Constructivism and the "Great Divides"

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► **Context:** To speak of constructivism – and in particular of radical constructivism – in education is to place oneself on a field which, like any other academic field, is the scene of tensions, debates, and indeed battles. While such controversies are, predictably enough, fought out between the partisans of constructivism and those defending other theses, they are also fought out between the constructivists themselves, as a number of group works have brought out (e.g., Steffe & Gale 1995; SRED 2001). In other words, constructivists do not express their views in unison whenever there is a question on the development of knowledge (an individual or collective matter?), the underpinnings of knowledge (be they of a psychological, sociological or other type) or, as humorously noted by Quale (2007), that "sin" which is said to consist in the relativist mode of questioning or critique authorized by constructivism. ► **Purposes:** In this paper, we would like to contribute to this discussion and to this plurality of ways of embedding oneself in constructivism, in particular by bringing out (as was so acutely shown by Ernst von Glasersfeld 1987a, 1995, 2007) that while constructivism offers a basis on which to revisit the question of knowledge, its contributions nevertheless extend well beyond this single preoccupation. By reincorporating "the properties of the observer" into his or her discourse as well as the conditions, stakes and issues surrounding the utterance in question, in short, by reincorporating the question of power into the utterance-making, constructivism also provides a basis for revisiting the "Great Divides" – that is, the (unequal) relationships between the various forms of knowledge as well as the (unequal) modes of evidence and authority that accompany these relations. ► **Method:** Through an examination of three topics, that is the "racism" of intelligence, the Semmelweis affair, and the question of endogenous knowledge, we will attempt to explicate various insights afforded by constructivism. ► **Conclusion:** So doing, we will show that radical constructivism, in its recognition of the plurality of possible modes of description and explanation, contributes to a form of epistemological democracy. ► **Key words:** Epistemology, science education, discipline-based power, orthodoxy, relationships between knowledges.

Introduction

As is testified to by the numerous publications and curriculum designs drawing on constructivism, Ernst von Glasersfeld has inaugurated *a way of viewing* the issues of cognition and learning. This he has accomplished, in particular, by showing the value and relevance of picturing knowledge from a pragmatic perspective – in other words, not in terms of what knowledge *states to be the case* but in terms of what it *enables us to accomplish*. From this point of view, knowledge is grasped in relation to ability, capacity and empowerment, as is shown in this excerpt from a text that von Glasersfeld delivered in French:

> "The success of an action or an operation is the basis on which we may gauge the validity of this action or operation. […] To succeed, however, it isn't a "correct" image of the world that you need but rather a kind of *map* that allows you to avoid the obstacles that the real world might place along the path of your actions. In English, I have illustrated this point by referring to the difference in meaning between the words "*to match*" and "*to fit*." In French, I don't know how you make this distinction. What I mean is that the main thing is not to devise a copy of the structure of the real world but instead to chart out or to plot out those itineraries that allow you to make your way through the world and to achieve the goals you have set for yourself.
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> "Here, a metaphor might prove handy. Imagine it is night time and there is absolutely no light to be seen. Imagine also that you are in the middle of a forest from which you wish to exit. You grope your way along. Every two or three steps, your hands or your feet bump up against some obstacle and you have to shift direction each time. Some time later, finally, you look up into the sky and see the stars, and you realize that the forest is now behind you. If, at this very moment, you were to ask yourself the question, 'What do I know about this forest?' you would have to say that the only thing you know about it consists in one possible path out of it, or, a way to travel through it. What is more, you have acquired this knowledge by making your way forward and by factoring in the movements that enabled you to go forward. That is what I mean by conceiving of knowledge as that which enables us to make our way through the world" (Glasersfeld 1985: 2–3).

This conception of knowledge is bound to make waves and, indeed, to whittle away at a few established privileges. Indeed, in asserting that our descriptions of the world are not of the world-in-itself but instead represent the world as we experience it, radical constructivism renders obsolete the epistemological/normative question of "correspondence" (between knowledge and a presumed ontological reality), with it being understood that these descriptions and knowledges are inevitably *situated*. In so doing, radical constructivism throws into question the ways we have learned to conceive of the status of knowledge – *knowledgES*, in the plural, we should like to say – not to mention the often biased modes of interaction occurring between different forms or types of knowledge. In short, radical constructivism bids us to revisit the orthodoxies and hence to cast a

critical eye over the monopolies and "Great Divides," à la Robert Boyle,[1] that these orthodoxies give rise to and which often generate social relationships of exclusion, pitting the scientific versus the non-scientific; reason versus un-reason; expertise versus amateurism; knowledge versus belief; etc. This is what we shall now attempt to show in brief in relation to three topics: the "racism of intelligence," the Semmelweis affair, and the question of endogenous knowledge.

