analyzing and negotiating their interface with the western scientific one, then we are obviously talking in a sense about the antithesis of the classical anthropologist-informant model. The shoe is now on the other foot. The practitioners or heirs of non-western traditions should be investigating their own craft to a much greater extent (Lassiter 2001). In fact the informant role has been increasingly questioned in recent years and researchers—particularly those in the Global South—have increasingly recognized the idiosyncratic reconstructions of the subject culture to which it may lead (e.g., El-Ariss 2007).

One must moreover be cautious of the idea that varieties of indigenous knowledge are simply lying out there waiting to be harvested. They are part of a particular cultural heritage and so part of what has heretofore served to *distinguish* one social group from another. It is no accident that such bodies of knowledge have often been treated as secret and transmitted only by initiation. *Sa dògòlen be dògò,* the Bambara of Mali say: It is the hidden snake that grows long. Traditions too easily revealed or disseminated may lose their identity-preservation value. Broader recognition of their worth may, of course, enhance identity even while creating new occasions for science learning. But the net effect depends greatly on how the discovery and recognition process is handled.

Questions concerning the source of indigenous knowledge and the procedure for eliciting it remain therefore highly pertinent. Involving teachers and students in the enterprise of "taking fuller account of IK" in the South African educational system is certainly all to the good, but the protagonists are unlikely to prove reliable references for documenting the substance of the knowledge base and, in the Hewson and Ogunniyi article, no procedure is proposed for identifying and cultivating more reliable sources. Since the pedagogical value of the exercise depends in part on enabling students (and their teachers) to grapple with the

contrasts and complementarities between IK and official science curricula, it depends as well on good information about the former. Others in the community might be of more assistance; and methods for identifying, enlisting and cultivating them must thus be part and parcel of the methodology. It is a topic to which I will return when discussing discovery learning and the role of parent and community participation.

Pedagogical strategy

The main thrust of the Hewson and Ogunniyi article is, of course, pedagogical and has to do with methods for promoting student inquiry into indigenous scientific knowledge and its relation to the western variety: methods to which both in-service and aspiring teachers could be initiated and that might have real potential for stimulating student interest in scientific topics. There is much of value here. The effort to align the different perspectives and to encourage a participatory style of inquiry into their parallels and divergences is certainly worthwhile in and of itself. And the proposed and field-tested mode of argumentation seems likely to generate real interest.

At the same time, however, this procedure does raise other questions in my mind. I propose to dwell on three closely-related topics that seem a bit undertreated in the Hewson and Ogunniyi article before returning to the fundamental quandary that their contribution poses: how to take more ample account of a variety of "indigenous knowledges" and their hybridization in the teaching of science. The three procedural issues treated below concern African styles of debate and argumentation, principles of discovery learning and some of the socio-political dimensions of IK promotion.

African styles of debate and argumentation

Hewson and Ogunniyi propose a style of patterned "argumentation" as one means for engaging students in exploring the relevance and relationship of different traditions of scientific thought in the classroom and they pilot the training of teacher education candidates in this approach. The undertaking has much promise. One can't help wondering, however, whether the effort to incorporate varieties of indigenous knowledge into the learning of science couldn't and shouldn't extend a bit more systematically to the *form of debate* and the *process of inquiry* as much as to the *topics under discussion*. Hewson and Ogunniyi do recognize that different types of IK may have distinct forms of argumentation; and they cite remarks by some of their participants about variant styles that traditionally characterized African procedures for decision-making and conflict resolution. But the type of exposition that they experiment seems largely inspired by the classic Greek model of debate prevalent in European legal proceedings (Timmerman 1993). Those skills are certainly worth practicing, particularly if recognized as such and not taken to be the gold standard of productive thought; and they do offer one medium for learning and for comparing the alternate science traditions with each other. However, traditional African styles of discussion and debate are rather different from this protocol and, as Frederick Nafukho (2006) notes, focus to a greater degree on building consensus through overlapping and carefully dovetailed interventions than on oppositional jousting.

A case illustration may help to make the point. I remember being responsible, in my fourth year of work with rural cooperative training programs in the Republic of Niger, for recording, transcribing in Hausa and then translating into French the proceedings of village meetings devoted to deciding whether or not communities would affiliate with the

government-sponsored cooperative movement and, if so, how to organize the local credit mutual. Though I was by that time competent in the Hausa language, having spent 3 years working in a national literacy campaign, and was well accustomed to the rural cultural environment as well, the exercise of transcription brought home to me a characteristic of such village meetings that I had never consciously recognized before. Briefly stated, by and large participants—all of whom were in this case men between 25 and 60 years of age—did not make individual or stand-alone speeches in parliamentary fashion and often did not even speak in complete sentences. Instead, one person would launch the outlines of an idea or the beginning of a sentence, a second would take it up and add other elements to the thought and a third or fourth would conclude the utterance. It seemed to be a well-honed technique for moving collectively toward group consensus and did in fact generally produce that result. If this procedure generated few reproducible sound bites, it led to a rather solid joint decision.[1] And it was suggestive of an alternate means of decision-making and "argumentation" that contrasted markedly with the forms of debate that I knew from my own schooling and cultural background.

