URBAN STUDENTS' IDEAS ABOUT THE "HEATED" BODY
IMPLICATIONS FOR SCIENCE EDUCATION

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This paper presents the results of an investigation into lower secondary, urban students' traditional beliefs about, and practices in, health related matters. The students were between the ages of 11-15 years and attended a seven year, single-sex school located in Port of Spain, the capital city of Trinidad and Tobago. The data were obtained through a written questionnaire, which was distributed to a class of 36 students and semi-structured, focused interviews. The latter were conducted with a sample of 10 students, who gave at least 70% of the responses on the questionnaire in accordance with traditional practices and beliefs, and their parents. Grounded theory methodology was used to analyze the data, and the dominant traditional category which emerged was the concept of the "heated" body. The students and their parents gave information on the factors which contribute to the heated state, the consequences of inappropriate management of the heated body, and strategies which are recommended for the management of the heated body. The implications of this prior knowledge for the development of lower secondary science curricula in Trinidad and Tobago are discussed.

It is now generally accepted that students enter the classroom with their own constructed prior understandings of many of the concepts that they encounter in the formal science classroom. This view is due, in part, to the increased popularity of the cognitive theories of learning, and since Ausubel's advice that we must teach in accordance with what the learner already knows, the educational implications of prior knowledge have been put solidly on the front burner of the research agendas of many persons. Consequently, there are many research reports on students' conceptions (Driver & Easley, 1978; Hills, 1989; Posner, Strike, Hewson, & Gertzog, 1982; Solomon, 1983, 1987) and ways of knowing (Aikenhead, 1996, 1997; Baimba, 1993; Costa, 1995; George, 1986, 1995; Hawkins & Pea, 1987; Stanley & Brickhouse, 1994) that attest to the resilience of prior knowledge, and in which strategies for making use of prior knowledge are suggested.

In 1991, Phelan, Davidson, and Cao reported the results of their investigations on the relationship between the understandings derived from life world experiences of 54 students, who attended four desegregated high schools in California, USA, and the students' commitment to schools and learning The daily experiences of many of

these students were categorized as a process of negotiating the boundaries between multiple worlds. Phelan et al. postulate that students' out-of-school experiences with family and peers result in constructions (ways of knowing) that delimit their worlds, and have varying degrees of congruence with their in-school experiences.

They posit that the success at negotiating the boundaries between these worlds depends upon the degree of congruence between the worlds of family/peers and school, and they conceptualize the degree of congruence between the worlds as a continnum which ranges from levels of high congruence to high levels of discord. According to Phelan et al., when there is congruence the transitions between the worlds are smooth, but when the worlds are highly discordant the students are unable to negotiate successfully. Consequently, students who belong to the former group are more successful at school and learning than those in the latter group.

In a related vein, Costa (1995) interviewed 43 high school students in California and found that the degree of congruence between in-school and out-of-school experiences influenced students' attitude to formal science and, ultimately, their responses to science classes. As demands are made for all students to achieve high standards in school science, research into students' prior knowledge and the subsequent use of the understandings gleaned from such research in the development of science curricula are gaining prominence.

During the 1990s, there has been some research into the traditional or indigenous knowledge of persons who reside in some developing countries, and also among first nation populations of developed countries, (Aikenhead, 1997; Baimba, 1993; George, 1993, 1995). This research has shown clearly that there are groups of persons who often have explanations, that are different from those which are encountered in the formal science classroom, for phenomena that are common to in-school and out-of-school experiences. Consequently, there has been a call for the inclusion of these ways of knowing--which act as prior knowledge for these students and, hence, as filters to new concepts--within the science curricula in these countries (George, 1993, 1995; Stanley & Brickhouse, 1994). It is felt that the inclusion of the students' prior knowledge may fulfill two functions: (a) school science curriculum may seem more relevant, and (b) the students may understand the conventional science concepts more readily as they deliberately confront the different ways of knowing.

Purpose of the Study

The purpose of this study was to develop and implement a unit of work for students who attended an urban secondary school in Port of Spain, the capital city of Trinidad and Tobago, henceforth referred to as Parkview Secondary. The unit was designed to provide opportunities for the students to build bridges between their prior knowledge on aspects of health and the conventional science concepts that are presented in the formal science classroom. It was expected that this approach would benefit the students by making the curriculum more relevant and interesting, and by facilitating their understanding of the conventional science concepts.

