# Whatknowledge is of most worth?

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Abstract: From one perspective curriculum or knowledge education has undergone significant change in the last twenty years. For example, the dominance of text over context has been so modified that now it is normal for curriculum education programs at all levels to emphasise context, even at the expense of text. Science education programs, for example, would be considered inadequate of they did not in some way address issues such as sustainable resource management, pollution and environmental degradation, gender effects on science learning, and the role and status of women in science. From a broad epistemological perspective however very little has changed. The science text that we include in our science education curricula is almost if not entirely western or Cartesian science text. There is no doubt that Cartesian science is more effective than any other known science in its capacity to engender technology. It is probably also unmatched in its undesirable effects on the environment. Indigenous sciences/technologies seem to have much less effect on the environment (but population size and density are confounding variables). There might be value therefore in considering some aspects of indigenous science/technology in the school and university curriculum. There has also been increasing recognition of the potential value of some indigenous folk remedies and this has led to considerable investment in research and development of naturally occurring pharmaceuticals. This paper examines the case for including some aspects of non-western science/technology in contemporary science and where and how it might be incorporated.

## Changing views of the curriculum

How do we decide what we should put in the curriculum? The question of what knowledge is of most worth for inclusion in the curriculum has a long history. If we had high levels of agreement in earlier years it was probably because the decisions were made by a relatively small group of people working ìin cameraî. This certainly no longer the case. In fact, the study of curriculum matters is a major academic enterprise. Perhaps because of this our ideas of ìcurriculumî have undergone significant change in the post-war period. Earlier views of the curriculum as a means of representing accumulated knowledge or as a compendium of exemplars of the fields of knowledge have given way to more complex notions of ìcurriculumî as a way of reinforcing dominant social structures and power relationships.

There are at least three broad reasons for this change in perspective. One of these is a growing acceptance of the view that schooling is a powerful, multi-faceted way of socialising the young. A second reason is that we are much less sure of the value of traditional ways of classifying knowledge. We are now more likely to think of knowledge as some kind of loose continuum or web with, perhaps, prototypical nodes. This seems to be more useful than the construction of exclusive categories based on distinctive methods of proof, type of evidence etc. The third reason is the pervasive influence of constructivism. From the constructivist perspective it is less useful to think of knowledge as something that exists independently of the observer than it is to think of it as something that is constructed by each individual. All, of these influences are embedded in a complex mix of Marxist sociology, feminist theory, social justice policy, linguistics and cognitive psychology. Traditional debates about what should be in the curriculum (for example we are still very concerned about technology and its effects on national economic recovery), about process and content (what

is happening with the new wave of multi-media technology?), about block and spiral designs etc. are still important but there are newer debates about how the curriculum might be used to foster social justice or to overcome the effects of gender or the integration of children with impairments into the regular school.

Context, pedagogy and text,

It is helpful to think of the curriculum domains (mathematics, music, science etc.)as having three interactive components - context, pedagogy and text. Each of these has been influenced by our changed views of curriculum. In science education for example there is concern at all levels of schooling to study the social and environmental effects of applied science - effects such as environmental degradation and the seemingly profit driven exploitation of non-renewable resources. These contextual dimensions are no longer seen as add-ons or matters at the periphery of science education - they are now given a great deal of attention. So much so that I think we need to be careful that our children do not become anti-science because of our (rightful) concerns about the negative social and environmental effects of science and technology. Of course we want our children to be aware of, and concerned for, these effects but problem-based science education curricula need to be monitored to see that they include problems and solutions (or management strategies).

Environmental effects are important but there are other contextual matters to consider. For example, there is ongoing concern about ways in which women (and minority groups?) are represented in the history of science, in science education and in the control of the science enterprise. At one end of the spectrum there are calls to recognise the achievements and competencies of female scientists so that students understand that science is not solely a male domain. At the other end of the spectrum that have been calls for the deconstruction of science so that it can be rebuilt in the public domain. It is argued that if we were to do this then everybody claiming an interest in science could have an effect on its construction and hence it would be inclusive rather than exclusive.

Science education pedagogy has not been immune from these influences. Debates about matters such as the relative merits of enquiry-learning, outcome competencies are now accompanied by debates about whether the gender-independent pedagogies that we have been using really do have about the same effects on males and females. It has been argued, for example, that the differences in individual and group dynamics for females and males is significant enough to warrant girl-only science education classes. Although the evidence is still coming in there is a growing acceptance of the belief that girls tend to be more cooperative than boys and that boys tend to be more competitive than girls. If this is so then there is a prima facie case for the girls only argument. There have also been speculations about there is a gender dimension to learning styles.