A good deal has been made in the literature over the last 20 years of consensus-building procedures in African societies and the virtues of *ubuntu. Ubuntu* is a word in the Nguni group of languages of southern Africa (Zulu, Khosa, northern Ndebele…) signifying "humaneness" or "compassion" and increasingly taken as an umbrella concept for an African philosophy that puts prime emphasis on community and social relationships,[2] in contrast with western individualism (Rambose 2003). *Umuntu ngumuntu ngabantu,* a Zulu maxim holds: "One is a person [only] through other people." And it is at least conceivable that cultural systems grounded in such a value outlook may harbor both their own epistemology and their own means of truth establishment.

Similar debates revolve around the degree to which and the way in which African cultures contain roots of democratic governance and civic education that are distinct from, while complementary to, the western variety (e.g., Dong'Arogo 1999). As much may be said of other non-western traditions. To cite an Islamic counterpoint once again, Muslim scholars have offered ample commentary on the democratic implications of Koranic thought and the relevance of concepts like *shura* (consultation), *ijma* (consensus) and *ijtihad* (independent decision-making) to popular rule (e.g., Kelsay 2005). Each of these claims to distinct epistemologies and truth-testing procedures has, of course, its critics (Enslin and Horsthemke 2004) and the debate continues. The significance of these examples for our present purposes is simply to suggest that there are strong reasons for considering alternate forms of scientific (or political) *discourse* at the same time as one investigates alternate traditions of scientific (or political) *thought*—and that any attempt to reinforce teaching of IK might take better account of the styles of debate and investigation common to its parent cultures.

Discovery learning

From a pedagogical point of view, one can also ask whether changing styles of discussion exhausts the innovations that would need to be introduced in order to better incorporate

[1] The importance of collective decision-making is highlighted in another highly elliptical Hausa proverb that echoes this procedure for debate: *Shawara ɗaukar ɗaki.*—"[Making a] decision is like grappling [the heavy conical thatch roofing that must be posed on the circular adobe walls to construct] a hut." It can only be handled if everyone bends down together and lifts at the same time.

[2] It is also, as things go, the name chosen for a computer operating system and a popular cola drink.

indigenous knowledge into the teaching of science—and whether it is in fact the most important one. The question of *how* a deeper awareness of the contributions of IK to science teaching is best generated and how the substance of the topic is brought to light seems to me a prior consideration that points in the direction of some variety of discovery learning (Kirch 2010) or action research (Sweeney and Tobin 2001) rather than simply new patterns of debate.

Here I draw another illustration from personal experience, this time in the Republic of Mali (West Africa) in the late 1970s when I helped with the development of basic training workshops in health and agricultural science conducted in the Bambara language for newly literate young men of the Beledougou region, which stretches north of the national capital toward the Mauritanian border. The participants were adolescents with no formal schooling who had become literate in their own (Bambara) language through participation in adult literacy programs and who were seeking alternatives for further training (Belloncle 1989). One of these sessions focused on prevention of river blindness (onchocerciasis). The French physician acting as technical director for the training was a proponent of action research and strongly advised that the agenda include an important dimension of inquiry with village elders concerning traditional perspectives on and knowledge about river blindness. The young trainees therefore fanned out to a series of neighboring villages to interview the local population and hold focus groups with prominent elders on the issue of river blindness. To everyone's surprise it was discovered that this "local lore" included details on some of the stages in the life cycle of the principal vector—the filarial worm *onchocerca volvulus*—that had only recently become known to medical science. In any case, the experience served both to ignite a spirit of inquiry in the trainees and to promote their mastery of the western science elements in the training curricula.

The knowledge they discovered is part and parcel of what Claude Lévi-Strauss (1966) famously called *la science du concret* (concrete science): the remarkable techniques and innovations that humankind (and before it, one might say, the biosphere in general) worked out over centuries if not millennia through practical and needs-based experimentation, observation and the extended self-correction of natural selection. These might be considered precursors of the scientific method, or, contrariwise, the latter might be interpreted as essentially a précis and development of the former. In either case, Lévi-Strauss' concept highlights the proto-scientific habits of inquiry that are booked into human evolution and the knowledge that they inevitably produce over succeeding generations. And either way one consequence is a high likelihood that any human tradition will harbor aggregates of wisdom to discover and translate.