In this article, the first two stages of this study are described. Firstly, selected aspects of the results of the investigation into traditional practices and beliefs that pertain to health are presented, and secondly, the implications of these practices and beliefs for the development of science lessons for lower secondary school students are discussed.

Theoretical Pillars

This is an instrumental case study (Stake, 1994) that is qualitative in nature and is underpinned by the philosophy of constructivism. Cultural constructivism (Cobern, 1994) is one of the branches of the constructivist school of thought, and it is one of the pillars of this study. Cultural constructivism is a vehicle for thinking about learning that takes a step beyond the unique, individualized, private sense-making activities that are the focus of personal constructivists like Bruner, Ausubel, and Piaget and the social constructivists' acknowledgment of the public dimension of knowledge production (Solomon, 1987). Adherents to cultural constructivism (Aikenhead, 1996, 1997; Cobern, 1994; Stanley & Brickhouse, 1994) acknowledge that there are norms, values, beliefs, and expectations of different groups that constitute the sub-culture within each society. They also posit that people engage in making sense of the ideas that are meaningful to the group to which they belong.

There are shared practices and beliefs that are meaningful to some groups in society but which are not meaningful to others. For example, "street science" with its concomitant practices and beliefs (George & Glasgow, 1988) is the product of the meaningful constructions of some everyday people. On the other hand, conventional science with its ways of thinking about, and acting on, phenomena are the

constructions of the trained scientists. These ways of knowing may co-exist within many Caribbean societies, and many people are exposed to both. Consequently, Cobern's concept of "cultural constructivism" seems highly suited to the study of societies like Trinidad and Tobago, where the traditional way of life is a source of meaningful concepts in the lives of some persons who interface with norms, values, beliefs, and expectations that constitute a different world view and are meaningful to conventional scientists. It is highly likely that some of the students who comprise the case fall into the category of persons who are exposed to traditional practices and beliefs in their everyday lives, and conventional science concepts in the formal classroom, on health related matters.

Target Group and Setting

The students who comprised the target group attended Parkview Secondary which is a single-sex, seven-year secondary school located in Port of Spain, the capital city of Trinidad and Tobago.

The research process in which the target group was involved spanned the period from April 1997 to May 1998 when the students were between the ages of 11 - 15 years. They were enrolled in a Form One class at Parkview from April 1997 to July 1997 and were promoted to a Form Two class in September 1997. There were 36 students in the Form One class who were engaged in the part of the study that is reported in this article.

There is, as yet, no official nationwide curriculum for the students at this level of the secondary system, and learning experiences in the science classes at the lower secondary level of Parkview Secondary are guided by the textbooks authored by Durgadeen, McClenan, West, and Williams (1991)). There are units on "health" in the textbooks, however, the teachers have not, in the past, investigated or used the students' traditional knowledge in the teaching of these units.

Methodology

This case study falls within the qualitative research paradigm. Grounded theory methodology was used to determine the principles which underpin the traditional practices and beliefs which guide the actions of the students and their parents in aspects of health. Grounded theory methodology has been defined by Strauss and Corbin (1994, p. 273) as "a general methodology for developing theory that is

grounded in the data systematically gathered and analysed. Theory evolves during the actual research, and it does this through continuous interplay between analysis and data collection."

Two main data collection procedures were used to obtain data on the students' traditional practices in, and beliefs on, health related matters. A written questionnaire was distributed to all the students in the class and focused, semi-structured, one-to-one interviews were conducted with a sample of these students and their parents.

Data Collection and Analysis

Instruments

The questionnaire was made up of 24 items which described a variety of everyday situations in aspects of health and nutrition. It contained a mixture of two main types of items--the multiple choice item and the free response type. The multiple choice items contained a mixture of traditional practices and beliefs and conventional science responses from which students chose. The free response items gave the students the opportunity to supply explanations for everyday practices and/or to suggest the actions that they would take, in response to some everyday health related phenomena.

Six of the items were obtained from a questionnaire that was constructed by George (1991) and piloted on students from two rural high schools in Trinidad. The other items were developed from a combination of literature searches, my own experiences, and discussions with relations and colleagues. The questionnaire was subjected to peer review, and was piloted in March, 1996 on two groups of 11-14 year old students who attended the same Port of Spain school in which the study was conducted. These students participated in the pilot test only, and the analysis of their responses revealed that there were some flaws in some of the items. The faults were corrected, and the final version was administered to the students who comprised the case in April, 1997. Sample items from the final version of the questionnaire are shown in Figure 1.

