Constructivism – rhetoric and reality

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Constructivism embodies a thesis about the way in which human societies have built up bodies of knowledge. This construction of knowledge is variously influenced by a range of factors including politics, ideologies, values and individual self-interest. Constructivism can also be described as a set of views about how individuals learn.

Dewey has observed that, although simple in principle, constructivist learning theory is by no means simple to apply in instructional practice. Passive and uncritical acceptance by teachers of content driven curriculum documents leads to students being expected to acquire the ‘right’ knowledge. Monologue rather than dialogue dominate practices which fail to engender further thinking and active inquiry by both teacher and student and students resort to playing games to survive the experience.

In this paper I argue that whilst the rhetoric of science education practice suggests that constructivist principles are at the forefront of educationalists thinking, it is not reflected in the reality of classroom practice, and for this reason the educative value of science education must be questioned.

This paper represents the beginnings of my exploration of the way in which constructivist principles are interpreted in the science classroom and how, in some cases, these principles are misrepresented in classroom practice. My interest has evolved as a result of my experiences as a western science educator in a non-western science classroom. In this paper I briefly address two issues associated with constructivism: the belief of some science educators that the nature of knowledge is something that need not concern students; and related to this, the interpretation of constructivism as a theory of learning is problematic in current classroom practice. In both instances I argue that the experiences students are involved in are mis-educative.

John Dewey (1938/97) has shown us that, throughout the experiences of education, the child increasingly becomes familiar with adult concepts. Students do not come to these experiences with blank minds. They have had a range of experiences which they have made sense of in various ways, forming a range of understandings and attitudes and values and beliefs. We cannot say that these ideas are incorrect because that presupposes that there is “some idea of a non mistake” (Richard Pring 1967:64) or that there is only one true account of the world.

And yet current practices in science education, embedded in constructivist principles, would suggest an understanding amongst science teachers that there is only one true account of the world. I am concerned that this attitude is disrespectful of young minds and in the context of non-western cultures, leads to a devaluing of other ways of describing and understanding the phenomenal the world.

Constructivism – two positions
There are two views of constructivism that are used to describe two different things. In one instance constructivism may be used to describe a methodological position; that is an understanding of how human knowledge is constructed. From this position knowledge is considered to be a social construct and for this reason is often called social constructivism Human beings are knowing creatures with an ability to make meaning. Vygostsky (1934/86) has suggested that the construction of meaning takes place in an area of cognitive structure that is prepared to accept new or altered ideas. Within groups of like minded individuals, for example social or cultural groups, negotiation of meanings can occur between them.

In the second instance constructivism is described as a cognitive position that is concerned with how individual knowers or learners construct knowledge. This position is often called personal or educational constructivism. Marilyn Fleer (1999) described personal constructivism as having two basic principles: that knowledge is not passively received and that learners must build or construct knowledge for themselves. In his discussion on personal constructivism Denis Phillips (1997) says that “Arguably it is the dominant theoretical position in science and mathematics education” (p.6).

**Seeing and describing our world(s)**

From the perspective provided by worldview theory it is possible to understand how it is that people from different societies or cultural groups see and understand the world we share in different ways. In this context the term worldview is used to describe the assumptions human beings use to form a set of beliefs to explain the meaning of life. A worldview may be described as “…culturally organized macro thought. Those dynamically interrelated basic assumptions of a people that determine much of their behaviour and decision making, as well as organising much of their body of symbolic creations…” (Kearney, 1984: 1). Individuals from the diversity of human cultural groups around the world have different underlying assumptions and thus have different worldviews. The different worldviews held by different cultural groups allow them to interpret their reality in different ways. The metaphysical bases of their understandings form a philosophical framework that can be very different from one another.

The following story illustrates an example of a particular philosophical framework and relates to the origins of sweet potato from the Mt Hagen area of Papua New Guinea.

**A story about the sweet potato.**

The sweet potato (oka) was first discovered by an old woman and a young girl. They found it growing from the excrement of a man – a Sky Being.

