The Challenges of Designing and Implementing a Cross-Cultural Unit of Work

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Abstract

This paper reports the challenges that were experienced as I engaged in an action research project in which I designed and enacted a cross-cultural unit of work entitled "Maintaining Health". George (1986) advocated the use of traditional knowledge as a strategy for increasing the relevance of science curricula within the Trinidad and Tobago context. Therefore, my intention was to improve my practice and to facilitate students' access to conventional science concepts by having them build bridges between their traditional knowledge about health-related matters and conventional science concepts. In my role as teacher-as-researcher at a single-sex (female) urban secondary school, I engaged in the first action research cycle-plan, act and observe, reflect- with a group of Form 2 students (12-15 years). My reflections on the planning phase were recorded in a journal, and the data from the classroom enactment were audio-taped and transcribed. The data were analysed qualitatively into themes and among the challenges that emerged were "resistance and doubt", "level of teacher control" and "communicative competence: the language of bridge-building." A second action research cycle was enacted with another group of Form 2 students who attended a rural co-educational school. The results of this second enactment revealed evidence of the three themes and also an overall improvement in my use of the language of bridge-building, suggesting that change is facilitated by the process of reflection on evidence gathered systematically. Action research is therefore recommended as a strategy for teacher development. Through the process of reflection teachers can begin firstly to understand their practice; secondly to understand the change process as they seek to improve their practice and thirdly, to acquire the skills that are congruent with the new relationships among teacher, students, subject matter and context.

Keywords: action research; traditional practices and beliefs; bridge-building; cross-cultural science curricula

Introduction

Don't you know that you have to "cool-off" or you'll catch the cold?
Child! You'll have to get some "cooling" and a purge before school starts.

Geertz (1973) defines culture as the ordered system of symbols and meanings in terms of which social interaction takes place. That a people's culture is a legitimate source of school curriculum is axiomatic (Fergus, 2002, p.239), yet, when I was a student in the formal science classroom in the twin-island Republic of Trinidad and Tobago, my teachers did not refer to the system of symbols and meanings conveyed in the statements above. In like manner, they did not form part of the curriculum when I became a science teacher. Perhaps, it is this state of affairs which contributes in part to Alleyne's (1995) view that the school curriculum was culturally irrelevant, and which may also explain the less than enthusiastic response of many students to school science.

From my experience as a science teacher at Parkview Secondary (a pseudonym for a single-sex secondary school located in the capital of Trinidad) for 15 years, I became aware that many students had developed a negative view of science, and many informally expressed the view that science was not relevant to their everyday lives. In some cases, even science students who performed well on teacher made tests tended to abandon the study of school science as soon as the opportunity arose, that is, as soon as the subject was no longer mandatory. In addition, the academic performance of some of my students was below my expectations.

Researchers who adopt a cultural lens to explain students' attitude to, and performance in, science in the formal setting, suggest that there is interference between the cultural background of the learner and school learning (George, 1995; George & Glasgow, 1999; Ogunniyi, 1988). For example, Costa (1995) and Jegede and Okebukola (1991) have reported that the greater the degree of congruence between students' in-school and out-of-school experiences, the more positive were their attitudes towards school science. The cultural view of science education seemed plausible in the context in which I taught. I felt that it was likely that some of my students had come from backgrounds similar to mine, and that they might have been familiar with traditional practices and beliefs described above. My belief that my students might have been knowledgeable of traditional customs was buttressed by the pioneering research work that was done within the Caribbean in the 1980s (George, 1986; George & Glasgow, 1988).

George (1986) identified students' knowledge of traditional customs as "street science." In addition, she reported that a large percentage of street science is not supported by conventional science principles. Further in-depth research work in the area of traditional knowledge with villagers from Seablast (a pseudonym for a village in the North-Eastern region of Trinidad), led George and Glasgow (1999, pp 22-23) to conclude that "the traditional practices and beliefs that exist in this community constitute an intricate knowledge system supported by a worldview that is in some ways similar to, and in many ways different from, the tenets of conventional science." For example, George (1995, p. 93) found that "one of the principles that is still fairly prominent is the principle relating to heat and cold. A "heated" body should not be exposed suddenly to cold environments."

These reports revealed that some students within Trinidad and Tobago possessed a framework of explanations that was sometimes quite different from the science explanations that are presented in class about the same phenomena. This finding is not unique to Trinidad and Tobago and the Caribbean. Researchers from developing nations in Africa (Baimba, 1993; Jegede, 1995) and those who work with First Nation peoples (Aikenhead, 1997, 2000a, 2000b; Snively & Corsiglia, 2000) have obtained similar findings. Within the last three decades, therefore, there have been calls for the development of cross-cultural science curricula (Aikenhead, 1996, 1997; Atwater & Riley, 1993; George, 1986, 1995; Jegede, 1995; Snively & Corsiglia, 2000; Stanley & Brickhouse, 1994).

It became evident then that my desire to improve learning in science in the classroom and to make the science curriculum relevant to students' daily experiences would naturally lead to an exploration into the development of a cross-cultural curriculum. My reading of the literature led to worldview theory and science as culture as two theoretical underpinnings for cross-cultural curricula.