Figure 1. A sample of questionnaire items on health related practices and beliefs

Do you think that you would catch a cold if you walk on a cold floor as soon as you awake?

A Yes B No C I don't know

Do you think that there are people who would catch a cold if they walk on a cold floor as soon as they awake?

A Yes B No C I don't know

Would you take a cold shower as soon as you awake in the morning?

A Yes B No

Give your reason:

_____

_____

Would you take a warm shower as soon as you awake in the morning?

A Yes B No

Give your reason:

_____

_____

John's mother told him that he must not walk barefooted on a cold floor as soon as he gets up from sleep. Why do you think she said this?

_____

_____

Five year old John had been playing in the sun all morning. At mid-day, he wanted to go over to his friend's house but he knew that he had to bathe first. What was the best thing for John to do at this time?

A. Bathe right away.
B. Sit down for a while before bathing.
C. Other (describe)

Give your reason:

_____

_____

The data were analyzed both quantitatively and qualitatively. The responses for each item were classified into major categories. Included among the categories for the responses were: traditional (for responses which conformed to traditional practices and beliefs), mixed (for responses which contained a mixture of the traditional practices and beliefs and conventional science. Included in this category were those responses that were described by George (1986) as "distorted conventional science" and those in which each mode of thought was clearly identified), accurate conventional science, and inaccurate conventional science (for those responses in which the students used conventional science terms incorrectly). The percentage of items per student which conformed with traditional explanations was then determined. Students who gave at least 70% of their responses based on traditional beliefs and practices were selected for the next data collection procedure--the semi-structured, focused interview.

Ten students met the criterion of 70% traditional answers, and they were interviewed using the semi-structured, focused interview format. The interviews were conducted during the period May - June, 1997, and were used to clarify data which were obtained on the questionnaire and for the purpose of elaboration. Each interview lasted for approximately 30 minutes, and all the interviews were audiotaped. The tapes were transcribed almost immediately after the interview was completed, and they were subjected to the first stage of grounded theory analysis--open (line-by-line) coding. Often the codes were obtained from the informants' expressions.

As more data were collected, codes were clustered into categories, and there were tentative attempts at concept formation. It was with this tentative framework that semi-focused interviews were conducted with 9 of the parents of these 10 students during the period June - December, 1997. Each parent was contacted by letter, in which they were asked to choose a convenient time and place for the meeting, and by telephone.

The interviews with the parents comprised the third component of triangulation of data sources/methods, and they were used to provide data which elaborated on, clarified, and verified the students' data. Each interview lasted for approximately 75 minutes, and all of the interviews were audiotaped and transcribed. These data were also subjected to grounded theory analysis: open coding, categorizing, concept formation, and concept development. In the later stages of data analysis, axial coding was also applied to the data from the students and their parents in order to obtain a rich, thick description of the theory. Axial coding is a process by which links

between categories developed by the open coding are created, in an effort to reconstruct the data in new ways. The main focus of this coding is the specification of categories in terms of the context in which they arise, intervening conditions, and consequences of actions and interactions (Strauss & Corbin, 1990).

Findings

Generally, it can be said that in response to the items on the questionnaire and the interviews, all of the students gave at least some explanations that are based on traditional practices and beliefs with respect to health regimens. The dominant category which emerged was the concept of the heated human body.

In this report, the students' ideas about the heated body are explicated. The students' responses are preceded by the symbols *S1*, *S2*, and so forth. The parents' responses are identified by the symbol *P* followed by arabic numerals which indicate the chronological order of the interviews. When two relatives were present during the interview, the responses are further distinguished by *a* and *b* following the arabic numeral. My comments/questions are preceded by the symbol *T*.

The Heated Human Body

The sample used the term "a heated body" to describe a state of the body that arises from (i) normal body processes (e.g., sleeping), (ii) exposure to thermal energy, or (iii) the ingestion of certain foods. Unless managed carefully, it is believed that the heated state can lead to illnesses, so the role of the heated body in the etiology of disease was a prevalent theme. The discussion that follows is restricted to factors (i) and (ii) only, and to the strategies that the informants indicated are used to manage the heated body.

Factors which contribute to the heated" state.

