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ABSTRACT

The purpose of the study reported in this paper was to compare the world view of students of the Traditional Kickapoo Tribe, the most culturally conservative Native American group in the United States, with the world view encountered in the science classroom. This qualitative study investigated world view expressed in science instruction by conducting periodic observations in two classrooms over a 9-month period, teacher interviews, and text evaluations. To define student world view, 28 students in grades 5-9 were engaged in science activities at the reservation and interviewed singularly and in groups. Adult Native Americans were interviewed and asked to reflect on the educational and cultural norms of the students. A variable-oriented analysis revealed strong differences in epistemology, preferred methods of teaching/learning, values, structural orientation, and perspective of the place of humans in the natural world. Strong differences between teachers and students were also observed in prior knowledge, cultural rules for behavior and language patterns. Worldview investigations may help us understand the problems of Native American students in the science classroom. Contains 90 references. (Author)

"VOICES FROM THE BRIDGE" KICKAPOO INDIAN STUDENTS AND SCIENCE EDUCATION: A WORLDVIEW COMPARISON

Draft

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Abstract

The purpose of this study was to compare the world view of students of the Traditional Kickapoo Tribe, the most culturally conservative Native American group in the United States, with the world view encountered in the science classroom. The qualitative study investigated world view expressed in science instruction by conducting periodic observations in two classrooms over a nine-month period, teacher interviews, and text evaluations. To define student world view, 28 students in grades 5-9 were engaged in science activities at the reservation and interviewed singularly and in groups. Adult Native Americans were interviewed and asked to reflect on the educational and cultural norms of the students. A variable-oriented analysis revealed strong differences in epistemology, preferred methods of teaching/learning, values, structural orientation, and perspective of the place of humans in the natural world. Strong differences between teachers and students were also observed in prior knowledge, cultural rules for behavior and language patterns. Worldview investigations may help us understand the problems of Native American students in the science classroom.

Introduction

I run away from school. My body says to run away.
I try not to run away, but my body says it wants to run away.
[My daddy says]"If you run away again you are out of school."
So I don't want to run away, but my body says ,
"Run away!"
(Olivar, sixth grade Kickapoo student)

Bridges fill the lives of these people, the most culturally conservative of all American Indians (Pope, 1958; Latorre & Latorre, 1976; Dardon-Martinez, 1980). They live in the shadow of the International Bridge between Mexico and the United States. Their religious center is in Mexico, their economic center in Texas, and so they migrate frequently between the two countries, crossing the International Bridge at will. More importantly, they are presently crossing from the eighteenth into the twenty-first century.

For over 300 years the Traditional Band of the Kickapoo Indians of Texas have resisted involvement with non-Indian society and the adoption of non-Indian culture. As part of this resistance, they have avoided Western education. Numerous factors in recent years, however, have forced the band to the conclusion that mainstream education is imperative for their survival. In 1988, the first member of the band graduated from high school. The present generation is essentially the first generation in public schools. They must cross the bridge from traditional education to Western education. For many of the students, it is a perilous crossing.

Purpose

The teachers don't know what to do with the kids. They ask me what to do.
I tell them,
"Start at the beginning."
(Susan, Kickapoo tutor)

The stated purpose of this study was to interpret, within a worldview model, the educational experience of Native American students in the contemporary multicultural science classroom. Specific objectives of the study were:

- to provide a clearer understanding of the world view of contemporary Native American students,
- to provide a clearer understanding of the world view projected by teachers of Native American students in the multicultural classroom,
- to identify elements of world view expressed by texts in current usage, and
- to identify areas of potential world view conflict.

More specifically, the purpose of this study was to determine whether worldview conflict was one of the stumbling blocks in the educational journey of Kickapoo students of science.

Significance

Susan: If something they know belongs to the Kickapoo, like if the schools belonged to the Kickapoo, then it might be different. They might be more aggressive.
Researcher: More aggressive?
Susan: Yeah, they'd do whatever they want, but it's not theirs.
Researcher: Do the Kickapoo feel like guests in the schools?
Susan: Yes, Exactly. They are guests.

The need to encourage minority participation in science is well-documented (Black, 1990; Green, 1989, Holden, 1989; National Science Foundation Report, 1989). It is especially important that Native Americans, who as a group face unique scientific challenges, be included in the scientific community. Native Americans control large areas of ecologically and economically fragile land and face health problems far exceeding those of the general population. They are, however, the most under represented minority group in the United States in the natural sciences, the health sciences, and mathematics (Green, 1989). Clearly, a problem exists in the science education of Native Americans, a problem of concern to both Indian and non-Indian educators.

Cultural alienation and inappropriate education have been identified as key factors in the under achievement of Native American students (*Indian Nations,* 1992). In response, educators have demanded culturally-relevant curricula that reflects the Native American perspective, or world view (Tippeconnic, 1988). These demands assume that Native Americans have a non-Western world view that impedes success in the science classroom. The significance of the present study is that it examines this assumption through research and provides grounded theory on world view. Benefits should include informed policy, appropriate educational strategies, and improved curricula for Native students; improved understanding of the multicultural classroom; and a deeper understanding of the ways in which culture and other prior knowledge affect the instructional process. The significance of the study for the Kickapoo Traditional Band is that it may lead to a clearer understanding of the educational experience of Kickapoo students of science and encourage the development of an educational environment in which they feel a sense of ownership, to classrooms where they do not feel like guests.