Conceptual framework

Worldview theory

The roots of worldview research are based in anthropological studies, but with the publication of Kearney's logico-structural model of worldview in1984 worldview theory has become a significant conceptual framework for science education research. According to Cobern (1991), worldview is defined as the fundamental presuppositions that guide one's understanding of the world. It is said to constitute the macrothought that guides behaviours and predicts patterns of responses. Kearney cited by Cobern (1991) identified seven universal categories, which constitute a worldview. These universals are Self, Non-self, Relationship, Causality, Time, Space, and Classification. Propositions that emanate from the universal categories constitute the content of people's beliefs, which, in turn, underpin many of their everyday practices. For first Nation peoples or traditional peoples, the propositions that describe their worldview- either as inferred from actions or direct statements- are often described as indigenous or traditional practices and beliefs. These practices and beliefs, which are valued in the community and serve as prior knowledge for some children before they are exposed to formal science learning, are often quite different from the explanations that are presented in the formal science classroom.

Science as culture

It is accepted by many researchers in science education and by some science educators that science is a sub-culture of Western culture (Jegede, 1995; Maddock, 1981; Pomeroy, 1994). Science as we know it today, which is often projected as objective, universal and value-free, was developed between the 16th to 18th century in Europe (Cobern, 1991) and has become the dominant worldview of modern society worldwide replacing, and sometimes existing side by side with, other ways of knowing. It is posited that in societies in which different ways of knowing coexist, science students must cross borders between the traditional ways of knowing (their traditional culture) and the western science way of knowing (the culture of science) when they enter the science classroom.

Extending knowledge in this area, Costa (1995) developed a typology of students based on the ease with which they independently crossed borders between their everyday worlds and the world of science. The categories of students were labeled as “Potential Scientists,” “Other Smart Kids,” “I Don’t Know Students,” “Outsiders,” and “Inside Outsiders,” and the ease with which they crossed borders between worlds ranges from smooth to virtually impossible. For “Potential Scientists” border crossing is so smooth and natural that the borders appear invisible; “Other Smart Kids” manage their border crossings well, but are generally uninterested in science; “I Don’t Know Students” experience hazardous border crossings but develop strategies to cope with these experiences; border crossings for “Outsiders” and “Inside Outsiders” is virtually impossible, and they tend to be alienated from school science. Consequently with the exception of “Potential Scientists,” some students, have very limited access to conventional science concepts in a normal science classroom unless the teacher acts deliberately to help them to manage the border crossings (Giroux, 1993), that is, unless the teacher adopts an anthropological approach to instruction and acts as a culture broker.

Focus of the study

It was against this backdrop that I embarked upon an action research project to develop a cross-cultural curriculum unit on health in which I attempted to have students build bridges between their traditional practices and beliefs and conventional science concepts. Bridge-building was conceptualized as a process during which traditional explanations and conventional science explanations for the same phenomenon were explicitly addressed during each lesson. The strategy for bridge-building was the explicit comparison of traditional practices and beliefs with conventional science concepts in terms of similarities and differences and strengths and weaknesses. Although I had read Wilson's (1981, p.40) caution that

> It is easy to assert that, to be effective, teaching must take full account of the multi-dimensional cultural world of the learner, but to apply this principle in a particular situation, and to express it in terms of curriculum material and classroom methods, is a formidable task.

I could not have anticipated the challenges that lay ahead.

This paper reports on the challenges involved in planning and enacting the cross-cultural unit of work. It continues, firstly, with the methodology of the study and then highlights some of the challenges that I faced as I ventured into this new approach to science teaching.

Procedures

This was a multi-case action research project in which, firstly, I investigated my practice as a science teacher at Parkview Secondary in an attempt to improve my practice, by increasing the relevance of the curriculum and facilitating improved student access to conventional science concepts. Action research consists of cycles of planning, acting and observing, and reflecting (Kemmis & McTaggart, 1988). The second cycle of research was conducted at Seablast Secondary –a rural co-educational school.

The students who comprised the first case were members of a class that I taught at the Form 1 and Form 2 levels (ages 11-15 years). Most of the Form 1 students had attained scores that placed them within the top 20% of the cohort of students who wrote the national placement examination for entry into secondary school. The majority of Parkview students would have fallen into the categories described by Costa (1995) as

“Potential scientists” and “Other smart kids.” These students represented the range of socioeconomic groupings, however, they were mainly middle class. The second case comprised students at Seablast Secondary. They had achieved a lower standard of performance on the national placement examination than the Parkview students. The majority of these students would have been classified as “I Don’t Know Kids” and “Outsiders,” and they were of a lower socioeconomic status than their Parkview counterparts.