1. The "racism" of intelligence

By suggesting that there is more than one way to map the world, radical constructivism bids us decompartmentalize the production of knowledge and to consider that knowledges are produced in different spheres and by different groups of society, as has been aptly shown by Darré (1999), and not just within the hallowed halls of academia.[2] For this reason, constructivism poses a challenge to what Bourdieu called the "racism of intelligence," which consists in ascribing the ability to produce valid bodies of learning and knowledge to certain groups only (Larochelle 2007a; Larochelle & Désautels 2007). In other words, students may not know whatever it is that we want them to know, but, according to radical constructivism, they cannot be considered to be suffering from a knowledge deficit for all that (see footnote 3). They too have developed knowledge and ways of doing things that enable them not only to engage viably in their day-to-day activities but also to make sense of their experiences and their paths in the world, including their school itinerary.

In this connection, the following episode is most instructive. It took place in a high school science class one fine Friday afternoon during one of those Australian heat waves. To David Geelan, the physics teacher, it was fairly clear from the outset that he was unlikely to stimulate much interest from his students slouched over their desks. All the same, he began to write out on the blackboard Newton's first law, the law of inertia: "An object remains in a state of rest, or of uniform motion in a straight line, unless acted upon by an unbalanced external force" (Geelan 2002: 23).

From then on, the afternoon turned decidedly hotter. Many of Geelan's students were soccer buffs, and to them Newton's law seemed to be only so much rubbish. Geelan soon found himself to be dodging a combination of corner shots and head shots from some decidedly un-docile students of his (Geelan 2002: 23–24):

> "*Neil:* But it doesn't! The first part is OK – if something's not moving, you have to have a force to make it move. But if something is moving, it's eventually gonna slow down and stop.
> *Teacher:* No, that's because there are forces acting that we don't notice. When things are moving they often have friction forces, from air resistance or whatever. That's what slows them down.
> *Neil:* Yeah, but the whole point is that Newton's Law isn't right, 'cos if something is moving it *will* slow down. So why make up a law that says it won't? What's a law like that good for?
> *Teacher:* OK, then... think about what happens in outer space, where there are no forces like friction and wind resistance. Out there, an object will continue in the same straight line forever.
> *Kelly:* But how do we know that? We've never been to outer space.
> *James:* Yeah, and you're always telling us that science is about trying to explain our own experiences – in our experiences, things always slow down and stop after a while. So Newton's Law is no good for explaining our experiences.
> *Phillip:* Lots of stuff in physics is like that though. It took ages for the scientists to even work out whether light's a particle or a wave, 'cos you can't see it or feel it or anything.
> *Jill:* Yeah, they still don't know. And there's other things in science – like atoms and molecules – that you can't experience: so what's the use?
> *Teacher:* I'll need some time to think about your point, but I think it's well taken. Perhaps we can investigate ways that Newton's law *might* be useful. Um...well, if you go on to do physics at university you will need to do this stuff."

This episode is instructive on three counts. To begin with, it shows that these students did not wait until the day they were in a physics class to develop some notion of what an object in motion does or does not do. It is on the basis of what they already know that they grapple with the knowledge that is being taught to them, as was shown repeatedly by Piaget. And this has also been shown for more than 30 years by a body of constructivism-based research in which students of all ages have been invited to give their point of view concerning not only particular concepts (for example, in relation to the notions of particle, ecosystem, revolution, objectivity, etc.) but also the fields from which such concepts are drawn (what is science, history, geography, etc?). The objective is to better grasp why students apparently do not understand – or, rather, do not understand the way we think they ought to – the contents of school disciplines or subjects.[3]

Secondly, it shows that students behave every bit the same way that scientists, academics and researchers do: they do not take the knowledge being proposed to them at face value. They subject this knowledge to trial; they test its viability by transposing it into a world in which soccer balls are confronted with sources of friction and resistance – with the rough ground of life outside the laboratory, to borrow from Wittgenstein (1953). And it is on this basis that they rule the knowledge in question to be un-receivable, or at the very least irrelevant. This knowledge does not appear to them to be a knowledge that will enable them to enrich their experience of the world.