In response to both questionnaire items and interview discussions, the students mentioned that the heated state arose from sleeping; exposure to thermal energy, for example, the sun; playing; and wearing socks and shoes:

S1. His body is heated from the sun and from playing ...
S2. When you wake up, your body, ... it might have a little heat in it ...
S3. Well, when you sleep, your body's hot ...
S4. Because you're asleep, your body temperature is warmer.
S5. ... And sometimes, you come home and you have on your shoes, it's warm inside your feet.

The parents corroborated the students' beliefs, for example:

P3a. If yuh now get up and yuh body hot, heated...
P9. When yuh get up, it have heat in the body

The interaction of the heated human body with the environment.

The analysis of the responses from the questionnaire revealed that 92 % of the students believed that there are people who would catch a cold if they walked on the cold floor or had a cold shower as soon as they awoke. Eleven students (31 %) did not think they they would catch the cold in this way, and only one student responded: "I don't know" in answer to the effect of these conditions on her body.

During the interviews, the students and their parents reiterated the effects of bathing or walking on the cold floor immediately upon awaking, and elaborated upon it in the interviews to include the consequences of the inappropriate management of a heated body. These ranged from a cold, to pneumonia, to a stroke:

S6. After the heat is in his body and he goes to bathe, he could catch a stroke.

S7. When you just came, like let's say you came out from the sun. You were outside planting or something, and you just poke your head inside of the refrigerator one time. That can also give you a head cold. But, the cold in general, but mostly a head cold.

S1. My mom's a hairdresser, she keeps the iron comb. She turns on the stove and keeps the iron comb on the fire. So she uses it to straighten the hair instead of chemicals, and after pressing, you cannot go to the fridge for a while.

P1a. Even when you sleep, whatever. If you sleep close to a window, a draught might be coming in. You get up in the morning, your nose stuffy. All these things you know.

P3a. If yuh now get up and yuh body hot, heated and yuh just go to the fridge, yuh go catch a cold too. They say yuh could catch a stroke with that too.

T. So they'll have sniffles and coughs for the whole day?
P3a. Yes. As they go in the fridge. If yuh now get up, as yuh go in de fridge, yuh does start to sneeze one time. Yuh does feel yuh face start to feel heavy. Catch a draught.

P9. Cause they say that you would get a cold from the sole of yuh foot. So to just jump out (of bed) and go on the cold floor...that does be bad too.

Some of the students expressed the view that a sudden change in body temperature is the cause of the illness, others believe that the illness is due to the mixing of the two temperatures:

S1. ... When you now wake up your body is warm ...you'll get the cold, cause when the two temperatures meet....

S2. When you wake up, your body, it might have a little heat in it... When the heat and cold mix, that could cause the cold.

S3. Well, when you sleep, your body's hot, so as soon as you wake up and you go on the cold floor or the shower, the temperature change in you r body too fast, and that might cause a fever or so.

S5. Well, when you get up right, it's kind of cold environment, so I think when you go in the bathroom just so, you can get some kind of stroke or something like that. And when you're walking on the cold floor, and sometimes you come home and you have on your shoes, it's warm inside your feet. So when you just go on the cold tiles on the bathroom floor, you can get a stroke or something so. Well, I say like the changing of the temperature so quickly can cause you to get that. Your body is not adapted to that sort of temperature.

S8. The mixing of the temperatures. It's a human body, and if you change the temperatures suddenly, you might get sick.

S4. It's like ... probably the sudden change in temperature. Because you're asleep, your body temperature is warmer. And then from when your body is all warm, and then you go and walk on the cold floor. That probably affects you.

Managing the heated human body.

A number of preventative measures that are adopted for effective management of the heated human body were expressed. The following example illustrates one management strategy. The students had been presented with a hypothetical situation on the questionnaire in which a boy, John, who had been playing in the sun all morning had to go to a friend's house but knew that he had to bathe first. Thirty-one of the 36 students chose from among the answers suggested that it would

be best for John to sit for a while before bathing. In their explanations, 30 students related their chosen action to the belief that the body was heated, that is, there was "heat" in the body. Although all students did not use the term "heated," their explanations implied that the body temperature was in excess of the normal state, and they wrote of a number of illnesses which arose when the heated body was exposed suddenly to cold environments without the precaution of "cooling-off" (allowing the body temperature to return to normal):

S1. His body is heated from the sun and from playing so his body needs to be cooled.