The Hausa proverb inscribed at the head of this paper expresses much the same idea. Over generations, hawks have learned nearly everything there is to know about the behavior of baby chicks. This sort of concrete understanding may not include a microscopic analysis of the chicken's genome, but it has led to a deep familiarity with the creature's daily life and an ability to exploit that ingrained knowledge very effectively for survival purposes. Such perspectives in any case enable us to see western and "indigenous" science not simply as alternate and competing paradigms or incompatible traditions but as overlapping and potentially continuous ones. A similar vision of complementarity has in fact played a prominent role for some time in the environmental sciences (Palmer, Elmore, Watson, Kloesel and Palmer 2009), in medicine (Minja and Obrist 2005) and in pharmacology (Smith-Oka 2008), due to growing awareness of the insights into botanical and zoological life and into the medicinal properties of plants that many traditional societies have developed.

However, it is the procedure of discovery learning exemplified in the Mali example and reflected in a history of action science and participatory research that is of prime interest here, because it suggests ways to make the treatment of IK in schools more effective (Tobin 2007). Any method that involves teachers in helping students to canvas and seek the accumulated insight of their families, their elders and other repositories of cultural wisdom in order to document and assess alternate bodies of knowledge would be promising and have the double virtue of developing the "sense of place" that many science educators feel essential to integrating IK into the curriculum (e.g., Glasson, Frykhom and Mhango 2006) and creating conditions of respect for local culture that may encourage its spokespeople to take part.

Broader issues at stake

The use and validation of indigenous knowledge in school settings is at the same time embedded in broader social and political issues that deserve at least passing consideration in any methodology devoted to preparing aspiring or in-service teachers for promoting the cause. Recognizing and developing IK is arguably one of those activities that has what political scientists would call contradictory payoffs: there is, at present, a real benefit to endorsing it but a real cost to implementing it in any institutional sense, a situation—as Hans Weiler (1983) classically pointed out years ago for the case of another poster child of development, popular participation—that lends itself to large gaps between rhetoric and practice. Understanding this lay of the land and appreciating its contours in particular sites is a skill every bit as important as those involved in investigating and documenting IK or coming up with curricula that include it. A good dosage of the sociology and politics of science is required, along with careful calculation of how best to advance, yet, as Michael Young (1974) foresaw and Matthew Weinstein (2008) confirms, the combination of sociology and science education has been slow in coming to fruition.

The key concern for practicing teachers and those still in training is doubtless getting a good sense of the stakeholders and of the stakes. Investigations of indigenous science may operate on mined territory of which it is best to be quite aware. As pointed out above, in certain domains like ecological and pharmaceutical science, access to native knowledge about environmental dynamics and the curative properties of drugs can be highly prized (Greene 2004) and has in some cases catapulted IK from an area of neglect to the status of hotly contested terrain (Shepherd, Anderson, Hicks, McWilliam, Eijck and Verran 2010). Yet the default case definitely remains one of second-class citizenship. These status differences between varying types of knowledge are not a matter of happenstance. As the Hausa say, *Ba banza ba, an iske ɗan jariri cikin kufai:* It's not an accident if you find a baby in an abandoned site (i.e., deserted village). In short, there's a whole story behind that unexpected discovery. The distinct stratification of bodies of knowledge is directly connected at one and the same time to a history of conquest, to differing perceptions of their relative efficacy and to the power gradient of the protagonists. These factors must be mentally mapped.

One of the prime stakeholders in the development of IK is in fact the university system itself. Higher education is in something of a contradictory position in this regard. On the one hand, it has traditionally played a privileged role in the dissemination and defense of western scientific knowledge, in addition to which the present *zeitgeist* of globalization and neo-liberal economics reform places a particular emphasis on international competitiveness and the importance of the STEM disciplines. The status and motivation structures that these commitments create cascade down to lower levels of education and to other domains

of society as well; and they help to explain why both students and parents at lower levels of the school system, whatever their personal knowledge of or affinity for varieties of indigenous knowledge, may not be very interested in seeing IK emphasized to the detriment of training in western science.

On the other hand, however, universities in African, Asian and Latin American countries are also becoming something of a beachhead for the promotion of IK in three particular respects: one political-cultural, a second instrumental and pedagogical and a third commercial.

- First, they have become a locus for increasing awareness of—and attention to—pre-existing non-Western cultural traditions within each country's borders, morally and sometimes financially supported by the parallel interest in "northern" institutions of higher education and non-governmental organizations (Morgan 2003).
- Second, a related broadening of approaches and curricula is turning out in many cases to be one key instrumental element in helping the new strata of secondary school graduates now acceding to higher education in Africa, many of whom have less familiarity with European academic customs than past cohorts of university entrants in those countries, to understand and deal with a tertiary program of study (Klos 2006).
- Third, the increasing commercial importance of selected branches of IK, like the native knowledge bases in pharmaceutical and ecological sciences mentioned above, are driving university-based investigation of those topics and producing spillover effects in other realms of academe (Shepherd, Anderson, Hicks, McWilliam, Eijck and Verran 2010).