Before I began the first action research cycle, firstly, I obtained permission from the Principal of Parkview secondary to engage in the research and from the parents of the students whom I taught at the time. Secondly, data on a selected class of Form 1 students’ knowledge of traditional practices and beliefs were obtained by means of a questionnaire, which I had designed and which had been piloted with Form 1 students of the previous year. Thirdly, semi-structured interviews were held on the school compound with 10 students from the class selected for the research. The students selected for the interviews had exhibited traditional knowledge on at least 70% of the items on the questionnaire. In addition, interviews were conducted with their parents at their homes on a separate occasion. These data were analyzed using the grounded theory methodology -open coding, axial coding, and selective coding (Strauss & Corbin, 1990).

One significant finding that emerged from the first phase of data analysis was the participants’ belief that the human body becomes “heated” as a result of various activities, for example sleeping, or exposure to thermal energy such as the sun or ironing or from the ingestion of “heated” foods. In addition, the participants believed that good health is maintained when there is proper management of the “heated” body. These beliefs were similar to George’s (1995) findings at Seablast.

From the students’ and parents’ descriptions, I induced two principles, which guided their practices and beliefs about maintaining health. These principles were termed the “cooling-off” principle and the “cooling/purging” principle. The first states “the ‘heated’ human body should not be exposed suddenly to cold environments, it must ‘cool-off’ first.” The “cooling/purging” principle is that “ ‘cooling’ and purges can be used to cleanse the ‘heated’ body of excess ‘heat,’ so as to restore balance.” Some examples of the “coolings” given were “burnt bread water” and “carrot water.” Participants said that purges were used to eliminate wastes, and “Senna” (a stimulant laxative) was the example of a purge, which was most frequently cited. These principles were used as the framework to develop the unit of work, which was entitled: “Maintaining health.” The intention was to build bridges between students’ prior knowledge about health related matters and conventional science concepts by explicitly comparing the two ways of knowing.

The unit comprised lessons that were entitled: *“The common cold: Catch me if you can,” “Cold or not?” “Homeostasis: Constancy in the midst of change,” “Cooling-off,”* “*Cooling: A home remedy*,” and *“Pimples and the adolescent.”* The unit of work was enacted over a period of two months with the same students who had responded to the questionnaire and who were at the time in a Form 2 class. The lessons were audio-taped and transcribed, and the data were analyzed to determine the themes and patterns emerging. In addition, I kept a research journal in which my reflections on the enactment and on the research process were recorded, and the data were also analysed. Based on the lessons learnt at Parkview Secondary, I conducted a second cycle of the research at Seablast Secondary, after obtaining the necessary approvals from the principal of the school and other key stakeholders.

Findings

The challenges that emerged during the design and enactment phases of the unit of work were categorized within the following three themes "Resistance and Doubt," "Level of Teacher Control," and "Communicative competence: The language of bridge-building." Each theme is presented below.

Resistance and Doubt

From the start of the research process, there were persons--the principal of the secondary school and colleagues at the University of the West Indies (UWI)--who were doubtful that the students who attended the urban all girls' school in which I taught would be knowledgeable about traditional practices and beliefs. Therefore, they were not convinced that an investigation into students' traditional knowledge was appropriate, and they expressed these concerns. For example, the principal said: "Do you think these students would know about these 'old time things'?" A few colleagues at the University of the West Indies expressed the similar misgivings, and seemed to believe that the inclusion of traditional practices and beliefs would somehow detract from science learning in the classroom. They did not think that the present generation of students would be knowledgeable about, or committed to, traditional practices and beliefs. These expressions of doubt, which symbolized some resistance to the use of traditional knowledge in the formal setting struck at the very heart of the research. I was challenged by these expressed concerns. In spite of my own experiences and my knowledge of the research of George (1995) and George and Glasgow (1988), I began to have some reservations about the orientation to the research. These doubts led to critical reflections on the issue.

I perceived that there were psychological barriers against the use of traditional knowledge, which could account for some resistance to the new approach to science teaching in the formal classroom. I wondered if it was wise to explore the use of traditional knowledge, and I found myself returning to the literature. For example, I reread Warner-Lewis (1991). She had found that many of the traditions of enslaved peoples in Trinidad and Tobago, which many thought had been erased from their memories, were in fact very much alive, and still guided the daily practices of many persons. I became more confident about the research orientation, but these doubts re-surfaced during the interviews with some of the students who attended Parkview Secondary.

Students had been selected for the interview on the basis of their responses to the questionnaire. As mentioned earlier, those interviewed had all responded to at least 70% of the items on the questionnaire in a manner that demonstrated their knowledge of traditional practices and beliefs. Yet, during the interview, these few students either initially feigned ignorance of the traditional practices and beliefs or they seemed uncomfortable with the topic. For example, when asked a similar question to one on the questionnaire, one student's response was "Miss? I don't know about this!" It was as the study was in progress at the second site--Seablast Secondary--that some of the students' comments revealed why they may have been somewhat cautious about revealing their knowledge of traditional practices and beliefs. It was their view that traditional practices and beliefs were "country" ideas--ideas from a rural setting—and that they were old-fashioned notions.