Finally, this episode opens itself to a third, less optimistic interpretation. For it shows how enterprises dedicated to seeking and expounding truth – and, in particular, an exclusively discipline-based form of reason, as is often the case in schools – also convey numerous epistemological taboos that ensnare teachers and students alike.

To re-cap: at the very outset, the teacher presents a statement, a principle as if it has emerged out of nowhere, without any reference to the properties of the observer (to borrow from Foerster 1992) or to the context in which this statement could be seen as offering a different but worthwhile way of formulating the problems relating to the movement of projectiles. In addition to being different but worthwhile, such a formulation might well prove to be upsetting and indeed threatening to whatever other principles or theories are held to be credible. The students have no rea-

son to suspect that the underlying principle derives its legitimacy from commitments and trials that bear very little relationship to any sort of immediate interpretation of the real. For this reason, these young people are entirely justified in throwing up some resistance. After all, in their world, objects that move, such as soccer balls, always wind up stopping somewhere if there is no one to give them a new kick.[4]

The teacher is aware that there is some basis for the resistance he has encountered, and yet he does not really grapple with it reflexively, epistemologically speaking. Quite likely, he has been ensnared by that mode of socialization characterizing the modern-era school according to which one does not learn for personal or utilitarian reasons (for example, about how to run a business or read the family's hand-written deeds). In fact, as Guy Vincent (1980) has aptly shown in a paradigmatic book on primary education in France, with the advent of this mode of socialization which he calls the "school form" (also sometimes referred to in English-language writings as the "grammar" of schools), learning is cut off from "doing" – cut off, in other words, from practices of reference or from contexts having meaning for students – and is thus placed under the domination of objectified, disciplined and discipline-inducing knowledges (with these knowledges often being selected for their potential to standardize behaviors and world views).

He thus avoids inviting (or forgets to invite) his students to unpack their descriptions – and Newton's descriptions – at the same time or in parallel fashion so as to bring out the limitations and the foundations of both. Instead, he comes to the defense of the canonical description. And in the same breath, he manages to compound the conundrum by introducing the notion of forces whose action goes unnoticed all the time. The students remain as dubious as before. It is not as though they can be easily persuaded to see things differently via depictions of outer space, of a great emptiness devoid of friction and resistance.

The discussion quickly aborts, much to the dismay of the teacher, who is compelled to impose the argument of "knowledge that will come in handy one day" and, in a way, to reinstate "the biased modes of interaction," to borrow from Delbos and Jorion (1990: 8). And to the detriment of the students, too, who are thus deprived of gaining some hands-on yet reflexive experience in ways of mapping worlds that diverge from their usual ways of picturing the real – i.e., ways of mapping the world that diverge from their own in terms not only of the basic assumptions but also of the aims of the project being pursued. At the end of this exchange, the students are still unclear as to what possible use the knowledge of these laws might be of to them. Nor are they any closer to fathoming how scientists manage to locate such mysterious entities as waves, particles, atoms and molecules, as two of the students also point out (Phillip and Jill).

After enduring this kind of regime for several years, many students will simply stop asking questions. They will lose any interest they might have once had in science classes, for they will have learned that there is only one right answer. They will also learn that the *answer that counts* is not the one that they may have developed on the basis of their experiences. Above all, they will learn (and on this point we borrow from Darré 1997) that their practice-related point of view and any reflections that they may advance in keeping with this viewpoint may not serve as the basis of a criticism of official knowledges. In other words, they will learn that while some people may criticize their views, they are not entitled to repay the compliment. Hence, they will learn that "there is, or can be, such a thing as an indisputable view" (Darré 1997: 34). For an idea of the weight that is carried by this kind of lesson, it is worth contemplating this verbatim of an exchange that followed upon a comment by a female Amerindian student about her fear of giving the wrong answer in class (Allen & Crawley 1998: 120):

> "*Researcher:* Is there just one answer? Maybe you just see the problem differently.
> *Girls:* [Laughter]
> *Carolyn:* No, it's wrong.
> Researcher: But what about in science class? Is there always just one right answer? Could there be more than one way to explain things?
> *Mary:* Two ways. There're two ways. The right way and the wrong way."