The vines had wound themselves around a tree. The old woman took the plant home and grew it in front of the door of her house. People came and took cuttings from the plant and so the sweet potato came to be grown all over the area.

Once an old woman did not look after her garden. After 6 months she returned to find that all the sticks for the vines had fallen down. When she tried to lift one of her sweet potato plants she discovered that it had sent shoots into the ground and could not be moved. So she dug out the tubers and found they were good ones.

When other people in her village saw how good the sweet potato was they no longer trained sweet potato up sticks but let the vine go underground, which is how we do it now.
Now we know that oka can be grown both ways. Before we trained it up sticks, now we let it grow on the ground and the best way is the way we do it now.

Based on Strathern, 1969; Berlin, 1972.

Bernard Narakobi (1993) gives us further insight into the complex and spiritual nature of Indigenous knowledge and understandings. “One of the most moving sights of my life is to see my mother talk to the yams and taro before she peels them to cook. And when my mother peels, she peels from the bottom up to the trunk which she cuts last as the final act of terminating the life of the plant. The deep appreciation she has of plant life shows through her silence” (p33).

Ontology is concerned with the way we exist in our world(s). Liz Stanley and Sue Wise suggest that the experiences we have as individuals are important in helping us to be ontologically grounded; we can recognise the values, attitudes and interests and our understandings that lead us to describe particular knowledge. “(O)ntology is the start of experience and thus of theory and knowledge” (Stanley & Wise, 1993:192). How we experience something is a part of who we are individually which in turn is a result of the internalisation of our particular social and cultural ways of knowing the world and the sense we make of it. For this reason I understand social knowledge such as science, to be generated as a part of, and a product of, human social experience. From within our ontological ‘being’ or worldview, we begin to interpret the world of which we are a part, and thus where we see our place in it.

Whilst there may be significant differences between different cultures and their worldview there are two fundamental characteristics which they also share. “All ontologies, that is the picture of the world a worldview develops, are essentially models; and these models are not equivalent to reality but rather are truths expressed as rich metaphor” (Michael Christie 1991:26). In essence the differences arise from the different ways each ask questions about the universe.

Around the globe where science is taught, it is taught at the expense of Indigenous knowledge and this precipitates charges of epistemological hegemony and cultural imperialism” (Cobern & Loving, 1998: 2). An epistemology is dependent on a particular worldview. Epistemology describes the questions we ask ourselves in order to make sense of the world we live in. It allows us to identify what we consider to be knowledge, and how this knowledge is generated to describe our ‘reality’.

An example is how we organise and name our world. The philosophical framework for the Mt Hagen people provides them with understandings that link the phenomenal world to the spiritual world. The people from the Hagen area classify the major plants and animals in a way that signifies their direct contact with nature.

The classification of sweet potato (oka) includes the introduced type of sweet potato and the indigenous tubers. The most important structures used in helping to classify the oka is the leaf.

<table>
<thead>
<tr>
<th>Oka ingk</th>
<th>Oka kanome</th>
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<tr>
<td>Introduced sweet potato</td>
<td>Oka pora</td>
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<tr>
<th>Oka mapumb</th>
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<tr>
<td>Indigenous edible tuber</td>
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</table>
Sweet potato like vine

----- Oka koeka
Wild edible tuber

----- Oka kombkla
Wild tuberless vine

The classification reflects an understanding that domestic crops are cultivated by men with the help of the ancestral ghosts (mbo tipu). The wild tubers are planted by the spirits (tipu rØmi). (Based on Strathern, 1969; Berlin, 1972.)

To consider these ideas and meanings as being no more or no less valid understandings of the phenomenological world than those we understand from our own cultural standpoint it is important to move beyond epistemological frameworks of understanding knowledge and meaning and consider the ontological metaphors in which our perceptions of the world are embedded.

Who determines which knowledge has value?