Theoretical Underpinnings

Sociocultural Construction of Knowledge

Est mikaki ikichi kikieki ma do chi apenoaki piechi
kiodemielipena etasiacue yohi.
(Kickapoo for "It takes a whole village to educate a child.")

The epistemological underpinnings of the study are from the theories of constructivism (Piaget, 1929; Kelly, 1955; Pope & Keen 1981; von Glaserfeld, 1992); more specifically, the theories of sociocultural construction of knowledge (Vygotsky, 1978; Solomon, 1987, Wertsch, 1991). It was assumed that students actively construct knowledge while interacting with a sociocultural environment. Alternate conception research (Ausubel, 1963, Osborne & Wittrock, 1985; Gilbert & Swift, 1985) provided theoretical support for the importance of students' views in the process of learning.

The role of social interaction in the learning process has become increasingly evident to educators. Solomon (1987) has pointed out that although individualist construction of world view occurs, it is "astonishingly hard to form or to maintain without the collaboration of others" (p. 63). Friendship patterns and social processes make viewpoints waver and convert (Moscovoci, 1976). Among tribal people, such as those in this study, these effects may be expected to be particularly strong.

There are words that we can't translate...
Not even the words that we use sometimes, just talking...
(Susan)

Language is an important element within socioconstructivit theory. Socioconstructivism affirms that individuals interact socially to form knowledge and

constantly hold individual concepts up for affirmation by the social group. Language is the tool we use to investigate our world and form our concepts (Rorty, 1979).

Language...is an experience.
(Daniel, Sixth Grade Teacher)

Wersch (1991) draws on the writings of Vygotsky (1934) and Bakhtin (1986) in establishing the sociocultural nature of knowledge. He argues that understanding is developed through dialogue and an interchange of ideas. It is cultural in nature because the language forms and frames of references are cultural. He draws on Bakhtin's theories that not only do we communicate in national languages, but also in social languages and speech genres (1986) to stress that speech by its nature carries with it cultural significance and shared meaning.

The cultural aspects of language are revealed in many ways. Kincheloe and Steinberg (1993) note the "disparate amounts of cultural capital or awareness [that students bring into the classroom] that can be traded in for advantage in the school microcosm" (p. 299). "Knowledge of White middle-class language, concern for academic success, and the ability to deport oneself in a 'courteous' manner all contribute to one's advantage at school"(pp. 299-300).

The details—It's hard to explain the details when we try to explain that one word.
(Susan)

Language may also be used in various conscious and unconscious power plays in the classroom (Delpit, 1988; Lemke, 1990). Delpit (1988) indicates five aspects of power in the classroom, all of which derive from language and culture. Essentially these rules state that there is "culture of power" in the classroom, reflecting the rules of the culture of those who have power. The rules relate to "linguistic forms, communicative strategies, and presentation of self; that is, ways of talking, ways of writing, ways of dressing, and ways of interacting" (p. 282). Delpit also states that those with power frequently are not aware of, or will not admit, its existence. Lemke (1990) suggests that some classroom rules, such as a rule against calling out, may reinforce teacher power and indicate a preference for individual over collective responsibility for success or failure. It may be significant that traditional Indian ways of learning include answering with a collective voice, "calling out", whereas western classroom rules favor individual responses.

The importance of language in cross-cultural studies cannot be overemphasized. As Schindler and Davison (1985) point out, when a culture does not categorize or abstract the same as another (concepts that proceed from one's view of the organization of the universe), language problems do not just consist of being able to speak the language in the classroom; whole concepts are not translatable. Learning science vocabulary is not just learning new terms; it is interpreting reality from a whole new perspective. Researchers have pointed out that often mainstream students experience problems in the classroom as a result of a mismatch between the teachers' use of scientific means and the children's understanding (Bell & Freyberg, 1985; Cleminson, 1990). If this is true for mainstream students, it is reasonable to expect it to be even more of a problem for students who may not be fluent in the language used in the classroom (Dumont, 1972).

Two studies that examined the ethnicity of the teacher and the cultural congruence of the instruction with Native learners illustrate the complex ways in which culture. language, and teaching may interact (Hurlburt, Gade & McLaughlin, 1990; Osborne, 1989). Both studies assumed that Native American teachers would teach in ways that were more culturally appropriate for the Native learner. Neither study found that relationship. Osborne states, "Hence, ethnicity, in and of itself, does not ensure that teachers will match learning experiences to those of students from their own ethnic group" (p. 17). It has been hypothesized that perhaps the Native teachers are modeling

those who taught them rather than drawing on their cultural experience. They are, perhaps, talking in a "teaching genre." Bensey (1980) questions the possibility of speaking in one's own voice because when we speak or write we must do so in one genre or another, and these genre's bring with them the sociocultural conventions which govern that discourse. These sociocultural conventions may interact with science learning for a student from a non-Western culture.