And, when one factors for the constant repetition of the message, plus the need to simply survive in the school system, it is quite possible that students will end up convinced that scientists effectively have a special window onto those invisible forces or beings that surpass the understanding of "mere" students. There is indeed a very strong chance that they will end up reconfirming the "racism of intelligence" that we referred to above. In the process, they will also be handing over to the so-called "experts" and the scientists the power to describe and explain the world – not to mention, dare we say, the power to *manage* it.

2. The Semmelweis affair

When constructivism throws into question the racism of intelligence, it also invites us to throw into question the belief in the transcendence of knowledge (including scientific knowledge). For it stands to reason that if knowledge, or knowledges, indeed represent points of view, this also means that knowledge or knowledges are situated in "a particular locus of a society or a culture" (Rocher 2005: 24). Knowledge is thus embedded in values and ideologies; it is also enmeshed in assumptions as to what counts as legitimate knowledge in a given group or culture. The upshot is this: if knowledge is, according to radical constructivism, to be conceived of in terms of the power or capacity it gives to individuals for making their way in the world, then knowledge has also to be viewed in relation to other forms of power – and of discipline-based power in particular.

In this connection, there is much to be learned from the case of the Austro-Hungarian physician and medical researcher Ignaz Philipp Semmelweis, who developed his revolutionary views on infectious pathology and hygiene at the Vienna General Hospital. Long before Pasteur's work developing the germ theory, Semmelweis postulated the infectious nature of puerperal fever (also known as "childbed fever"). According to explanations current at the time, this fever came about as the result of all manner of things – fate, the dubious morality of unwed mothers giving birth, foreign-born interns, etc. Semmelweis, on the other hand, managed to identify doctors themselves as being the primary vector in the spread of this disease. In a further radical stance, he advocated the application of stringent measures of hygiene as a means to reduce

the mortality rate of women in labor. Specifically, he required that doctors wash their hands in chlorinated lime solutions prior to examining expectant mothers. In Semmelweis's own obstetrics unit, in which he tested out his ideas, the mortality rate plummeted from 18% to 1% in a very short time; thereafter, not a single mother in the care of his unit was to die from puerperal fever (Broad & Wade 1987).

On the basis of such results, one might think that Semmelweis had made two groundbreaking accomplishments to his credit: he contributed not only to the improvement of the conditions under which women gave birth, but also to the advancement of knowledge. However, aside from a few trusted colleagues, Semmelweis's peers saw things quite differently. Practically no one believed what he said or could be persuaded of the scientific basis of this knowledge, which did not fit with any of the theoretical frameworks or protocols admitted at the time. Whether in Vienna or abroad, Semmelweis and his theories met with almost universal disbelief, if not outright hostility.

In other words, as Foucault has emphasized, while it may be possible to speak the truth outside of the disciplinary space, "one is 'in the true'" (Foucault 1981: 61) only within this space and only by reactivating the authorized ways of saying and doing things. Knowledge and power are thus intimately bound up with one another, as the Semmelweis affair goes to show, but as is also revealed by the question of endogenous knowledge, as will be developed in the following section.

3. Endogenous knowledge

As was noted above, for lack of an epistemological reflection concerning the production of knowledge, David Geelan's students are prone to becoming persuaded that only scientists have the capacity to describe and explain the world, or to disclose what philosophers usually refer to as the "first qualities" of that world. These students are also prone to developing a relation with knowledge that is hardly likely to be emancipative. This relationship, if they do develop it, will reconfirm the established way of thinking (the orthodoxy) and its "Great Divides." In short, and considering the dogmatic character of science teaching,[5] it is rather unlikely that these students will be afforded the opportunity to develop potentialities for grappling, here and now, with the socio-technical controversies now confronting our societies (Callon, Lascoumes & Barthe 2001). For want of gaining some understanding of the relative, contingent character of scientific knowledge, these students will have a hard time picturing themselves as partners qualified to take part in the very definition of what constitutes a problem in the "risk society" in which they live (Beck 1992) – that is, a society crawling with entities whose effects on the reconfiguring of our common, shared world are unpredictable. Depending on whether this world is "inhabited" or not by GMOs, nuclear radiation, gene therapies, AIDS, or nanotechnologies, it is not the same common, shared world for everyone.

As can be readily seen, epistemological issues are inseparable from the world of politics, which may be defined as the ways and means that are employed to organize active, collective participation in the body politic. That much is clear in the Western world, where the old theological order, which was controlled by the clergy and founded on a revealed truth, was gradually supplanted by a secular, disciplinary order, controlled by scientists and scholars and founded on a truth said to be disclosed (or proven) but that is every bit as transcendent as what preceded it. Indeed, from one order to the next, the same vantage point is occupied and maintained – namely, that point from which it is possible to state the truth about the world.