This move opens up for us the need to embrace uncertainty and challenge our own taken-for-granted notions of how the world is. This is necessary when we come to consider the value that institutions such as schools for example, place on different bodies of knowledge and on the meanings individuals make of their world. These values are often embedded in particular notions of ‘truth’ and understandings of how the world really is.

Dewey’s notion of warranted assertions arises from the idea that the more closely we examine our own ‘truths’ the more inaccurate they appear. “All certainty becomes subject to inquiry including the certainties of these very canons of logic which older logics had treated as the powerful possessors of certainty in their own right”. (Dewey 1989:187)

I disagree with Osborne (1996) who says that “the nature of science has no necessary bearing on the nature of teaching and learning science, for the former is a philosophical issues to do with the nature of science while the latter is an educational issue to do with the best way of educating non scientists about science” (p67). I believe it is fundamental that we acknowledge the nature of the knowledge systems we are working with if we are to enable young people to think about and make meaning from the experiences that they have.

The various knowledge systems that arose from different human cultures did so to serve the purposes of that culture. Science is just one of the ideologies that propel society and should be treated as such (Feyerabend, 1975). Through an education system modelled on western structures and knowledge frameworks, says Theodore Roszkak (1974), mechanistic science is “aggressively replacing” a traditional style of knowledge that is predominantly an accumulation of meanings rather than facts. This knowledge or gnosis is “augmentative knowledge in contrast to the reductionist knowledge characteristic of the sciences. It is hospitality of mind that allows the object of study to expand itself and become as much as it might become, with no attempt to restrict or limit” (p23).

What is at issue for me is that constructivism centres on epistemological notions of knowledge and uses the socially constructed knowledge of the discipline of science to make judgements about the
value and worth of what is referred to, often in derogatory terms, as common sense, everyday, folk stories – non scientific knowledge. And yet as Bulmer (1975) pointed out in a discussion on how we name and organise our world, it is extremely important to emphasise that the question ‘what is the best system for naming an organism’ cannot unequivocally be answered. Indeed he says, it can be argued that the question while an important one lies outside the domain of science.

By not questioning the nature of science knowledge, it gives questionable legitimacy to the idea that scientifically incorrect conceptions can be labelled as being misconceptions, intuitive ideas, naïve ideas or alternative ideas. The underlying assumption for such labels is that western science knowledge has a privileged position in describing natural phenomena. For example, Driver et al (1986) talk of the “study of children’s thinking of scientific phenomena” as if the naming of the world around us in western scientific terms is a given – it belongs to western science. As Paulo Freire (1970/93) has observed “to exist, humanly, is to name the world, to change it . . . Human beings are not built in silence, but in word, in work, in action-reflection. . . saying the word is not the privilege of some few persons, but the right of everyone” (p69).

It is not the authenticity of a particular body of knowledge that is the issue but rather the value that it is given.

**Scientism - privileged naming of the world**

When people say the word science, says Masakata Ogowa (1999, online), they are usually referring to the canon of Western science. Furthermore, modern science is justified only by the scientific community itself and we are expected to accept it without objection.

The content of science education courses is consistent with what William Cobern and Loving (1998) call “the Standard Account of Science” (p4). The *Standard Account of Science* is based on western concepts and explanations of natural phenomena that have grown from a way of describing the world with origins in Greek and European culture. The sixteenth century science revolution saw the beginning of an epistemological tradition that used mathematically idealised models and representations to describe phenomena based on highly mechanistic ways of thinking. Thus today, in western cultures are the heirs of 300 years of rhetoric about the importance of distinguishing sharply between science and religion, science and politics, science and art, science and philosophy and so on. This rhetoric has formed the culture of Europe. It made us what we are today. For this reason, argue Cobern and Loving, “. . . what become known simply as science has always been engaged with western culture” (1998:4).