S9. He needs to cool off and going straight in the bathroom after playing in the hot sun may cause pneumonia.

S10. John should wait before bathing ...allow his body to rest and return to his normal temperature, because if he immediately goes to take a bath his body will react to the change in temperature and he may get a stroke.

S11. Because if he was playing in the sun all morning he has to cool off and let most of the heat escape from his body.

Of the students who applied the traditional belief to explain their choice of action, 15 students wrote the term "cool off," six referred to the body as being "heated" or "hot" and two referred to a change in the normal body temperature. These results indicate that the majority of students believe that the body which is in a heated state should be allowed to attain its normal state or temperature before it is exposed to cool/cold environments, including water.

During the interviews, the students were asked to explain further why persons who were exposed to these situations would become ill. The responses all reinforced the idea that the sudden exposure of the heated human body to a cold environment would result in illnesses because there was a rapid change in the temperature of the body:

T. What causes you to get the stroke or so?

S5. Well, I say like the changing of the temperature so quickly, can cause you to get that. Your body is not adapted to that sort of temperature.

S4. It's like ....probably the sudden change in temperature. Because you're asleep, your body temperature is warmer. And then from when your body is all warm, and then you go and walk on the cold floor. That probably affects you.

The students described strategies which are used to manage their interaction with the environment and, hence, prevent illness. These strategies are adopted so that the body can adapt to the temperature of the surroundings. The following preventative measures were given: (i) always wear slippers when walking on the cold floor after waking, (ii) do not wet your body if your body is warm, and (iii) do not immediately wash your feet after taking off your shoes.

The last two preventative measures illustrate the impact of water on the human body. Generally, the students believe that if they are exposed to water for a prolonged period, then they are likely to catch the cold:

T. Are there any other precautions that you would take to prevent the cold?

S4. If you are watering the plants with the hose, try not to get your feet wet, and leave it wet for long.

T. You have to dry it off quickly?

S4. Yes miss.

T. That could also give you the cold?

S4. My brother gets the cold. Everytime he washes down the garage, he always ends up with a cold afterwards. He likes to play in the water.

S8. If I come home from swimming and I don't dry my hair, I'll get the cold. That always happens to me. I always have the cold.

The data from the parents corroborated the practices and beliefs of the students, and the parents also provided more detailed information on the practices which occurred in the household. The parents reiterated the idea that the heated body must be carefully managed in its interaction with cold environments, for example, by drying the hair after bathing, and monitoring times when the children take baths:

P4. ... And while people might have said to me :"but why you sending them in the pool so early? They might get colds." But, they never did get the cold. Because as soon as they come home, you dry the hair and you make sure that the body is dry and that kind of thing.

P1b. When J. was small, I remember she had a bad cough, continuous. She was coughing all the time. And we took her to so many doctors and they all recommended cough syrup. And I remember when we went to Doctor X, they all said he was good. Before he write the prescription, I said: " we went to so many doctors so I want somebody to tell me what is the problem. I don't want them to just write a prescription." And while I was talking, he was writing. And when I look at it, it was for another cough syrup.

> And that problem continued. And then after, in those days when they come from school they would take a bath. And then I say well, listen nuh, let's probably stop off the bathing. And that was it.

Summary and Discussion

The data reveal that the students and their parents believe that the human body becomes heated and that the conditions which contribute to the heated state of the body are sleeping, exposure to thermal energy (work/play in the sun, use of the iron comb), and wearing shoes and socks. They also believe that the heated body must be managed because the interaction of a heated human body with the physical environment can lead to illnesses such as the cold, stroke, and pneumonia. Consequently, people must be wary of exposing the heated body suddenly to cold environments, such as, the cold floor, refrigerators, or water, and appropriate preventative measures such as the use of slippers and cooling off are recommended.

Other persons who have researched lay people's understanding of the functioning of the human body (George, 1995; Harwood, 1971; Littlewood, 1988) have indicated that a "hot/cold" principle seems to underpin peoples' belief in this area. George and Harwood found that persons believe that the heated human body should not be exposed suddenly to cold temperatures/environments, and they termed this belief as the "hot/cold principle." From the data, a similar principle seems to be embedded in many of the actions of this sample of students and their parents.