Although there are still substantial matters about how we learn to be resolved there has been a general swing away from viewing the school learnerís task as one of comprehending and organising received knowledge to a view in which the learner is seen as an integral part of the very construction of knowledge itself. This constructivist argument is now so widely accepted that it is almost in the realm of commonsense. Having said that however some state-level agencies have tended to move away from considerations of this type and back towards an emphasis on content. To some extent the pendulum swings back and forth but there is little doubt that curriculum discussions are more complex now than in earlier times.

Although we can identify text, context and pedagogy they interact so much that there is usually no great gain in treating one dimension in isolation. Hence, when we come to consider science education text we are implicitly considering the other two dimensions. How then are we to decide what text (or content) should be included in a science education program? There are many ways that we can go about the task. We might for example argue the processes of science are at least as important as the factual material - if not more so. When we go down this track we have to identify at least some of these science processes. This is not particularly difficult at the elementary level because they include things such as observation, hypothesising, measuring, estimating, describing, recording and reporting. From this perspective process and content become recursive because the processes are the content. This has certainly been tried but it is impossible to teach these processes without applying then to some non-process content. We could take a different approach and argue that first things should come first. That is, that science is essentially a linear and incremental domain in which the principles need to be learnt first so that that later learning can build on prior learning - a form of scaffolding. We could take a student-driven approach and emphasise relevance. Young children seem to be very curious about plants and animals and their general functioning. This suggests that the content might well focus of gross natural phenomena in the early years. In sense these all represent a paradigmatic approach in which we try to present the central features of science as a form of enquiry or discourse. As I indicated earlier it is quite possible to develop a problem centered curriculum in which the emphasis is on creativity and problem-solving. Overlaying all of these considerations is a possibility that certain science content is inherently more interesting to girls than boys and vice versa of course.

These perspectives all provide a guide to the selection of material for the curriculum but they all have one thing in common - they are based on a particular view of the material and spiritual worlds. This particular view emphasises the separation of the material and the spiritual, the observer and the observed and the notion that effects have physical causes. When we consider how effective this kind of Cartesian thinking has been there can hardly be any doubt about its technological productivity. No other belief system has been so effective in engendering technological development. If this were to be the sole criterion for the selection of science education content there would be no point in further debate. Cartesian science wins hands down! Of course it isnít quite as simple as this. I have already mentioned concomitant problems of environmental degradation etc. These are now on a scale where it is difficult to sustain our confidence in the limitless power of science to overcome all problems. There is another dimension altogether and this has its origins in the idea of inclusiveness. All indigenous groups have worldviews that incorporate various observations and speculations about the natural environment. Although there are often incompatibilities between western science and indigenous science (Johnson , 1992) we should not conclude that the disjunction between western and indigenous belief systems is absolute. Hewson & Hamlyn, (1983) for example note that:

Sotho people may be at a relative advantage in learning about heat energy when compared to their western counterparts because their existing knowledge of heat is, in some sense, close to a kinetic view.

We can reasonably ask why indigenous science is rarely or minimally represented in science education. Such a question might be dismissed out of hand by asserting that indigenous belief systems are

antithetical to scientific reasoning. They are primitive and belong in the realm of superstition and so are not subject to the requirements of rationality. But is this really the case? Perhaps we need to distinguish the processes of rationality from the content ore assumptions to which these processes are applied. Although there is some reason to believe that whole groups of people can behave irrationally, as for example in the so-called Jonestown case, it is more generally true that we are more or less rational according to our circumstances. It is misleading to speak of indigenous peoples as a homogenous group but one can say that all humans strive to make sense of, or construct, a coherent view of the universe and their place in it. Indigenous belief systems combine experiential knowledge of the natural environment with speculation about the metaphysical world. The resultant body of knowledge is systematic and coherent in that all of the components are in relationships. There are no outliers. This is their strength and their weakness. On the one hand everything is explained (and not just described) -they are closed systems. On the other hand they are not readily amenable to internal change. In the absence of contact with more complex technologies the resultant systems are stable over very long periods of time. This stability comes at a price because there is no room for alternative descriptions or explanations. In many such systems there is no concept of chance for example, because everything has an explanation. Because of the continuity of structure and function the same principles apply to social organisation and this is one reason why such social systems can be stable over very long periods of time. It could also be argued that this emphasis on equilibrium is evident in the relationship between indigenous groups and the natural environment. It is quite clear that indigenous peoples have not damaged the natural environment to anything like the same extent as European peoples have using western science. No doubt this is in part a result of such belief systems and the concomitant low technology but it is also partly due to relatively small populations and low population densities. However, I think that one can reasonably conclude that all groups seek some form of social and spiritual equilibrium. For example Amuah (1989) writes:

If one of the essential functions of theory is to help the mind transcend human limitations, it will be fair to say that both the diviner and the physicist are making the same use of theory to transcend the limited vision of natural causes provided by common sense.