The tug and pull of these countervailing forces inevitably creates new dilemmas and tensions for the university, as for other formal institutions in African countries. Resolution of these tensions can't easily be predicted but it is at least important that those who would promote IK in science teaching be very aware of them and able to map their incidence.

The principal challenge

This brief tour of some of the contextual issues that are posed by the methodology that Hewson and Ogunniyi propose brings us back to the basic conundrum that they address: how to take fuller account of indigenous knowledge in the teaching of science in South African schools and hopefully at the same time boost student achievement in the subject matter. And it makes clear that there is one additional and more basic challenge.

The authors, it will be remembered, were tackling the third in the sequence of steps outlined by Barnard and Kawagley (2005) for introducing IK into the school curriculum, the two prior ones having been the documentation of different species of indigenous knowledge and the identification and reconciliation of the epistemologies that underlie them. It seems no exaggeration to say that the difficulties experienced in devising appropriate pedagogical strategies stem in good part from the fact that the prior steps have not been fully accomplished either in South Africa or in many other places around the world, at least to judge by the experience on which Hewson and Ogunniyi's methodology appears to be built. Though western science generally prescribes basing inquiry and theory on a foundation of previous discovery, the procedure outlined in their article includes little study of lessons learned from South African IK or discussion of its varying epistemologies; and even the methods of inquiry included in their scheme seem weak as a means of

uncovering it, given the lack of appeal to reliable sources of such knowledge and of more systematic involvement of parents and communities.

Hewson and Ogunniyi can scarcely be faulted for this. Constructing such a "multicultural science" is a daunting task. In fact, most of the literature on that topic (e.g., Atwater 2010) deals more with how western science can be introduced to increasingly multicultural student bodies than it does with how the alternative knowledge traditions that those students may represent can best be evoked and reconciled. The puzzle of cultural hybridity remains poorly addressed in conceptual terms, despite the fact that is more and more of a demographic reality and so is being resolved—or at least negotiated—to an increasing degree in practical ones.

In the South African case and in an increasing proportion of others, teachers are operating in a distinctly *multicultural* environment and so dealing not with a single alternate body of tradition and knowledge, but in fact with several different types of varying provenance and sophistication. The Republic of South Africa has many. Moreover, these forms inevitably interact and cross-breed, a process likely to be accelerated by their juxtaposition in schools and attempts to examine them side-by-side. Allison Gonsalves, Gale Seiler and Dana Salter (2010), for example, argue for the virtues of hybrid viewpoints on scientific inquiry, but offer few practical guidelines for elaborating them and neglect the fact that admixture of the western scientific method with variant assumptions and procedures has usually been treated as adulteration in our own historical tradition.

Is there a common core, or at least a thread of mutually understandable and mutually acceptable insight, that can begin tying together a genuine multicultural science and serve as a bridge among its various elements over which teachers and students may cross? William Cobern and Cathleen Loving (2001) maintain that "good science explanations will always be universal"—from whatever tradition they come—and therefore suggest "what works" and the attempt to understand *why* it does as a simple and widely-accepted criterion for dovetailing the different bodies of knowledge. Practical consequences, it is true, constitute a recognized standard for judgment in many African traditions. *In ta yi ruwa, rijiya; in ba ta yi ba, gadumbo,* they say in Hausa: "If it yields water, it's a well; if not, it's a hole". However, this perspective also leads Cobern and Loving to counsel against trying to fully integrate western science with various manifestations of IK for fear that the first will inevitably dominate and exercise hegemony over the second. Indigenous viewpoints should constitute a different order of insight, they insist, a sort of *tertium quid* that "can be valued for its own merits, play a vital role in science education, and maintain a position of independence from which it can critique the practices of science and the Standard Account" (p. 50). They offer little tactical advice, however, for getting IK into such a catbird's seat.

In short, the prime difficulty with the methodology proposed by Hewson and Ogunniyi seems to be that the prior conditions defined by Barnard and Kawagley have not been realized in their setting—or much of anywhere, for that matter—and that there is thus an insufficient basis for developing fully informed pedagogical approaches. The conclusion, I feel, is simply that the endeavor must be carried out in close tandem *on all three fronts*—alternately eliciting and documenting IK, identifiying the underlying epistemologies and developing instructional approaches for introducing students to its interface with western science. Pedagogy cannot outpace discovery and philosophy. And such a compound strategy will entail both drawing on personnel from other sectors of society and the university who have advanced significantly in this realm and building more of a discovery learning and action research procedure into the methodology.

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