Summary/Reflections

It was evident that traditional knowledge was considered to be a relic of the past by some key stakeholders. Some either felt that modern day children would not have been exposed to such practices and beliefs or that any traditional knowledge to which they had been exposed would have been replaced by modern western thinking. It is plausible that these persons who have themselves been certified by the current system of western education were either enculturated into, or had been assimilated into, western scientific thought, and it is quite likely that in the latter case they were guided by the idea that persons who were exposed to scientific thinking within the formal school setting would similarly have abandoned their traditional knowledge. Rampal (1994) reported a similar finding that captures the idea that "newer is better." The students from a rural district in India with whom she conducted her research wanted their family to know of, and sometimes be convinced about, the new ideas encountered in school.

I interpreted the stakeholders' statements and concerns as evidence that traditional practices and beliefs did not enjoy the same status as the conventional science ideas that were presented in the formal science classroom. I believed that the expressed concerns were related to issues of cultural capital (Bourdieu, 1971) and culturally-sanctioned opposition-- the response of these stakeholders to the notion of multiple realities (Cobern, 1991, p.28). Hodson (2003, p.664) makes a similar point. He says: "science education has dealt with established and secure knowledge, while contested knowledge, multiple solutions, controversy and ethics have been excluded." Certainly, traditional practices and beliefs constitute contested knowledge, which provides alternative health care options. Further, Bourdieu (1971) suggests that symbolic violence-- the reproduction of structures of domination in society by imposition of cultural values that are represented as universal--often occurs when different cultures meet.

It is plausible that the stakeholders' responses indicated that larger and seemingly powerful structures and forces were at work. The expectations of administrators and students about what science is and how the science class operates can present a strong challenge to attempts to change the status quo. In addition, as demonstrated below, my past experiences as a teacher were a source of some of the challenges that I faced in my attempts to change how I functioned as a science teacher.

Level of Teacher control

I was challenged by the new approach to lesson planning as I began to design lessons based upon the "cooling-off" principle and the "cooling-purging" principle, which underpinned participants' practices and beliefs about selected health-related matters. The level of teacher control emerged as the main challenge to change and was the underlying factor that guided the decisions that I made as I entered these un-chartered waters. A high level of teacher control was manifested as I “reverted to old ways of planning”and as my actions revealed “contradictions between my espoused theories and theories in use.” These challenges are illustrated below, beginning with the design stage.

<u>The lesson design stage</u>

As reported in the literature, the contextualized lesson (Lubben, Campbell, & Dlamini, 1995) is one in which students’ everyday knowledge is used as the starting point for the science lesson within the following format:

- An incident/situation from the learners’ context is used to start
- Students are then invited to explain or comment on the incident/situation
- An enquiry/investigation/discussion is undertaken. This allows the embedded conventional science to surface
- Students are asked to make sense of the initial incident/situation which was used at the start of the lesson in light of the information gathered from the enquiry
- An evaluation exercise is given

The design allows for active student construction of knowledge through experimentation, discussion, and small group work. I felt that the students’ initial knowledge of traditional practices and beliefs could serve as the starting point for the lessons, and that the science concepts could be addressed within this lesson format. Therefore, the contextualized lesson design underpinned as it was by constructivism as a philosophy of knowledge seemed suitable for the work upon which I was to embark.

I discovered, however, that the process of including traditional practices and beliefs was not as straightforward as described in the model of the contextualized lesson. The difficulty arose primarily because there was sometimes a lack of congruence between the principles that underpinned the traditional practices and beliefs and those of conventional science. George (1986, p.6) compared indigenous knowledge (traditional customs and beliefs) with conventional science and classified the relationship between traditional practices and beliefs and conventional science as follows:

- Category 1: The indigenous practice can be explained in conventional science terms.
- Category 2: A conventional science explanation for the traditional belief seems likely but is not available.
- Category 3: A conventional science link can be established with the indigenous knowledge, but the underlying principles are different.
- Category 4: The indigenous knowledge cannot be explained in conventional science terms.

The incongruence between the two ways of knowing is evident in two of the four categories- -Category 3 and Category 4- proposed by George (1986), and is illustrated by the following examples from this present study. In traditional wisdom, a prevalent belief is that one of the consequences of mismanagement of the “heated” body is the occurrence of the common cold. The conventional science concept that a virus causes the cold does not exist in the traditional knowledge, and in conventional science there is no link between "heat" and the common cold. There were other instances of conventional science explanations that were at variance with traditional practices and beliefs. In traditional wisdom, pimples signify that the body is "heated." The appearance of pimples in conventional science is explained in terms of the combined role of hormones and bacteria.