The Biblical narrative has, obviously, been replaced by Galileo's metaphor of the grand "book of nature"; considering, however, that nature would appear to be a book written in the language of mathematics, it would for this reason appear to be an "open book" requiring no work of interpretation provided that one had the appropriate code (Biagioli 2006). According to Legendre (2004: 37), this structure of thought would appear to be characteristic of what he has called the Western Text:

> "All Westerners are the direct inheritors of this vision of Nature as a message to be deciphered, and of the image of Power as a despot exercising his rights of mastery over the universe. The elimination of the divine figure […] and its replacement by secular figures – Progress, Science, Democracy: all figures promoted since the Age of the Enlightenment – serve to show, with the perspective afforded by history, that the *Western Text* carries one and the same structure of thought over from one millennium to another."

In other words, whether it is a theological or a disciplinary order we are dealing with, in either case, it is the same miracle that is effected: knowledge that has been produced by human beings is freed of all social contingency and, as such, becomes laden with the privileged status of objective, universal knowledge. As a result, this knowledge would appear to acquire, first of all, the power to bring discussion and debate in society to a close. It would also appear to be endowed with the capacity to sanction, justify or arbitrate a certain social distribution of power, in particular by causing this order to appear natural or self-evident. This power manifests itself radically in the so-called developing nations, as has been shown by a certain body of research in anthropology and science education.

Concerning anthropologists

For decades now, Western anthropologists have studied other cultures, examining their mores, traditions, and political and social practices, including the way other cultures go about producing their knowledge. Likewise, for many years, Western anthropologists operated under the assumption that a magical representation of the world held sway over the minds of the inhabitants of these exotic cultures – whence the "primitive" belief in the effects of the doings by fictional entities inhabiting the natural world. This was the era of "*They* believe, whereas *we know*!", as Delbos (1993) has so cogently expressed the Western anthropologists' underlying worldview.

It is true that the so-called "primitive" mindset eventually came to be viewed as exhibiting a bias of the anthropologists' own devising. That being said, the norm used to gauge the quality of the knowledge produced in these other cultures – knowledge that, moreover, is referred to by such terms as ethnomathematics or ethnosciences – was and continues to be Western knowledge, which, as everyone knows, has nothing "ethno" about it. According to Descola (2005), this manner of characterizing endogenous sciences as *ethno*sciences helps to create or entrench the false

impression that they share in a universal venture of decoding the world; at the same time, this view implicitly relegates these other sciences or knowledges to a lower ranking in the hierarchy of knowledge:

> "This procedure serves to reify certain portions of indigenous knowledge; it does so by establishing their compatibility with the modern division of science – in particular as the result of establishing, upstream, the boundaries of the [indigenous] field [being studied] on the basis of classes of entities and phenomena that the corresponding [Western] disciplines have delimited into self-constituted objects of study, against the overall backdrop of the world. […] At that point, it becomes increasingly difficult to avoid falling prey to the illusion that the objectification of the world courses down the same natural slope everywhere, in a continuous flow hindered, apparently, by the occasional boulder occurring in the form of magical thinking. Such obstacles are nevertheless viewed wistfully as constituting testimonials to an as yet imperfect apprehension of the regularities of the physical world and to the ambition to exert surer control over this world" (Descola 2005: 124–125).

Descola's thesis, and his views concerning a reifying procedure, is tellingly – if unwittingly – illustrated in the research conducted by Berlin et al. (1996) concerning herbal medicine among the highland Maya of Chiapas. This team of researchers identified more than two hundred plants that are used systematically by these Amerindians in the treatment of gastrointestinal ailments. They conclude that:

> "[The] highland Maya traditional medicine is an ethnoscientific system of traditional knowledge based on astute and accurate observation which could only have been developed on the basis of explicit empirical experimentation with the effects of herbal remedies on bodily function" (Berlin et al. 1996: 45).

Now, on what basis have these researchers reached this conclusion?

It is important to note from the outset that these researchers adopted a (Western) theoretical framework, which locates ethnomedical systems according to a separation operated between two distinct realities. The first such reality, which is usually visible, is said to be natural, whereas the second, often invisible, is referred to as being supernatural. According to these researchers, the Maya's "healing practices" can be classified in reference to both these realities and to their underlying cognitive frameworks. The first such framework is based on natural causes whereas the second is based on supernatural causes pertaining to souls, divinities, demons, ancestors and sorcerers.