There have been significant challenges to the *Standard Account of Science*, including its claims of being rational and apolitical, and the belief in its ability to give explanations that provide the ‘truth’ about the physical world; to be able to know nature. Science has been very successful in using an empiricist approach for constructing and improving its representations of the world. Thomas Kuhn (1962) has challenged this empiricist’s philosophy of science that suggests that we have direct observational access to the way the world ‘really’ is. Kuhn says that when scientists observe they do so selectively and these selections are governed by their theoretical and sometimes practical interests. In his book *The Structure of Scientific Revolutions*, Kuhn challenged the idea of science as being a rational, objective and value free activity; rather said Kuhn, it proceeded via practices embedded in the social relationships and interactions of the scientist. In the post Kuhn era “science is seen as a complex, value laden enterprise, subject to the range of human and social behaviours including ambition, care, jealousy, prudence, friendship and altruism” (Wallace and Louden, 2002: 7).
Feminist writers such as Sandra Harding (1986) raised questions concerning whose knowledge is expressed in science. Science, she argues, is a socially produced body of knowledge and a cultural institution. Our Western culture is deeply and fundamentally structured socially, politically, ideologically and conceptually by gender as well as by race, class and sexuality. It then follows that the dominant categories of cultural experience (white, male, middle /upper class and heterosexual) will be reflected within the cultural institution of science itself, in its structure, theories, concepts, valued ideologies and practices. Harding argues that we must make visible the assumptions behind science and this is a part of achieving a new ethical and culturally appropriate form of scientific objectivity.

There is little evidence to be found in the science curriculum that these values and the attitudes and beliefs they give rise to are made explicit to the students. Brent Kilbourne (1980) points out that:

If provoking such awareness were to become a goal of science education it would require that we reveal this aspect of hidden curriculum by explicitly talking to students about the metaphysical context of knowledge in science. It would require discussion of both the beneficial and detrimental consequences of human action based on mechanism as well as discussion of the power of limitations of other worldviews (p42).

Michael Christie (1991) warns that “The western scientist censors out the intuitive, the ideas and traditions of uneducated people, and the folk wisdom of the past and confine themselves to empirical data. The metaphor building at the heart of western science lies in its refusal to admit non hard data and it gives rise to a hard mechanistic model of the world in which human appetites and weaknesses are out of the picture” (p27). It gives rise to the notion of scientism. John Ziman (1980) has argued that “[Scientism] reinforces, without question or comment the widespread sentiment that science should be the only authority for belief and the only criterion for action . . . the trouble with scientism is that it takes as given an attitude for science without deeper analysis”(p33). This is dangerous because, as Christie (1991) has pointed out, “If we cannot see the selection processes of metaphor making and censorship at work, we may fall victim to the myth that science is discovered not negotiated, a myth perpetuated at all levels of western science and science education” (p27).

**Science education as a coercive activity**

Dialogue is the encounter between men, mediated by the world, in order to name the world. Hence, dialogue cannot occur between those who want to name the world and those who do not wish to speak this naming – between those who deny others the right to speak their word and those whose right to speak has been denied them.  

*Paulo Friere 1970/96:69*)

In order for a person to become educated her beliefs must become changed. Education then deals primarily with belief systems, it must be holistic and it must involve the many relations in which persons are immersed. John Dewey (1916/97) says that “Learning in the proper sense is not learning things but the meanings of things” (p176).

Learning, especially educative learning cannot be understood as a simple absorption of information. Learning does not occur through passively listening to a teacher’s monologue. It cannot be reduced to the simple memorisation of information. It requires the making of meaning and thus the idea that information can be simply absorbed into existing themes is not possible. Meaning is not found in the things being studied, rather it exists in the relationships between learners and other entities in the world Meanings are made, and to make meaning is to think.
Educative practices in education then are to do with the mind and the development of the mental life of the individual, and thus the growth of knowledge and understanding. It is to do with individual persons and their feelings and emotions. Persons who are “questioning, seeking, explaining, doubting, feeling, hoping, reacting, imagining, fantasising” (Richard Pring 1976:7). Pring went on to say “education, as opposed to drilling or conditioning would seem to be concerned with the development of mental qualities which constitute the life of the mind” (p7). Science education, using constructivist principles, seems to have little to do with the development of the mind or with the making of meaning.

