Summary of Proposed Research Program for Doctor of Philosophy

Title

Culture, World View and Conceptualisations of Nature: An Interpretive Analysis of High School Students' Scientific Literacy

Abstract

This research program seeks to examine the compatibility between the fundamental presuppositions held by school students, and science as it is taught in the classroom. It addresses the question, How do school students' world views affect what they believe about the world around them? and achieves this purpose by comparing and contrasting basic conceptualisations of nature of students from widely different cultural backgrounds.

Data will be collected in China, Africa and Australia via semi-structured interviews. This involves the student in a series of tasks which will encourage a dialogue between the student and the researcher. Descriptive categories or codes are applied to each interview transcript and this allows the synthesis of each student's basic belief system, based on a logico-structural world view model (Kearney, 1984). The beliefs will then be illustrated by the production of a concept map and a first person narrative account on Nature for each student interviewed.

From the concept maps and narratives, assertions regarding the beliefs of different cultural groups will be postulated. This research method will allow the examination of issues of gender, urbanisation, religion, politics, nationality and other overlapping factors which, together, form a "culture", or "sub-culture".

The examination of the relationship between students' culturally-based belief systems and the basic tenets of traditional science education, will serve to help science educators to understand their students better. It will provide a perspective on the differing presuppositions school students bring to the classroom, and aid teachers in their reflections on the relevance of their own pedagogy and science curricula in a multi-cultural teaching situation.

Objectives

The objective of this research program is to address the fundamental question: "How do the cultural backgrounds of school students affect their world view and what relationship is there between this world view and students' scientific literacy'?

In order to determine the degree to which students enjoin scientific knowledge with knowledge gained from other domains, the research also asks the question: How does culture affect school students' conceptualisations of Nature?

This question will be further investigated by examining the degree to which gender, urbanisation, religion, politics, and other distinct cultural constituents, influence the students' incorporation of scientific knowledge. The focus on the effect of culture on scientific literacy leads to the emergence of several questions which will be addressed by this research.

1. What are the major assertions made by young high school students about the natural world?
2. How do these assertions compare with those of western science education?
3. How do the assertions vary with gender, nationality, urbanisation, religion and other cultural factors?
4. How might the knowledge of these assertions facilitate effective science education and improve scientific literacy?

Background

I began teaching in Australia in 1991, after living and working in Asia, particularly Hong Kong, for almost ten years. During this time I worked predominantly with Chinese people.

While teaching tertiary level information technology in Australia, I realised that Chinese students would not understand or apply the content of my teaching in the same way my Australian students were being asked to. I began to ask myself the questions, What is distinctive about Chinese thinking? How does their cultural framework affect the way in which Chinese students respond to scientific concepts? Do other cultures have different fundamental beliefs, and how do these influence a school student's desire or ability to learn western science?

As Australia becomes increasingly multi-cultural, and with the continuing drive to export Australian education, the issue of the effect of culture on the presuppositions that students bring to the classroom is one of relevance to the individual science teacher as well as to educational institutions.

World View Theory

If the goal of science education is to eliminate scientific illiteracy, then some measure of scientific literacy has to be made. Cobern (1995, p. 4) proposes that an effective measure of scientific literacy is the degree to which science has become a part of a student's everyday thinking. He proposes that, because "science is unarguably relevant to the topic of nature", then eliciting students' concepts of nature will give an indication of the degree to which science has influenced their customary thinking of the world around them. Cobern (1991, 1993 1994, 1995a, 1995b) has developed a research method which identifies six component parts of a student's world view based on Kearney's (1984) logico-structural world view theory. This allows a measure of the degree to which a student displays "scientific" thinking in everyday life and an indication of the factors which are responsible for "non-scientific" thinking. In this context, world view is defined as:

> Culturally organised macrothought: those dynamically inter-related basic assumptions of people that determine much of their behaviour and decision making, as well as organising much of their body of symbolic creations ... and ethnophilosophy. (Kearney, 1984, p. 1)

Kearney's (1984) model of world view assumes that a world view is an organised set of fundamental cognitive hypotheses shaped so as to produce a logical internal consistency and kept in tension by the need to maintain a coherent relationship with the external environment. This produces internal presuppositions which are *logically* integrated and universal beliefs which are structurally integrated - this leads to the use of the term *logico-structural.*

Kearney's model classifies human universal beliefs into seven basic cognitive categories: *Self, The Other, Relationship, Classification, Causality, Space* and *Time.* Cobern (1995a) builds on Kearney's model and divides these seven universal beliefs into three groups: first order, second order and third order universals.

Cobern's first order universals are *Self* and *Non Self.* Simply explained, *Self* is every individual's primary point of reference within the universe with which he relates, that is, the *Non Self.* Second order universals - *Classification, Relationship and Causality* - describe *Self's* attempts to differentiate between elements of the *Non Self,* relate with the *Non Self,* and understand the rationality of the *Non Self.* Third order universals, *Time* and *Space,* allow for variations of concept of *Time* and *Space* by the *Self* within the *Non Self.*

Cobern (1991, p. 81), quoting from Smolicz and Nunan (1975), cites a typical school-mediated, scientific world view as:

> The *anthropocentric view* (man as conqueror and controller of nature through science), the *principle of quantification and demystification* (science as a rational process for obtaining quantitative information about the world), the *positivistic faith (*faith in the continued advance of technology through the application of scientific method) and the *analytic ideal* (the assumption that the whole is best understood by a study of its component parts). (Cobern, 1991, p. 81)

This proposed research project builds on the basis of Cobern's research method, but is specifically applied to the effects of culture on school students' propensity to think scientifically.