In their field research, the team nevertheless stuck to their so-called "self-constituted objects of study," to again borrow from Descola, and which in their case referred to the framework of natural causes. They thus compared, on the one hand, the symptoms of various ailments and the therapeutic effects obtained from the use of these plants, as reported by their Amerindian sources, with, on the other hand, the results of laboratory analyses designed to identify what is commonly referred to as the active principle of various isolated substances.[6] For example, these researchers reported lab results showing that extracts obtained from the leaves and stems of a plant resembling mistletoe (*A. ligustrina*) and used by the Maya to treat diarrhea produce effects on the longitudinal muscle of guinea pig ileum and on cell cultures. Socio-epistemologically speaking, however, it is clear that the scientific categories current in Western molecular and medical biology constitute the norms used to assess the quality of this endogenous knowledge.

In short, the Maya of Chiapas are thus presented as having developed systematic, effective knowledge which, according to our norms, offer evidence that their cognitive actions are rational and indeed scientific. It is tempting to summarize this point of view as "*We know*, but so do *they*!" However, such a conclusion can only be reached by ignoring or eliminating the very large role played by a set of cultural practices in which the use of medicinal plants takes on shape and meaning for these Amerindians. In addition, it presupposes that the Maya make the distinction between "nature" and "culture" as we do. All in all, we are dealing with the scientization of endogenous knowledge, to borrow from Agrawal (2002), which has a mutilating effect since it eliminates or blocks out the other forms of knowledge and the practices in which the particular area of endogenous knowledge is embedded. We have here an example of what Semali and Kincheloe (1999) have called the "epistemological hegemony of the West," which in the context of colonization and post-colonization has transformed endogenous knowledge into subjugated knowledge, of interest merely for its value as additional odd folklore – at least until recently, judging from the rising number of cases of biopiracy.

However, as we use the concept here, "endogenous knowledge" means that this hegemony – and the classification of knowledge conveyed by it – is not completely watertight and continues to be the subject of debates and critical reappraisals. Precisely, it was within the framework of reflection on the status of traditions of knowledge in Africa that Houtondji (1994) proposed the term "endogenous knowledge" in lieu of the terms "traditional knowledge" and "indigenous knowledge." He has argued that the qualifier "traditional" – whose meaning derives from a contrast with the qualifier "modern" and its connotations of prestige and renewal – introduces an asymmetric relationship between the knowledge systems in question. It creates the impression of dealing with a body of static knowledge that is definitively rooted in the past and that possesses no specific historicity or dynamic. Likewise, Houtondji stresses, the qualifier "indigenous" not only always conveys a pejorative connotation but also refers to the perspective that a foreign observer adopts toward a necessarily local knowledge tradition. Indeed, it would never occur to Western observers to use this term to qualify their own knowledge. All in all, both these appellations marginalize the knowledge to which they are applied, fossilizing them, temporally speaking, or turning them into a local curiosity, spatially speaking. In this context, then, the term "endogenous knowledge" appeared to be more appropriate, for it evokes "the origin of the knowledge systems in question by referring to them as internal products stemming from the specific cultural base, in contrast with exogenous knowledge, which is imported from elsewhere" (Houtondji 1994: 14–15, our translation). Obviously, as the author also notes, this qualification has its limits too, since what is endogenous today might have been exogenous in another time (e.g., corn farming in Africa). In other words, an "imported" variety of knowledge may be assimilated and mastered to the point of becoming embedded in the specific culture.

So doing, the previously exogenous knowledge becomes an "endogenous knowledge" – that is, a "knowledge that is experienced by society as being an integral part of its heritage, in contrast with exogenous knowledge, which continues to be perceived, at this stage at least, as items belonging to another system of values" (Houtondji 1994: 15). In short, the concept of endogenous knowledge encourages us to break with the "great but unequal divide" between various traditions of knowledge, along with the stasis induced by this perspective. It also encourages us to create a space for dialogue between civilizations, as opposed to demonizing or idealizing one or the other in an agonistic confrontation.