Douglas Roberts (1988) suggests that virtually every science teaching programme tries to encourage students to adopt a scientific way to explain things. “Implicit (and sometimes explicit) in the way the subject is taught are reasons or purposes for students to learn it - curricular contexts in which they are to understand the subject” (p32). They are therefore mis-educative practices.

Hand and Prain (1995) say that “we do not call the concepts that students bring to the learning situation misconceptions because they are valid for each individual, although they may not necessarily be acceptable in scientific terms” (p.x). This is little more than dishonest rhetoric. In the next sentence these authors say “Teachers need to negotiate the process of change from private, scientifically unacceptable knowledge to public, scientifically acceptable knowledge. Private and public knowledge need to be one in the same thing” (p.x). They provide no rationale or justification for why this change must be negotiated. It is clear however that the underlying assumption is that science knowledge is in some way the superior, acceptable knowledge as opposed to any other.

In the text for pre-service science teachers, titled Teaching primary science constructively editor Keith Skamp argues “that children should be changing their ideas towards those currently accepted by the scientific community so that they can make better sense of the way in which their world works. This interpretation of learning science underpins this book . . . the intention is that the change is toward more scientifically acceptable concepts and understandings” (Scamp, 2004:8). Despite some passing discussion of the nature of knowledge, Skamp reflects Osbornes belief regarding the nature of knowledge as a given. “It should be noted that science educators may hold views about constructivism as a theory but not necessarily agree with the interpretation and implications of constructivism as a theory about the nature of knowledge” (Skamp 2004:11). Neither does he discuss any need to bring ideas regarding the nature of knowledge, that is, the ontological frameworks in which we make meaning from our experiences, forward into classroom. By not making the move from epistemology to ontological understandings there is little chance for discussion on why we believe what we do and how this might compare to other perspectives.

Intellectual violence

Paradoxically, therefore, “constructivism informed pedagogies often appear to be learner centred but teacher controlled in a way that there is always something the learner is called on to construct” (Fensham et al 1994:6). What could be argued as being unethical practice that does not make visible the nature of the construction of the body of knowledge encompassed in the discipline of science, constructivist principles have given rise to the acceptance of violence in the language being used in the literature that describes constructivist approaches by science teacher in their work. For example we find terms such as subversion (Bence 2000) strategic warfare (Cobern 1996) intervention (Fensham, et al 1994) and angles of attack (Slezak 1998).

Hand and Prain (1995) describe some case study work they carried out and concluded that “Most teachers plan perhaps a six week unit of work on a particular topic and work out which activities will best explore that topic. To allow children’s questions to direct the exploration of the topic is, for most teachers, unreasonable . . . In the case study described in this chapter the teacher was
persuaded that the activities she had planned would be entirely suitable because we had a reasonably good idea of what students would know and what they would want to know” (p225 italics added).

For me there is and inherent arrogance in accepting such attitudes as described by Hand and Prain and it demonstrates great disrespect for the developing minds of young students and the individual’s quest for making meaning of the world in which we live. Stage managed lessons and teacher conducted demonstrations engineered to provide “correct” results are designed to fit externally imposed ‘learning’ outcomes within time frames that lack consideration for individual responses to their own life experiences.

Deborah Britzman (2003) observes

Can we face the same sort of choice, between the empirical child made from the science of observation, behaviourism and experimental and cognitive psychology and the libinial child who dreams yet still desires knowledge? The field’s dominant tendency is to choose the empirical child over the dream, the child the adult can know and control. But in doing so, education has reduced the childe to a trope of developmental stages, cognitive needs, multiple intelligence and behavioural objectives. And these wishes defend against a primary anxiety of adults: what if the dream of learning is other to the structures of learning?