It was at this point that I recognized that traditional practices and beliefs consist of many Category 3 and Category 4 types, so the task of contextualizing the science lessons became one of dealing primarily with differences between conventional science and traditional practices and beliefs. By contrast, the contextualized format is premised on the assumption that the target science explanation is embedded within the students' everyday experiences, which would be similar to George's (1986) Category 1 classification. For example, a lesson that was developed within the contextualized format began with students' everyday experience of a run-down car battery (Lubben, Campbell, & Dlamini, 1995). The conventional science concepts of current and voltage were clearly embedded in this everyday context. However, "Category 1" practices were not the norm in the health related traditional practices and beliefs under investigation in this study. Table 1 following shows two of the category 4 lessons (George, 1986) that were developed: (Place Table 1 here)

Table 1: Lessons designed to facilitate bridge-building between traditional practices and beliefs and conventional science concepts

Lesson	Traditional belief	Traditional principle	Conventional science
The common cold: Catch me if you can	The “heated” body should not be exposed suddenly to cold environments because the person will catch the cold.	“cooling-off” principle	The virus causes the cold
Cooling-off	Persons who have been sleeping or playing in the sun should “cool-off” before bathing.	“cooling-off” principle The body temperature changes suddenly	Homeostasis an internal mechanism by which the body maintains a fairly constant internal temperature

Accordingly, unlike the model presented by Lubben et al (1995), a fairly high percentage of each lesson was to have been devoted to a comparison of traditional practices and beliefs and conventional science concepts in terms of similarities and differences, and strengths and weaknesses, as suggested by Ogunniyi (1988). I was challenged by this approach to lesson planning. Traditionally in my teaching, I had relied on the similarities between students' knowledge and the target concept, and I had entered "un-chartered waters." As illustrated in the lesson entitled *"Cooling: A home remedy,"* in selecting the target science concepts, I "reverted to old ways of planning."

In conceptualizing the lesson, I had myself built bridges between the traditional ways of knowing and conventional science by selecting the traditional practice that I thought was similar to the science concept. I attempted to find a conventional science explanation for the use of "cooling." I selected the example of "burnt bread cooling" deliberately, not only because it was the "cooling" with which most students had indicated they were familiar, but also because I could have established a clear link between "burnt bread" and carbon. I linked the use of carbon with adsorption, which is a conventional science concept that explains the purification of solutions, with the traditional belief that "coolings" purify the body by removing "heat." I drew on my knowledge that the "heated" condition is sometimes attributed to the intake of substances such as preserved products, which are usually coloured. I was, therefore, convinced that adsorption was the scientific principle that could explain the traditional practice of using "burnt bread cooling" (making this a category 1 lesson), although I recognized that this western science explanation was not appropriate for the use of other "coolings," that the students mentioned, for example, “carrot water.” My stated intention was to have students compare the traditional practices and conventional science concepts in terms of similarities and differences, but I had reverted to a design that was based on the similarities between their prior knowledge and conventional science concepts.

Summary/Reflections

The unit was one that was meant to address differences between traditional practices and beliefs and conventional science concepts. Yet under conditions where I discerned a similarity between the traditional belief, as illustrated by one or two practices, and the conventional science concepts, the traditional practices that could not be explained in terms of conventional science were ignored. Consequently, the process of bridge-building- comparing the two ways of knowing was not fully developed in this lesson.

In sum, my actions revealed that I exercised control over the selection of ideas for inclusion in the lesson. I restricted the ideas that were raised in the science classroom to those I felt confident to explore in relation to conventional science, as I was accustomed to do. According to Ogunniyi (1988, p.7), “there is the tendency to reject anything that is causing us mental disequilibria and hence to withdraw to our former self (i.e., to what we are used to),” which may explain my actions in designing the lesson entitled *“Cooling: A home remedy.”* While this coping mechanism allows for a measure of “teacher ease and comfort,” it impedes innovation and change.

There seems to be a paucity of empirical research that evaluates the congruence between the stated philosophical orientation of curricula and the lessons that are designed to operationalize such curricula. However, of those reported, there is evidence that a mismatch between intention and lesson design does occur, and for which Oguyinni's explanation seems credible. For example, Mayoh and Knutton (1997, p. 859) researched teachers' behaviours in designing new curricula that incorporated everyday contexts for classroom activities. The results implied that there was a discrepancy between curriculum intentions and the lessons that were designed. They noted "while the problems were dressed up with real-life scenarios, they were essentially school-based problems…also, some of the problems were not of real of immediate concern to their everyday life."

It is apparent that changing from familiar behaviours is not unproblematic, and a deeper understanding about the process of change was intimately connected with my engaging in the process of reflection. Critical reflection on my decisions and actions was instrumental in developing my understandings of the impact of teacher control in the selection of ideas/concepts during the design process and in helping me to discern, and respond to, the challenges of change at the second site. In addition, as the unit was enacted at Parkview Secondary deeper understandings of the contradictions between my espoused theories and theories in use as related to my operating within my "zone of comfort" and indicative of teacher control emerged.

The enactment

The challenges that emerged as I enacted the bridge-building process of having students compare traditional practices and beliefs and conventional science were again underpinned by teacher control, and were related to my management of students' contributions. I discovered "closed" sessions in which my responses could be labeled as "inadequate probing of the students' responses," "falling into the trap of padding students' responses which I thought were incomplete," and "reinterpreting students' responses."

I induced that these responses were based on my "preconceptions" about the manner in which the differences between traditional practices and beliefs and conventional science concepts should be resolved in order to achieve my goal of having students access conventional science concepts and my attempts to exercise some control over the development of the lesson. In addition, at times I was "not adept at shifting roles" based on student characteristics and needs as the situation demanded. The open codes were placed into the category that was labelled "teacher comfort." "Teacher comfort" was further subsumed under the more abstract category "teacher control."