Concerning science teachers and educators

In their baggage, the colonizing nations brought not only religious dogmas with which to replace centuries-old beliefs but also a "true" form of knowledge about the world with which to eradicate the primitive mind founded on magical thinking. In this endeavor, the school would serve as the means and locus of socialization charged with disseminating the West's disciplinary order. To begin with, this regime called for disciplining bodies and making them obedient via the rituals typical of the "Western schooling habitus" (Larochelle 2007b). It also called for disciplining minds in keeping with the intellectual requirements of the curriculum imported from the "home country," all as part of pursuing the civilizing mission. Students in the colonies would thus learn to read, write, do arithmetic and divide up the real according to the discipline-based categories invented by Westerners and in the language imposed by the conqueror – French, English, Spanish, Portuguese, and so forth.

This process, which goes forward today in the form of a planet-wide standardization of school curricula (de Brabander 2000; Lyons 2006), constitutes a form of symbolic violence (Bourdieu 1997). According to Ogunniyi (2007), science education in the so-called developing countries[7] is probably the area where this violence has been exerted to the most damaging extent:

> "Indeed, of the school subjects that were imposed on learners from [of] indigenous cultures, science (taught as a culture-free subject) has been regarded by several scholars as perhaps the most notorious in eroding indigenous cultures and associated knowledge of their environment and values, making them lose their sense of identity" (Ogunniyi 2007: 979).

In this connection, the study conducted by Waldrip and Taylor (1999) in Melanesia is very insightful. These researchers performed a series of interviews on the subject of so-called natural phenomena with, on the one hand, teenage boys and girls who attended a secondary boarding school located on a Pacific island and, on the other hand, the elders inhabiting these young people's native village.[8]

From the start, these researchers were surprised to discover that the students either did not recall or pretended to be unable to recall traditional explanations for various natural phenomena. For example, with the exception of one older male student, none of the interviewees mentioned that according to their elders, the hurricane season could be unleashed by eating certain kinds of fruit or chopping down trees at a certain time of the year. What was more, these young people seemed to vaguely ashamed of their native culture and felt that their parents' traditional narratives about natural phenomena (including winds, waves, thunder and lightning, etc.) were ridiculous if not indeed idiotic.

It thus appears that while these students had been interiorizing the school hierarchy of knowledge, they had also been affected both personally and socially. As the great majority of them were unable to find work in the communities located on the island at the end of their high school studies, they then had to go back to their village to settle down. They then experienced feelings of estrangement toward their home environment, which in turn became a major source of disturbance for the local culture, particularly in the form of intergenerational conflict. On this subject, it is worth listening to the comments provided first by two elders and then by one of the older students, who was endowed with a solid capacity for reflexive thinking (Waldrip & Taylor 1999: 295):

> "*Laki*: [The younger generation] did not know the old ways. They see them as foolishness. They think they know better.
> *Lapun*: The young people think that the old ways are rubbish."

In contrast with these elders' views concerning the young people's ignorance of or contempt for traditional ways, the older male student instead felt that the traditional ways could be useful for surviving in the village but that in this situation school knowledge was not all that helpful (Waldrip & Taylor 1999: 299):

> "*Aso*: Because school only helps in the village if you have money. If you don't have money, traditional skills and knowledge are far more important. Because you can do things, all the resources are there. If you don't know how to handle them, and, say, build [a] house with local bush materials and all this, it would be quite hard for you to survive in the village."

It is rather clear that the clash occurring between these two cultures does not take place on an even playing field. It is detrimental to one of them, which, like many other cultures, is threatened either with becoming extinct or with becoming a mere repository of folklore. Key to this process is the relationship that these young people, as students, develop with knowledge and power and that prompts them to discount the value of their own culture.

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Conclusion

Throughout this paper, we have attempted to show that: (1) radical constructivism, in its recognition of the plurality of possible modes of description and explanation, contributes to a form of epistemological democracy; and (2) by the same stroke, radical constructivism also throws into question the monopolies and the "Great Divides" that, from the start, establish a pecking order among knowledges and those who would claim to represent them. Thus, this theory also serves to bring out how the orthodoxy suffered in varying degrees by David Geelan's high school students, Ignaz Semmelweis, or Melanesian boarding school students, does not constitute an ineluctable fate.