(Britzman 2003:53)

Our science classrooms are often places where the structures of learning dominate the dream of learning, where issues of control form the basis of relationships. Knowledge becomes associated with certainty and there is little room for new ideas. It is scientism that arises in such an environment, not creativity, wonder and imagination.

Rethinking constructivist approaches

On the whole much of what is presented to students in science classrooms is contradictory to common sense, everyday experience and expectations. It is also based on the misconception that the science curriculum itself represents a body of rational universal truths, and to impose this scientifically acceptable knowledge is to engage in mis-educative pedagogical practice. Science explanations are often counter intuitive to the explanations and meanings students provide for their own experiences. Lev Vygotsky (1934/86) argued that “practical experience also shows us that direct teaching of concepts is impossible and fruitless. A teacher who tries to do this usually accomplishes nothing but empty verbalisation, a parrot-like repetition of words by the child, simulating a knowledge of corresponding concepts but actually covering up a vacuum.” (p150).

Thus we find that students develop games to survive school science and in this way it is possible for them to pass school science without really having to understand or learn the material in any meaningful way. Jo Larson (1995) called the games Fatima’s rules and showed that students memorise main words and definitions. When playing Fatima’s rules pupils (and some teachers) go through the motions to make it appear as if meaningful learning has occurred, but at best rote memorisation of key terms and processes is only temporarily achieved (Tobin & McRobbie 1997:366). Medvitz (1996) described how students learn the specific rituals and practices of the science classroom (silent accommodating). Loughran & Derry (1997) reported that, by year 9, students have learnt how to learn sufficiently well to succeed in school without expending excessive time or effort. It would appear that students are excellent strategists at surviving the school system and its processes, but at the cost of educative experiences.

Leach and Scott suggest that “More honestly learning science can be considered as a process of enculturation into a particular ‘way of knowing’ rather than an individual making sense’ of the natural world in their own terms” (Leach and Scott p48). Whilst everyday notions are perfectly
adequate for every day use, they are different from scientific theories. “Learning science thus involves developing new ways of knowing about familiar phenomena. It involves internalising the perspective of a different culture and in this respect might be conceptualised as breaking away from rather than building upon everyday ways of knowing” (Leach and Scott p48).

Unless students can relate the school view of the natural world to their own well established world views then they are less like to engage with other views. To learn science is to acquire the culture of science and to acquire the culture of science students must travel from their everyday life world to the world of science found in the classroom. Border pedagogies (Aikenhead 1998) offer a useful way to enable this intellectual movement cross worlds.

A border pedagogy enables educators and students to understand that different and valuable views of the world exist. If science education is to be worthwhile and achieve its goals then student and educators need to be cultural border crossers. Border pedagogy challenges the notion of the gift of acceptable knowledge being bestowed by those who consider themselves to be knowledgeable on those they consider do not know.

An ontological understanding of the nature of knowledge acknowledges a range of different sciences (Ogawa 1995). Science as a cultural activity ensures that western science shares the curriculum with other knowledge systems and helps to make the borders between the domains explicit. It promotes the harmonisation of world views and challenges the traditional borders put up by scientism that reproduce relationships of domination, subordination and inequality.

Educative experiences “then must be a moving force that arouses curiosity within the students, strengthens their initiative and set up desires for further growing. (Dewey 1938:38). Cliff Malcolm argues that we must allow students to bring their lives and experiences into the classroom if we accept that it is from this background that students are able to make meaning from new experiences and thus construct new understandings. This understanding of the way students construct knowledge encourages them to question the ‘truths’ of school science and raises the possibility for the “discussion of issues of viability and comparability of alternative explanations (including western science) testing ideas of criteria of ‘being’ and bringing into the open underlying assumptions about the nature of evidence (Malcolm 2003:26)

From this perspective science educators will embrace difference rather than trying to impose one true story, to enable a space to be made for dialogue based on respect, empathy, and understanding for difference.
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