In the section following, the category "padding and reinterpreting" students' responses is used to illustrate how these contradictions reflect the main category "teacher control."

<u>Padding and reinterpreting students' responses</u>

In the normal course of the teacher/learner interaction, there were opportunities for me to scaffold the students' responses in order to develop the lesson in the manner intended.

However, as the excerpts below reveal, there were times at Parkview when I reinterpreted the students' responses to lead them to the "correct" answer, the one that I had constructed, which in essence changed the meaning of the students' utterances, but which allowed the lesson to progress in the manner intended. These actions, however, were diametrically opposed to the theory of constructivism that I had espoused. The teacher's role in mediating learning is acknowledged, however, constructivism is premised on the tenets of dialogue and negotiation of meaning instead of imposition of meaning:

> S: I think the factors that affect the work of scientists is that the community that the scientists is in, their colleagues, their opinions, and the ahm..characters
> T: Their personalities, okay
> S: The beliefs affect because it restricts them in the way they can't…they go with the flow. Their experiments…and ahm…also…
> T: Okay. Very good. That's a very good point, that the community of scientists can affect what you're doing. Right. Very good. Some will hinder you and some will encourage you.
>
> T: Why don't medical doctors recommend purges?
> S1: It could be addictive.
> S2: And Miss, sometimes, you could overpurge yourself.
> T: You may not know what you're doing and overpurge yourself.
> S3: They could exercise the use of more modern medicine because they believe that it works better. Or like so that ahm the profession of doctors could ahm
> T: Okay. To promote their own profession, their own beliefs, their own views, their own theories.

Adjusting teacher role

With the experience of teaching similar cohorts at Parkview for 15 years, I had become used to, and comfortable with, the process of assigning small tasks to individuals and small groups of students, who assumed some of the responsibility for learning. I behaved in the same manner during the bridge-building segments with students at Seablast at the start of each lesson just as I had done at Parkview. My first choice of strategy was one in which my concerns about "my level of comfort" took precedence over students' characteristics and needs. At Seablast, there was not the cadre of more capable peers that facilitated the independent type of group activity that worked well at Parkview. The Seablast students needed more scaffolding and simpler language, however, I only adjusted to the role that required greater scaffolding and guidance when the students demonstrated that they were unable to complete the task independently:

> T: I want you to compare your ideas about "cooling-off"…with the explanation given in science class for cooling down the body. Compare the two, and let's see what we can come up with. Talk amongst yourselves. What are the differences between what we thought of as "cooling-off" and what we learnt in science to explain the cooling of the human body.
> S: [No response.]
> T: discuss it among yourselves for a few minutes. What does one say that you have to do? How does the other explain cooling down?
> S: [Little response, seem confused]
> T: Are people having difficulty? [Without input from students, T writes comparisons on the chalkboard]. All right, look at the board. Let's see if you would have come up with some of these when you were discussing.

Summary/Reflections

Padding and interpreting students' responses was a feature of my interaction with students in some situations at the beginning of the enactment of the unit. These interjections served to change the meaning of students' contributions without the benefit of dialogue that was necessary for negotiation of meanings.

Within the structures of formal schooling, the teacher has an important role to assist learners in understanding the selected concepts of the lesson. For example Aikenhead (2000a, p.7) explains that "students are more successful if they receive help negotiating their cultural border crossings." However, the strategies that the teacher selects determine the level of overt teacher control. Edwards and Mercer cited by Scott (1998) identified pedagogical interventions in terms of the level of control exerted by the teacher. They describe *Paraphrasing pupils' contributions*, *offering reconstructive recaps* and *Direct Lecturing* as interventions, which reflect high levels of teacher control. Padding and reinterpreting students' responses as demonstrated in this project fall within this level of teacher control and illustrate an authoritative stance as opposed to the dialogic approach (Scott, 1998).

In addition, I assumed roles that were familiar and with which I was comfortable, even when these roles were not suited to the particular group of students with whom I was interacting. Seablast students required more guidance than the Parkview students. Aikenhead (1996) suggested that

> Border crossing will resemble (1) highly structured guided tours for Costa's (1995) "I Don't Know students" who will be tourists in the subculture of science, with a tour guide teacher; and (2) less structured academic bridges for Costa's "Other Smart Kids" who will be travelers in the subculture of science, with a travel-agent teacher.

It is clear from the above that teachers who adopt a cross-cultural approach to science teaching/learning are acting differently from the norm. These teachers must recognize that students vary in the ease with which they cross borders between alternative ways of knowing, and must adopt roles as "travel agent" or "tour guide" as needed. I needed to develop new skills that reflected this commitment to student diversity, but I learnt that there was a tension between feelings of safety and comfort associated with familiar behaviours and the uncertainty associated with the risk of trying something new. I had espoused theories of constructivism and had acknowledged the diverse nature of the student population, but the actual process of operationalizing these ideas, for example, by placing the students at the center and to cater to the different skills and attributes of various categories of students was a challenge, particularly at Seablast Secondary.