Significance

In America, science educators, and particularly curriculum developers, have been responding to the issue of sub-cultures in their own society since the early 1980s (Patrick & Remy, 1985). Internationally others, such as Ogawa (1986) and Ogunniyi (1988), have looked at issues of scientific and traditional world views in Japan and Africa, and identified the tension between non-western culture and the culture of science.

Cobern's (1991, 1993 1994, 1995a, 1995b) research method allows for the identification of a student's world view based on logico-structural world view theory. This proposed research program is founded on Cobern's research approach but extends it specifically to investigate the effect of culture on students' conceptualisations of nature.

Research Method

The research approach is underpinned by a constructivist theory of knowledge. Constructivist theory of knowledge presumes that a conceptual framework is built as individuals interact with their world (Von Glasersfeld, 1989). These interactions cause the individual to construct a plausible image of reality which *interprets* but does not *correspond* to external reality. Within a constructivist perspective, therefore, knowledge becomes that which is *viable,* rather than the *absolute truth,* which has been that which has been traditionally sought by the positivist. A constructivist epistemology underpins the proposed interpretive research approach.

The approach which this research proposes to take is that of "interpretive research". Proponents of interpretive research (Gallagher, 1991, p. 5) argue that human sciences must be hermeneutical, or interpretive, so as to investigate people in their own context as they seek to comprehend, and give meaning to, their interactions with each other (Erickson, 1986, p. 123).

Interpretive research also includes the concept of critical subjectivity, in which the researcher takes into account his or her own beliefs and cultural biases, when recording, reporting and analysing the results of his or her project. This approach is explained by Tobin (1991) as one which "makes sense of experiences".

> Imaginative explanations of experience, using extant knowledge as an interpretive base, enable grounded theories to be constructed and to be applied as interpretive frameworks. ... Interpretive research is seen as a means of learning and, as such, appeals as a tool not only for researchers, but for students of science teaching and science. (Tobin, 1991)

Data Collection and Analysis
Cobern's (1991, 1993 1994, 1995a, 1995b) research method identifies students' world views using the universals described above. It is a modified naturalistic inquiry (Guba & Lincoln, 1990) using a semi-structured interview technique.

Twenty students of approximately (Australian) Grade 10 age are interviewed, using two different tasks designed to elicit their personal views on the natural world. The findings are given descriptive codes which are then used to produce a concept map and first-person narrative for each individual student. Case studies are then produced and cases are then compared and contrasted and assertion analysis techniques (Denzin & Lincoln, 1994) used so as to extract assertions which are made by the sets of students.

In this proposed research, two of Cobern's (1995) research instruments will be used with adaptation made for any local variables. The first instrument is a task which is designed to draw out students' thoughts about concepts such as characteristics and knowledge of nature. Words are chosen as prompts and students are asked to discuss which words are appropriate to their understanding. The second task consists of reading a list of 18 statements about nature and asking the student to indicate whether he or she agrees with them, and then to rank those they agree with.

All the words and statements are rooted in western culture. The Namibian students will be interviewed in English (since this has been the language of education in the country since 1990). The Chinese students will be interviewed in Mandarin and the interview tasks will be adapted to use the vocabulary of Chinese Middle School science, while maintaining the spirit of the original tasks.

There is also the need for me as the researcher to be reflective and pay due regard to my own cultural bias as I interpret data and produce assertions on behalf of the participants in the study (Guba & Lincoln, 1989, p. 65).

Consequences of this constructivist underpinning are that standards and criteria by which evaluation will be made will be those of *credibility, transferability, dependability and confirmability* rather than the positivist ones of *internal and external validity , reliability and objectivity* (Guba & Lincoln, 1985, pp. 228-269). I will ensure this by allowing student participants and their teachers to have a voice in the interpretation of data.

I have selected this research approach since it is firmly founded on the basis of scholarship, which is widely accepted in the science education community. While data are being collected from the various locations, I intend to be self-reflective and critical of my own research methods (Marshall, 1990) and to narrate the details of my own inquiry (Clandinin, 1993) and use alternative genres to recount the details of the participants' lives (Van Maanen, 1988).

I intend to structure my narration of my journey in research around the "living education" theory of Whitehead (1993). I feel that questions suggested by Whitehead provide a useful organising framework within which I can report and reflect on my research. These questions are:

- Identify an educational problem where my own personal values are negated
- Imagine a solution to the problem
- Act in the direction of the solution
- Evaluate the solution
- Modify my actions/ideas in the light of my evaluation

Ethical Issues

All data collected will remain confidential and anonymous, and will be stored in a secure environment for a period of 7 years. All respondents will be volunteers and, if minors, will be interviewed only on receipt of the signed permission of their parent or guardian.

Facilities and Resources

Since I am based at the University of South Australia, facilities and resources required are available to me:

1. IBM PC and software for word processing
2. Audio recorder
3. Access to Grade 10 age school students in Australia, China and Namibia.

As a member of the academic staff, I am entitled to annual and study leave. I therefore have the opportunity during 1998 to complete the final phase of data collection in China to write up the thesis by the end of this year.

Data Storage

The data storage provisions are outlined in the attached Research Data Management Plan and meet the Curtin University Research Data and Primary Materials Policy.

Time Line

Pilot Study - Queensland	August Year 1
Literature Search	September - December Year 1
Thesis Proposal	January - March Year 2
Fieldwork - Namibia	April Year 2
Data Analysis	May - November Year 2
Literature Search/ Write Thesis	January - June Year 3
Fieldwork - Namibia	July Year 3
Data Analysis	August Year 3

Literature Search/ Write Thesis	September Year 3 - March Year 4
Fieldwork - China	April Year 4
Data Analysis	January - September Year 4
Submit Thesis	December Year 4

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