In recent years, as we have been forced to acknowledge the finite nature of some of our resources, we have also become much more aware of the general principles of conservation and of active management of our resources. Concepts such as sustainable development and renewable resources are now commonplace. Despite the confounding factors of population size and density some elements of our thinking about these matters appear to be converging with indigenous beliefs. Western science and indigenous sciences are already on a convergent path. The result will not so much be the incorporation of one into the other. It is more likely to be some blend of the two. To some extent we have been influenced by our increasing knowledge of indigenous epistemology. It may also be that, for different reasons, all human groups will gradually come to about the same view. It seems however that we will have to learn the hard way. In a recent thesis Ingraham (1990) captures the notion well:

Anthropocentric perspective, linked to the "Dominant Western Paradigm," sees humans as separate and superior with respect to non-human nature. It provides other species value only as a "resource" to other humans, exhibits a strong confidence in science and technology, and has been

implicated as a source of environmentally destructive attitudes. A biocentric perspective, linked to the "New Environmental Paradigm," places humans within the context of nature, extends "intrinsic value" to other species, and has been suggested as supporting more ecologically sustainable attitudes.

Contemporary science education

How can all of this possibly be relevant to contemporary science education? It is not - if we persist with the unexamined view that indigenous, holistic systems ipso facto have no scientific merit. If however we are convinced that there are some general principles guiding all human cognition and all human systems we would be wise to try to identify them and apply them where appropriate. At first glance we would have to regard epistemologies that do not rigorously distinguish between subject and object as less useful than those that do. This is one of the cornerstones of western science - the requirement that observations be independent of the observer. In recent years we however we have seen, in the social sciences, the growing appeal of the idea that this distinction is largely illusory. A significant group of social scientists argue that all human knowledge is simply a construction and that far from being independent of what we study we are an integral part of it (Cobern, 1993). In this argument there is less sense in talking about subject and object than in talking about systems of relationships. Any conceptions about the purity, rationality and even elegance of science that we might harboured have been severely tested by these views. Not only have the boundaries of science been stretched, we have also had to think very carefully about arguments that would have seemed untenable even two decades ago.

In the final analysis I agree with this but for practical purposes I think that it is more productive to act as if there is world of objects and events independent of observers. We now accept as absolutely commonsense the notion of interdependence of life-life systems and life -nonlife systems and we have learnt that altering one part will have effects on the system as a whole -ecology is now a legitimate and vital field of knowledge and study. We didnít come to this view by studying indigenous epistemologies but nevertheless we too now take for granted what indigenous peoples have long believed. We have come to this view because the unplanned effects of our manipulation of the environment became so obvious that we could not escape them. Indigenous people held this view because it was inherent in the belief system.

How then can we take these matters into account when we develop science education programs? What we do will depend to some extent on the level of students that we are teaching. However there will be one common element and that is the notion of intrinsic value referred to by Ingraham in the above quote. If we can accept that simple models in which humans reign supreme over nature ought to be replaced by world-views in which all species have intrinsic value we will be more likely to respect ourselves and our environment. This seems to me the most fundamental principle. If we thought that science education is, can or ought to be value free we were wrong!

We can also accord some respect for other learning. For example, in considering astronomy courses, McClure (1984) suggest that:

[...]a study of non-western views be incorporated into astronomy curricula.

This view is echoed by Marinez & Ortiz de Montellano, (1982) in an earlier paper on culturally relevant science education..

We need of course to be very careful that we do not replace one belief system that does unsustainable damage to the environment with another that does unsustainable damage to the intellect. Nevertheless science education programs and the people who take them will be enriched by incorporating elements of indigenous thinking into them. To prepare curricula of this type we need a systematic research program in which we document indigenous scientific thinking and examine how best to incorporate selected non-mythical elements into western science education.

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