Lucas (1994) says that teachers are not omnicompetent, and Adey (2000, p. 170) suggests "teachers often need plenty of time to meet some of the underlying theory, to become familiar with the activities, and above all to practise the new skills…" The findings of this study provide empirical evidence of these principles, however, it seems that Lucas and Adey have ignored the contribution of reflection to the development of teacher knowledge. It was through the process of critical reflection that I began to understand my practice so that I could begin the process of change. Reflection was also crucial in helping me to understand and to develop the "language of bridge-building."

Communicative competence: The language of bridge-building

In addition to the above, other challenges emerged as I engaged in the process of explicitly comparing traditional practices and beliefs with conventional science concepts. These challenges were associated with my inexperience in enacting cross-cultural curricula, and my responses were subsumed under the label "developing communicative competence in the use of bridge-building language." For example, I discovered teacher/learner interactions during which I was "not explicit in identifying the mode of thought to which I was referring." I omitted signposts such as "according to conventional science," or "the traditional view is," and my language at times implied that the “conventional science explanation was universally accepted.” Following are illustrations of these categories.

During the enactment of the first few lessons at Parkview, I did not use the appropriate qualifying phrases in my explanations. For example, in the excerpt below, the phrase: “according to conventional science” was omitted before the phrase “the virus,” and that omission could have led the students to the false conclusion that I was promoting the conventional science explanation as sacrosanct:

> So what you’re saying is a very good point that I wanted to make. The virus, which causes the cold is always around us. But do we always have the cold?

The same pattern was observed as I introduced the concept of “homeostasis” in Lessons 4 and 5. I did not explicitly use the phrase “western conventional science” and, to compound the issue, in my use of the word “we,” I fully associated myself with conventional science. In other words, I did not mention explicitly that the explanation presented had emanated from a specific community-those adhering to Western conventional science- and I continued to use the term “we:” In so doing, I conveyed the message that the conventional science explanation was universal:

> T: So we’re saying that homeostasis is a mechanism by which the body maintains its balance or steady state….
>
> S1: I think the charcoal sucked up the dye
> T: Okay. Very good. The charcoal or the carbon must have sucked up, taken up somehow the coloured material, and the colourless one was left back.
> S2: Doctors use carbon when you take poison.
> T: Okay. So carbon has a special property by which it can actually suck up… and the word that we use for sucking up these poisons or dyes is

> Ss [interject] absorb
> T: The word is not absorb. In this case it's adsorption.
>
> T: We don't use the term cold-blooded and warm-blooded any more because it gives the wrong impression.

However, by the final lesson at Parkview, having engaged in the action research process of acting and reflecting, I became aware of the messages that I conveyed by my use of language and the small steps towards change began in subsequent lessons. As illustrated below, I did not always refer explicitly to the mode of thought in which I was engaged, for example, in the excerpt below, the phrase "in traditional ways of knowing" was omitted, but by this time I had come to recognize that my language reflected an implicit bias toward western science, and I began to qualify my statements by referring explicitly to "western science":

> The sebaceous gland produces oil, which covers the hair or skin…. So that is how the appearance of pimples is explained by western science. What we're seeing in common here is the idea of oil, but it's not taken in directly (as explained in traditional ways of knowing)

Additionally, I began to use the more specific reference "they" instead of the universal "we," though I did not always use the term "western scientists"

> Some people said that puberty was a factor. What we will look at now is the idea of puberty and how that explains the presence of pimples or acne. Actually what they (Western scientists) say is that at puberty, there is an increased level of hormones.

The challenge in the use of bridge-building language was reduced significantly by the time that the unit was enacted at Seablast. The following excerpts illustrate my use of qualifiers "in science class" and "what happens for the scientist":

> Now, when we use the term “is cold” we are referring to the temperature. In science class, we say it feels cold. And why? Because when we measure the temperature with a thermometer, we find that things, which feel cold are not necessarily at temperatures below that of the room.
>
> Now let’s see what happens for the scientist. In science class, you learnt about allowing the body to regain its normal temperature. You learnt that they tend to explain the processes by which heat is lost (by sweating).

<u>Summary/Reflections</u>

Language was used to help students to develop the conceptual line, which Scott (1998) describes as the first purpose of discourse in the classroom and which he defines as “pedagogical interventions directed towards, ‘Shaping ideas,’ where the teacher might: guide students through the steps of an explanation by means of a series of key questions; paraphrase students’ ideas, differentiate between ideas.” But Aikenhead (2000b) cautions that special demands are made on the teachers’ use of language during the enactment of a cross-cultural curriculum. He advised that teachers’ inappropriate use of language confuses students:

> A culture broker must let students know what culture he/she is talking in at any moment …because as teachers talk they can unconsciously switch between cultures, much to the confusion of the students.

This advice relates directly to Scott’s (1998) second purpose of teachers’ interventions in the classroom: developing the epistemological line. In a cross-cultural unit, one of the purposes of teachers’ interventions is to develop the epistemological line (Scott, 1998). In this study my intervention was intended to have students understand each way of knowing “in terms of the conceptual tools, as well as the epistemological framing of those tools” (Scott, 1998, p. 57). When applied to cross-cultural curricula, student understanding is facilitated when teachers make the clear distinction between different ways of knowing, and distinctions among concepts are more likely when teachers communicate clearly the culture in which they are speaking.