The hot/cold principle can be said to be one component of the "hot/cold theory" that has been articulated by researchers who have investigated health related behaviours among different groups of people (Harwood, 1971; Madsen, 1955; Randall, 1993). The hot/cold theory is believed to be the remnant of the Hippocratic theory of body humours which has survived up to the twentieth century, and it is an explanatory system for illness and health in which the terms "hot" and "cold" are abstract terms. These terms are used as descriptors for causes, symptoms, and treatment of illnesses (Harwood, 1971; Wong, 1976), bodily states, food, individuals, and illnesses (Randall, 1993) and, according to researchers in this field, the terms "hot" and "cold" may or may not be related to the concept of temperature. It was noted, for example, that a hot tea may be classified as "cool," and cold beer as "hot" (Harwood, 1971). Temperature, however, does surface in some ideas about the etiology of diseases, for example, in exposure of the

human body from heated to unheated surroundings (Harwood, 1971) and the effect of body temperature (Madsen, 1955).

It is evident from the excerpts cited above, that the practices and beliefs that were enunciated by the students and their parents who constitute the sample, fit in with those aspects of the theory that are related to temperature, as it is related to the etiology of disease. It seems then that this target group of students and their parents from an urban environment in Trinidad subscribe to practices and beliefs which are similar to those identified by George (1995) in her study of the rural village "Seablast" on the north-eastern coast of Trinidad, Harwood (1971) in his study of Puerto Ricans in the USA, and Madsen (1955) in his research on Nahuatl Indians in Mexico.

Implications for Science Education

The data have shown that the students at Parkview come to the science class with firm notions that have been also identified in other regions of Trinidad, and in other territories, about health related issues. Some of these notions derive from the traditional practices and beliefs existing in the communities from which they come. For example, the students entered the classroom with the expressed belief that the cold is caused by a sudden change in body temperature, and this belief serves as prior knowledge for this area of study. In the view of cognitive theorists, this concept may act as a filter for the conventional science concepts that are presented in the classroom. Given the tenacity of prior knowledge (Garrison & Bentley, 1990; Novak, 1988; Solomon, 1983), the conventional science explanation that the virus causes the common cold may not become a part of the students' conceptual scheme, because their prior knowledge is so different from the conventional science explanation that is presented in the formal science classroom today. Furthermore, the concept of "homeostasis" is presented as a dynamic, internal regulatory mechanism which ensures that the body temperature remains fairly constant, under normal circumstances, and this concept is also very different from the students' prior knowledge that the body temperature changes suddenly. It is plausible, therefore, that these traditional beliefs may hinder the students' ability to access (i.e., to come to a clear understanding of) the conventional science that is presented in schools. They may remain unconvinced of the plausibility of the concepts that are presented in the science class because of their prior experiences and beliefs, and their emotional commitment to these ways of knowing.

The use of the students' prior knowledge in this aspect of health provides an opportunity for their traditional concepts to be confronted in the science class and examined explicitly. By the deliberate inclusion of traditional practices and beliefs, there may be increased relevance of the science curriculum and, hence, the students may be motivated to engage actively with the concepts that are presented in class. The students would then be forced to bring their prior notions to the fore and to compare these with the notions from conventional science. This comparative analysis may assist students in understanding the conventional science concepts that are presented in the classroom as they discuss the similarities and differences between the two views. At least, the students may come to understand that there are different explanations of phenomena, of which conventional science is one.

Three potential science lessons emerge naturally from the students' prior knowledge. Two are based on the common cold and related environmental conditions, and the third on homeostasis. The conceptual framework for the lessons is outlined in Table 1.

Table 1. An Outline of Three Science Lessons Which Can Facilitate Bridge Building Between Traditional Practices and Beliefs and Conventional Science Concepts

Lesson	Traditional belief	Traditional theory	Conventional science
1	The floor is cold	Intrinsic property the temperature of materials is independent of the temperature of the surroundings	The floor feels cold due to differences in temperature of surfaces and thermal conductivity
2	The 'heated' body should not be exposed suddenly to cold environments such as the 'cold' floor because the person will catch the cold	hot/cold theory	Germ theory - a virus causes the cold
3	Persons who have been sleeping or playing in the sun should `cool-off' before bathing, or exposure to cold environments	hot/cold theory Body temperature changes suddenly.	Homeostasis - Internal mechanism by which the body maintains a fairly constant temperature

A sample lesson on the common cold is presented in the Appendix.

