

International Development and Science Education: Issues and Considerations

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Putting Bulbul to the test

Yug-yug rests his spear against the rock wall and sits back on his haunches. The three meter high wall sweeps along the contour of the mountain. Above this wall a second wall set back 20 meters follows the curve of the first. Another terrace wall and yet another extend up the mountain like a giant stairway. These terraces, thousands of years in the constructing, cradle the life sustaining rice fields of the Ifugoa, a Philippine tribe people. They live in the remote Central Cordillera mountain range of northern Luzon.

Yug-yug wears a traditional woven breechcloth. He appears somewhere between forty-five and one hundred years old. His leathered skin, weathered into an antique patina, clings tightly to a thin frame body, toughened from a lifetime of maintaining and working the steep mountain rice terraces. Palm thatched huts form a crescent village on one of the wide stone terrace. The huts form a protective shelter for the group sitting in a circle, Yug-yug, a number of young tribal men in jeans and T-shirts, and John, a US Peace Corps Volunteer. John is twenty-two years old and teaches science in the village elementary school. About twenty native children, many of them his students, elbow one another to get into the group. Bulbul, a small wooden carved statue, also sits in the circle silently watching. He seems attentive with his elbows on his knees.

Yug-yug continues his talk about the powers of the carved statue. "Not only does he guard our rice supply but also during the night he increases the amount of the stored supplies. I keep him and his holy spirit in this tabernacle when it is not the harvest season. Only I can touch him. If anyone else touched him it would be a mortal sin." He learned his English in the mission schools and mixes the local dialect with his English as easily as he mixes his traditional beliefs with Catholicism. The group sits silently listening attentively and respectfully to stories and lessons of this elder of the tribe, this self-described "witch doctor."

The next day, in his sixth grade science class, John starts his science lesson with this set of questions; Can anyone think of an experiment that would test whether Bulbul can increase the amount of rice in the storage huts. What kind of experiment could be designed? What variables would have to be controlled? What variable would be measured? How would we measure it? He looks for responses from a room full of suddenly quiet learners.

Introduction

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Yug-yug rests his spear against the rock wall and sits back on his haunches. The three meter high rock wall sweeps along the contour of the mountain. Above this wall a second wall set back 20 meters follows the curve of the first. Another terrace wall and yet another extend up the mountain like a giant stairway. These terraces, thousands of years in the constructing, cradle the life sustaining rice fields of the Ifugoa. Science education represents a major component in the educational planning of countries in pursuit of national and economic development. The architects of strategic development plans aspire to provide nations, the benefits associated with a scientifically literate working force. Science education planners at the north and south compass points of development often view science development as chiefly a matter of transfer. The question for them becomes how to orchestrate a science and technology transfer from industrialized countries to those with little scientific capacity. One part of this transfer approach places science teachers like John in communities to act as catalysts for change.

The international transfer model of science education has engendered criticism over the years. Recent efforts in science education reform in many donor countries have called into question some basic tenants of the model. Questions such as; Should John be teaching in a Philippine village at all (e.g., Baker & Taylor, 1995)? Is he teaching science or Western science, one form of multiple sciences (e.g., Ogawa, 1995)? Should he lift children out of their culture (e.g., Dart, 1972; Hawkins, 1974)? Should he challenge, celebrate or ignore indigenous science beliefs? Should culture play a role in how and what science is taught? (e.g., Kawagley, Norris-Tull & Norris-Tull, 1998) Is the science John teaches an icon of cultural imperialism? Are John's efforts unwittingly contributing to a hegemony of subtle global coercion in what and how people think (e.g., Kyle, 1999; Gray, 1999)?

These questions relate to the central question of the role of culture in science and science education. This paper reviews some varied viewpoints on these issues and examines contributions of relevant science education research. Based on these inputs, some considerations are offered for science education in international development.

A rich understanding about the issues related to the transfer of science and science education across international borders requires knowing more than common definitions of terms such as multicultural science, cultural knowledge, indigenous science, science and worldview. It requires an understanding of competing and sometimes conflicting meanings. (see Ogawa 1989). While the scope of this paper cannot begin to capture this richness, a working knowledge of these terms might be useful as a starting point for further reading.

The term multicultural education implies that culture plays some role in education and that educators should take culture into consideration when making educational decisions. Multicultural science education is defined as a construct, a process and an educational reform movement, with the goal of providing equitable opportunities for culturally diverse student populations to learn quality science in schools colleges and universities Atwater & Riley (1993) The premise is that culture plays a major role in the learning of science.