My ability to signal explicitly the culture (way of knowing) in which I was engaged on each specific occasion improved as the unit progressed at Parkview Secondary and as it was taught at Seablast Secondary. Adams (2000, p.9) cites Huberman and Miles as saying that "change is messy and trying. Early implementation particularly can be rough, with teachers running through cycles of trial and error…"

Reflections and discussion

During the design and enactment of this cross-cultural science curriculum unit, which made use of students' knowledge of traditional practices and beliefs, the challenges that emerged within the classroom setting were "level of teacher control," and "communicative competence in the language of bridge-building" within a context of "resistance and doubt" from key stakeholders.

Teacher control is a phenomenon that has been reported repeatedly in the literature, and in the view of Shymansky and Kyle (1992, p. 754), teacher control is intimately interwoven within the fabric of teaching. They state that:

> The teacher's task…is to help students acquire 'studenting' skills, select material to be studied, adapt material to the level of the student, create conditions conducive to studenting, monitor students' progress, and serve as a source of knowledge and skill.

Furthermore, this perception of teaching, especially the mandate to “serve as a source of knowledge and skill,” is held not only by teachers but also by other stakeholders in the education system--members of the society at large. It was evident that many stakeholders did not expect that traditional knowledge would form part of the science curriculum, which they felt would impede students in acquiring western science understandings.

Within this context, I found that during the design and enactment phases I acted either consciously or unconsciously in a manner that was congruent with these expectations. In addition, having established that I set out with an aim of employing a strategy that would facilitate students’ access to conventional science concepts, it is expected that my behaviours would have reflected “teacher control” in selecting the concepts explored and in mediating learning. However, behaviours that demonstrated attempts at imposing meaning on students’ utterances, that ignored aspects of traditional knowledge, and that showed a bias towards conventional science ways of knowing are antithetical to the philosophy of cross-cultural curricula and indicate a negative dimension of teacher control that was underpinned by attempts to transmit knowledge.

These findings are significant when it is recalled that the theoretical underpinnings of constructivism, which guided the approach to the design of the lessons, reflect a philosophical framework that promotes active learning on the student’s part and accepts that students may construct meanings that do not necessarily conform to teacher’s intentions. In addition, I had designed the cross-cultural curriculum unit, which was supposed to facilitate students' crossing back and forth between the two ways of knowing.

Segal (1998, p.199) observed "teachers often find themselves engaged in practices which they do not believe in." However, he suggests that "the classroom practices of teachers are not simply a product of their 'espoused theories,' but they emerge out of the ways in which teachers respond to classroom contingencies" (p.200), and he postulates that the system in which teachers work plays a significant role in determining teachers' responses. He says

> There is evidence to suggest that over and above individual and interpersonal dimensions, there are tensions whose source lies in the very structures of the expectations placed by the culture of schooling on both teachers and pupils (1998, p.201)

In addition, Fullan (2001) concluded that practitioners experience a lot of uncertainty and doubts about their skills and abilities to mange their new responsibilities and that innovations require unlearning of old behaviours and relearning new ones. Morris (1987) reported a similar finding. The Spanish teachers in Trinidad and Tobago whom she observed reverted to the traditional approach to the teaching of grammar instead of using the strategies intended to promote communication in the target language. One such teacher said: "I try but I lapse, when I remember I try to use it."

It was the deliberate use of action research, during which data were collected and systematically analyzed, that facilitated my understandings of my actions in the classroom and of the conditions under which these acts were performed, and of the challenges associated with attempting a new approach to science teaching, ultimately leading to improved practice. Jennings (1993) has reported Taylor as stating that teachers have the power to close their classroom doors to any innovative idea (1993, p. 131). However, it is quite conceivable that teachers maintain the status quo because they unconsciously and uncritically resort to past practices, which have given them a sense of efficacy, within specific contexts rather than deliberate, rational choice. That this is so, however, can only be corroborated by action research projects in which teachers critically reflect upon their practice.

Based on this action research experience, I learnt at a personal level that I must fully appreciate the uncertainty of the teaching/learning process, become comfortable with this uncertainty, and adopt strategies that would allow me to focus more on the learner's understanding (by probing more) instead of reinterpreting students' ideas. I learned that the use of the language of bridge-building demonstrated the new reality in my classroom--that there was discussion of two ways of knowing--and that I was unable to fully use the bridge-building language-- implicit in this shift in ontology--until I had systematically and deliberately reflected upon my actions in the science classroom. A number of other researchers (Elliott, 1991; Hodson, 2003; James, 1997; McAlpine & Weston, 2002) have recognized that reflection facilitates the transformation of practice and allows for development of teacher knowledge, and they advocate that teachers adopt the important role of teacher-as-researcher. I add my voice to this call, with specific reference to action research on the development and enactment of cross-cultural science curricula.

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