Through class discussion, the differences and similarities between the two ways of knowing can be made explicit. In other words, the students are given opportunities to build bridges between the two ways of knowing by analyzing the respective concepts, and by evaluating the strengths and weaknesses, and similarities and differences of each system. As the conventional science theories are highlighted and compared with the traditional beliefs, the students may experience some disequilibrium and cognitive conflict (Niaz, 1995; Settlage & Sabik 1997) that are important elements of teaching and learning (Posner, Strike, Hewson, & Gertzog, 1982). Consequently, the students may recognize that there are different ways of explaining the phenomenon of the common cold. For students who can compare the strengths and weaknesses of these abstract concepts, a deeper understanding of the conventional science concepts may also emerge.

In today's world, with the increasing intrusion of science into all facets of living, personal decisions among alternatives become more important, as these decisions may affect the quality of life. However, informed decisions are achieved only through a deep understanding of the different ways of knowing, including conventional science.

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APPENDIX

A Sample Lesson on the Common Cold

Summary description

One prevalent belief is that the cause of the common cold is the sudden exposure of a "heated" body to cold temperatures (a cold floor, cold water). Students are asked to recall a popular television (TV) advertisement and to observe a role play which depicts a conversation between friends. They are then encouraged to speculate on the differences between these beliefs and the conventional science view in explaininig the common cold. The strengths and weakness of these explanations are then explored. The terms *triggers* and *mediators* are introduced, and students discuss the application of these terms to both systems of beliefs.

TIME	ACTIVITY	OUTLINE	KEY POINTS / OUTCOMES
5 mins	presentation of stimulus material	1. reference is made to a video of popular ad used on TV which shows man sneezing on exposure to the rain 2. role play which depicts a conversation betwen friends about the cause of the common cold	the belief that the sudden change in temperature may cause the cold and that this view is widely held
10	T/S discussion	T and S give other examples of situations which are associated with the common cold	the concept that a virus causes the cold
15	student-student group discussion	students discuss the stimulus material in order to produce a statement on the beliefs which underpin the presentations to compare with scientific explanations for the common cold	different explanations of the *same* phenomenon (viral theory and temperature theory)
10	plenary discussion	one member of one group presents findings, other groups react and present their findings	class consensus on principles which govern the different explanations

TIME	ACTIVITY	OUTLINE	KEY POINTS / OUTCOMES
15	student-student discussion and presentation	identify similarities and differences and the strengths and weaknesses of each system	the role of theory in explaining and predicting phenomena and hence actions
5	teacher presentation	teacher presents the terms: *trigger, mediator*	definition of terms
10	T/S discussion	the following question is discussed: Are these terms applicable to the cause of the cold in each system?	a simple cause-effect model is inadequate to explain illness, the conditions of life are important
10	individual activity	students answer a question on the common cold	

Requirements: role play, definitions of terms: *trigger* and *mediator.*

A1: Role Play: The Common Cold

A: But girl, how you always have the cold so? Think back! What did you do today?

B: *Well, I got up, and it was late so I rushed to the bathroom quickly without putting on any slippers. I had a cold shower, then...*

A: What kind of floor do you have?

B: *Tiles*

A: But you don't know that your body is heated when you get up and you shouldn't walk on the cold floor until you cool off? That's why you always have the cold!!

A2: Guiding questions for T/S discussion

1. Are there any other examples of circumstances in which parents give advice like this?
2. What do you think are the reasons why parents think that people will get ill if they do not follow the advice given?
3. We sometimes hear the term *virus* associated with the common cold. What is the role of the *virus* in symptoms of the common cold.

A3: Guiding questions for S/S small group discussions

In your groups, answer the following questions:

1. From your role play, what would you say is the cause of the cold in everyday life?
2. What explanation is given in science class as the cause of the cold?
3. What are the differences between these two explanations?
4. Are these explanations similar in any way? If so, how?
5. What are the strengths of each explanation of the common cold?
6. What are the weaknesses of each explanation of the common cold?
7. Can you apply either of the terms: *trigger* or *mediator* to the cause of the cold in everyday life and in the science class?
8. What would you say about each theory of the common cold in terms of its ability to describe, explain, and predict the occurrence of the cold, and hence to suggest precautions against the cold?

A4: Individual question to be answered by students at the end of the class

Imagine that you are a medical doctor/scientist. What advice (i) for the present (ii) for the future, would you give to a mother whose daughter has the common cold? Give reasons for the advice that you would give.