From this point of view, we believe it would be worthwhile integrating into the education of both scientists and teachers the particular manner of identifying and decoding the orthodoxy (as well as disputes and controversies) that is made possible by constructivism. It would be a worthwhile venture on at least two counts: first, by fostering a grasp of the ideological, political and social stakes, issues and impacts surrounding the production of knowledge; and secondly, by giving all current and future stakeholders the chance to gain some competency in using a mode of analysis to reflexively control the distinctions and categories everyone uses to configure the world, knowledges – and others (for a telling example, see Aikenhead 1996, 1997; see also Fourez 2007). It is a worthwhile enterprise indeed, although it is also one that comes weighted with certain risks for those who embark upon it, as Ernst von Glasersfeld (2007b: 3) has aptly pointed out:

> "To introduce epistemological considerations into a discussion of education has always been dynamite. Socrates did it, and he was promptly given hemlock. Giambattista Vico did it in the 18th century, and the philosophical establishment could not bury him fast enough… It seems that to discuss education from an epistemological point of view was a sure way of committing intellectual suicide."

Notes

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1. According to the Irish scientist and natural philosopher Robert Boyle (1627–1691), the study of nature – and thus questions of science – had to be made autonomous from the study of human affairs – and thus from questions of society. Such a move would prevent dissension and "internal civil wars" in natural science, since it would thereupon be established that in this field, the only thing that matters is what can be shown to be a matter of fact. For his opponent, the philosopher Hobbes, this divide was unacceptable, for it implied, in particular, the appropriation of questions of knowledge by a particular group. This debate thus proved to be crucial in that it brought into play issues bearing not only on the delimitation of intellectual space, but also on what counts as knowledge, and by the same token, on social order (Shapin & Schaffer 1989).
2. This section and the section (below) concerning the Semmelweis affair discuss ideas that were more fully elaborated upon elsewhere (Larochelle 2008, 2007b; Larochelle & Désautels 2003).
3. By way of example, see one of the major pioneering compendiums of research on this subject brought out by Driver, Guesne and Tiberghien in 1985; see also Audigier (1993), Désautels & Larochelle (1998), Leach, Driver, Scott, & Wood-Robinson (1996), as well as the most recent version of the bibliography dedicated to the issues surrounding of students' conceptions concerning various topics in science (Duit 2007).
4. The interpretation of the movement of objects is dependent upon the theoretical frameworks structuring it. For example, as Piaget and Garcia (1983) argued, the principle of inertia was self-evident for the Ancient Chinese, for whom movement constituted the "natural state" of things in a world that was perpetually coming into being. For them, it was the absence of movement, or a state of rest, that compelled explanation. In contrast, during the same period, the Greeks adhered to a vision of a static world in which rest characterized the "natural state" of objects in the physical world (with the exception of stars); thus, for them, movement was what required explaining. Therefore, depending on the theoretical framework or the paradigm, as has also been shown by Hanson (2001) and Kuhn (1983), different problems will be addressed, and the same principle applies to students attending science classes.
5. In a recent article, Lyons (2006) reviews a number of studies dedicated to students' conceptions of school science in Australia, England and Sweden. He takes note of three recurrent themes throughout all the countries involved, namely: 1. transmissive (i.e., authoritative) pedagogy, which induces students to think that science is a body of knowledge to be memorized; 2. decontextualized content, whose lack of relevance to their personal lives appears, in many cases, to found their decision to forego further study in traditional science paths; and 3) the perceived unnecessary difficulty of school science in comparison with other course contents. These observations are confirmed by several other studies, which have brought out how science education – be it in the form of textbooks, programs or laboratory activities – is generally dogmatic, ritualized and (mono)disciplinary (Cross 1997; Hodson 1996; Lemke 1993). As a result, science education would appear to disseminate a form of *pensée unique* (i.e., doctrinaire or monolithic thinking). To paraphrase Bourdieu (2001), one might well speak of a sort of "epistemological communism," according to which science is held to produce universal truths by designating the entities that fill our world and by decoding the immutable laws of a Nature for the beholding and examining of it.

6. The findings of these researchers do not stem from any long-term personal immersion in Maya society with a view to studying the social and historical factors involved in the production of this people's knowledge, in reference to their worldview. Instead, these researchers bring into play a fictional, Westernized Amerindian observer, who conducts empirical research in conformity with the canonical procedures applying in Western experimental science.
7. As a reviewer has noticed, this type of violence is not only a "cross-cultural phenomenon": it also happens between subcultures of a "same" culture. On this subject, the research of Hoggart (1970) in the area of cultural studies is particularly instructive. For an example in the field of science education, see Roth & McGinn (1998) and Trabal (1997).
8. The boarding school mentioned in this study takes a dogmatic approach to education and makes no effort to adapt its curriculum with a view to providing some room for the local culture.

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