Cultural knowledge is a large determinant of one's worldview. A worldview provides organizational structure to life experiences and determines how new knowledge will be assimilated. Indigenous science is the study of systems of knowledge developed by a given culture to classify the objects, activities and events of the universe. It interprets how the local world works through a particular cultural perspective or worldview. According to Coburn (1993) there are five functions of worldview;

1. It explains the how and why of things, and why things continue as they do
2. It validates goals, institutions and values of society
3. It reinforces points of anxiety or crisis in life providing security and support
4. It integrates, allowing one to order and systematize sense perception, and
5. It is resilient and acts to reconcile old knowledge with new so as to maintain a state of equilibrium.

This view holds that every culture has its science called indigenous science. Groups hold indigenous science not an individual.

Culture and Science

While some view the origins of science as a social-cultural organism created by humanity (Zinchenko,1989), others hold that it is largely a product of Western culture and must be considered a foreign culture for non-Westerners (Ogunniyi, 1988). Proponents of a universal science point out that gravity respects no cultural barrier. Critics of a cultural free view of science site differences in the broader goals of science. Ogawa (1986) compares differences in Japanese views of nature and Western views. He identifies two elements in conflict; the view of man and nature and the kind of logic employed or the answer to the question, How do we know. According to Ogawa, Western science culture employs a man versus nature world view while Japanese may not see nature as an object of man's investigation or of exploitation for human benefit. Ikeda (2000), supports this view but separates science from science education suggesting that for many people science has the same meaning all over the world while science education may be influenced by history, culture tradition or policy.

Differing views of universal science versus Western science may have profound implications for international development projects involved with the transfer of science education. (Deru & Riley II, 1996) Some science educators involved in international development, who hold science to be cultural free, view their efforts in the north south transfer of science knowledge a moral obligation. Some see themselves as missionaries of the way of knowing. This was a prevailing view among United States Peace Corps Volunteers in the 1960's. Peace Corps science teachers were expected to be catalysts for change, challenging non-science thinking and practices at the village level.

This missionary development approach to the transfer of science education stands in sharp contrast to the views of others concerned with enhancing science education through international development. Where some see the benevolent missionary of science truth, others see one more vestige of colonial power (Jegade, 2000)

Ogawa (1995) argues for a multiscience view of science. He suggests that there are three different types of science, personal science, indigenous science and Western modern science. He takes the position that in the slogan Science for all means Western science and such a slogan forces everyone to learn Western Modern science alone. His argument for multiscience is built in part on the relativization of science within western modern science itself and he uses the history, philosophy and sociology of science as examples.

Indigenous Knowledge and Science Learning

Under what conditions can Western science education be integrated into a traditional (non-Western) culture without destroying its inner harmony? What research is available that might inform international cooperative efforts in the development of scientific literacy in a culturally sensitive manner? Little research exists in this area in part because development efforts of the past rarely took indigenous knowledge into consideration. However, there have been a handful of studies that have examined relationships among science reasoning, science achievement and indigenous knowledge of students and teachers.

A study by Jegede and Okebukola (1991) found that Nigerian University students with a high level of belief in African traditional cosmology, superstitions and taboos, made significantly fewer correct responses on a process skills test in comparison with those with a low level of belief. They also found a significant interaction between gender and main effects of achievement and African traditional cosmology. They recommended that, curriculum and instruction for learners of science in non-Western societies must begin with and reflect the world-views the learners already possess. In another study by the same authors, (Jegede and Okebukola, 1992) they were unable to find significant differences between Nigerian secondary school male and female students on the outcome African worldview. The authors pointed out that previous studies report that both males and females hold these views.

A Philippine study (Riley II & Chuapoco, 1986; Riley II & Chuapoco, 1985) examined the relationship among science process skills, logical thinking abilities and indigenous beliefs. Fifty students were randomly sampled from each year of a four-year high school in metro Manila and given instruments measuring the three outcome variables. The results indicated an inverse relationship between student achievement on the inquiry skill test and scores on the belief instrument. The same inverse relationship existed between scores on the logical thinking test and on the belief instrument. In both cases students who scored high on the science and logical thinking measures tended to score lower on the measure of indigenous beliefs. The correlations were significant at the .001 level. However when gender results were analyzed separately there were no significant correlations among the females tested. High scoring females on the logical thinking test and on the science process test were as likely to have high scores on the measure of indigenous beliefs as females who scored low on the science and logical reasoning measures. One explanation offered for this gender difference centered on the female role in the oral history traditions of Philippine indigenous beliefs. Taken together these studies suggest that overall, students who achieve high on science related measures tend to hold a more tentative view of

traditional beliefs. However this does not hold true for all students and may vary by gender.

The ability to hold apparently conflicting worldviews, as in the case of the Philippine female students, has been observed in other research conducted in Africa. According to Shumba (1999) research evidence suggests that teachers raised in a traditional society have a teaching philosophy which derives from both their scientific training on the one hand and their sociocultural upbringing and points of view on the other.

The cultural background of the learner may have a greater effect on education than does subject content, especially in some aspects of science education (Jegede & Okebukola, 1991; Okebukola, 1986). In a review of research on the effect of culture on the learning of science in non-Western countries, Baker and Taylor (1995) concluded that attempts to nationalize Western science curricula are likely to be ineffective because of the disconnection between the students' culturally based view of the world and the view provided in the science classroom. Waldrip and Taylor (1999) suggest that in developing countries the process of enculturation into a Western science view involves the implicit devaluation of students' traditional values and practices. They assert that enculturation into a Western school view has a deleterious effect on the perceived status of students' traditional worldviews. They also assert that a Western school view is of limited practical viability in relation to traditional values and practices (in the context of a developing south pacific country where they conducted their research).

Borders

Border crossing has become a useful analogy for cross cultural science education. Traweek (1992) used this as the title of a study examining narrative strategies among physicists in Tsukuba, Japan. The concept of science as a culture triggers the parallel thinking of anyone traveling from one culture to another. Who gets to cross the border? How do they cross? Where do they cross? What facilitates border crossings? These border crossings occur in science classrooms everywhere. Students in Western countries also face difficulties in crossing into the culture of science. The problems of these same crossing are compounded in non-Western countries where border crossings include not only into the culture of school science but also from the culture of home to the culture of schools. The crossing are not smooth and issues as to whether they should even attempt to cross give the feeling of a skirmish, if not a war, along this border.

Border wars

These quotes help define the border wars between science education and culture.

Western science is only but one way through which the human mind is able to explain the physical world but certainly not the only way or even the most valid way. It is just that it has become, through several means including imperialism and subtle coercion the globally enforced way. (Jegede 2000)

In traditional culture, problems cannot and should not be formulated unless, of course one risks

being labeled a witch. (Shumba, 1999)

Because science tends to be a Western cultural icon of prestige, power and development, its ethos and culture permeates the culture of those who engage in its pursuit. (Ermine 1995; Simonelli, 1994)

What often occurs in classroom situations in most parts of the world is that Western type of education is imposed on everyone irrespective of the cultural diversities within the classroom and it is used as a hegemonic icon of cultural conquest. (Jegade, 2000)

We obtained disturbingly little evidence of the positive influence of the school view of science on young people 1 s traditional worldviews. (Waldrip & Taylor, 1999)

Western science is used to further oppress students who are often from non-Western/indigenous backgrounds. (Jegade, 2000)

The alienation of students through western science can cause symbolic violence...the unintentional devaluing of a learner 1 s cultural beliefs. (Tobin,1996)

Cultural alienation results when education seeks to replace traditional culture instead of blending with it or building upon it. (Eyford, 1993)

The differences between indigenous thought and practice and Western science are real and pose problems for everybody. (Yakubu,1994)

We have reached a time in society where we can no longer afford to make comparisons between different kinds of knowledge in Western and non-Western cultures. (Kyle, 1999)

The view of Western Science as an icon of power and cultural imperialism might surprise some science educators involved in international development. The validity of the attacks might be challenged on a number of grounds but if the sentiment is strongly supported in developing countries then where does science education fit into development? Do countries turn away from Western science and seek development goals related only to other knowledge?

Border Crossings

The borders of science and culture are not all at war. In fact, many of the same voices that ask us to question the universality and the role of Western science in development are the same voices leading the way in pointing out potential theories and strategies that would make border crossings smoother. Here are a few examples.

Cultural border crossing involves flexibility, playfulness, and a feeling of ease, all matters of the heart. (Aikenhead & Jegede, 1999)

Science should not be offered as a substitute or replacement for what a child learns at home but rather as a second culture valid in its own right and taught in much the same spirit as a second language is taught. (Dart, 1972)

The transfer of scientific knowledge should be concerned with culture, that learning involves interpretation in light of personal culturally embedded background of knowledge. (Jegede, 2000)

Teaching Western modern science is enhanced when students become aware of the personal and indigenous sciences in a classroom. (Ogawa, 1995)

To compartmentalize the world into domains, each with an interpretive framework (Western science versus magic), is not perversity but an effective survival technique. (Lowe, 1995)

(Border crossing can occur) Yby modifying and elaborating seemingly naive traditional beliefs without arrogance and patronage but with sensitivity. (Arseculeratine, 1997)

Ideas associated with border crossings have combined with developing learning theories to suggest frameworks and strategies for culturally sensitive teaching. Jegede (1999) has developed a theory of learning based on worldviews and science he terms collateral learning. Collateral learning is based on research findings indicating that it is possible to simultaneously hold indigenous and scientific views of the world. This theory gives a richness and depth to issues related to culture and science education. Collateral learning takes us beyond the simple indigenous science vs. Western science issue to a conceptual framework which promises more fruitful discussion and research in cross-cultural science education.

Questioning the need for Borders

Some writings in the area of culture and science education suggest that breaking down all borders between Western Science and Indigenous science might be the answer to a true universal science a science without the need for border crossings. There are some that have trouble with this idea. Francis Bacon predicted that hostility to science would originate from three sources; from government and their associated churches, from philosophers and from occultists, jealous of a science that contested their claims to possess uniquely a knowledge that was power. Are calls for recognition of Western science, African science, Japanese science, attacks on science from a new source? If science is to be so inclusive as to accept the occult, as an extreme example, then where should the boundaries be drawn between science and non-science between Western science and non-Western science? According to Passmore

(1975), it is unpolitically correct to emphasize the peculiarities of science without being called elitist. He points out that Bronowski in a plea for the disestablishment of science from government made the assertion that the morality of science with its emphasis on loyalty to critical inquiry is not compatible to the morality of power with its emphasis on loyalty to authority. According to Passmore he was condemned as an elitist for emphasizing the peculiarities of science. Nowadays it is elitist to suggest that chalk is different from cheese. Is Western Science the cheese and Indigenous science the chalk? Can they be broken down to find the essence of a universal principle common to all science? This relatively new area of discourse is extremely useful to reflect on our views of what is science and what is meant by science for all. How inclusive can science be how exclusive must it be?

In the United States we are again caught up in an evolution/creationist debate. A flashpoint of religion, culture and science that takes the question of what science gets taught in the schools out of academia and into the classroom. The state of Kansas recently excluded the study of evolution from the state curriculum. The beliefs of many who live in Kansas and other states, hold that the world was created in days. Kansas did not want a science that included evolution, imposed on them. They wanted a creationist view of science taught and when they were unable to get that passed they successfully sought the ouster of the study of evolution, a corner stone of Western science. Should school science reflect indigenous beliefs? To what extent? Is the border the extent to which loyalty to critical inquiry is abandoned for loyalty to some authority?

Considerations

Open discussion over intentions and outcomes of science education in international development efforts should be ongoing and encouraged. The discussion of issues related to the North/South delivery, transfer, adaptation and/or construction of science education helps more clearly define the mission of science education in development.

Cross-cultural science education is a relatively new area of research. Much of the writings draw heavily from anthropology and cognition. Research studies and theories in the field of national development are not often cited. This research could provide a stronger applied contextual framework to the emerging field of cross-cultural science education. For example, the view that Western science has deleterious effects on development by devaluing local traditions and making students dependent on values established by more developed countries aligns closely with dependency theorists in the field of national development. According to dependency theory, the transfer of resources, in this case Western science knowledge, can occur in many ways including colonial or neo-colonial relationships. Dependency theory focuses on the process whereby the condition of the less developed regions of the world are seen to be caused by the activities of the rich countries. In considering the dependency relationship between countries it is not necessary that the rich country physically dominates the poor. It is enough that the leaders or the elite of the poor countries hold attitudes, values and interests consistent with those in the rich countries. Dependency theorists regard education as reinforcing the dependency condition of less developed societies. Arguments that the North/South transfer of modern science results in

dependency are open to the main criticism of dependency theory in general, its failure to provide a viable alternative strategy for development. (Fagerlind & Saha 1989)

In the Philippine Ifugao village, it is not Bulbul but John who is being put to the test. Those involved with science education and international development should be conversant with the issues related to culture, science, education and their interacting effects. We need to understand the worldview of students we teach and for whom we design curricula. We need to know what beliefs they bring to the classroom so that we know where to construct scaffolding from indigenous knowledge to modern science and where not to. We need to understand our goal need not require that science become a substitute or replacement for what a child learns at home but rather a collateral learning that encourages students to make their own linkages that accommodate and assimilate knowledge. We need to design science curricula tangent at many points to the culture of the learner.

As Hawkins (1974) pointed out, We need to find ways by which exciting resources in developing countries, each with its own special traditions, pressing problems and sources of strengths, can grow to meet and feed the needs of an expanding material economy without losing, as is so tragically possible, its distinctive style and genius, without breaking the cup that holds its life.

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