[The Indian Students] don't understand the scientific terminology they use. It gets them confused because they don't know what it means.
(Susan)

Lemke suggests that some foreign languages, such as science, are more difficult to learn because they are less like the languages you know (1990). He further suggests that for the student who has a different perspective from that of the teacher and text, for whom the words, the rules, the concepts, and the experiences may have different meanings, the learning of science may be particularly difficult (1990, p. 139). Kickapoo is the first language of most of the students in this study. English is difficult, and scientific language more difficult still. It is the relationship of these difficulties with the cultural perspective of the student that is of interest to this study.

The Cultural Nature of Science

Doug (a Kickapoo adult): What do you teach?
Researcher: I teach science.
Doug: What science?
Researcher: Well, I teach environmental science and chemistry and...
Doug: No, I mean..what is science?

Early in the study, as I taught a literacy class of Kickapoo adults, I was asked the question, "What is science?" Answering this question turned out to be a major emphasis of the study. How the nature of science is understood has important implications in the multicultural classroom. If, for example, science is taught from the perspective of the "Leibnizian ideal"—the belief that all matters of fact can be impartially resolved by involking appropriate rules of evidence and when consensus is not reached it is because of lack of data or blind stubbornness (Laudan, 1984), then teachers might well interprete alternate interpretations of data as stubbornness or ignorance. Cultures whose world view does not include scientific assumptions might well be considered, from this perspective, as inferior or and their world views as undeveloped.

A contemporary understanding of science takes into account its historical and social nature (Feyerabend, 1976; Kuhn, 1962). Science may be understood as constructed knowledge within communities of knowers rather than as a mirrored knowledge of a positivistic reality (Hawkins & Pea, 1987). The strong cultural nature of science is becoming increasingly recognized. Hawkins and Peas argue the rationale of teaching science as if one were teaching cross-culturally (1987). In recent times, not only is science seen as a foreign culture, but it is often seen as a oppressive culture, finding itself in the ideological role in which religion was sometimes placed at the turn of the century (Bredo, 1994). Science is often seen as consisting of discourse, rather than facts, and local stories and cultures seen as a refuge from scientific rationalism (1994). This reliance on local culture is just the focus that the scientific community spent a century avoiding during the move toward positivism. Now, however, in the era of postpositivism, science seems to have turned again to these socially derived, linquistically expressed sources of knowledge. Science has thus been viewed throughout history as blasphemy, method, actual representation of a positivistic world, paradigms socially derived, and, more recently, as

discourse. This study questions which of these paradigms of science are presented to the student in the multicultural classroom.

Cultural Conflicts for the Native American Student of Science

When [the Indian Students] get to high school. The frogs—
They shouldn't work with frogs. They shouldn't work with animals.
(Susan)

Cultural conflicts may exist for the Native American student in the classroom in respect to content and to learning style. The science classroom is particularly suseptible to such conflicts. Certain materials, such as mammal and bird skins, may not be looked at or handled by some Native American students. Bones may not be touched, blood typed, saliva collected for amylase demonstrations or urine tested without causing offense (Burgoyne, 1988). Researchers have also reported conflict for the Native learner in which public performance preceding competence is expected (Appleton, 1983; Brewer, 1977; Cajete, 1988; Leacock, 1976; Swisher & Deyhle, 1989; Wax, Wax, & Dumont, 1964; Werner & Begishe, 1968)

Classroom organization may also produce conflicts for the Native American student. Philips (1972) and Dumont (1972) both found that Native learners would not respond (demonstrate learning) in classes that were teacher dominated, but when allowed to participate in student-led group projects the Native students were talkative and productive. Brown (1979) found that high levels of classroom competition were negatively related to the achievement of Indian students. A study among Cherokee grade school children found that the Indian students were more cooperative and less competitive than an Anglo comparison group and that cooperative behavior was shown to relate negatively to measures of their school achievement (Brown, 1980). Public reproach or a public display of anger is considered inappropriate in traditional values and may cause conflict for the Native American child in the classroom (Wax, Wax and Dumont, 1964). These effects were evident in the current study as well.

Researcher: I've noticed that the children are very quiet in school. The teachers tell me that they are always very quiet. But when I am with them outside of school or at the reservation, they are not quiet at all. They are very outgoing and friendly and talkative. Why are they so quiet in school?
Susan: Um...sometimes, the kids,...Someone will talk to them in a mean way, aggressive-like, and they get very disappointed with the person, and then from there on, they say, "I don't want to work with that person." They get withdrawn from then on.

The aquisition of science skills may be hindered by cultural conflicts. Jegede and Okebukola (1991) noted that cultural beliefs significantly affected the acquisition of science process skills (observation). In the investigation they reported that students who held cultural beliefs concerning cosmology were significantly less likely to observe data at variance with those beliefs. Lawson and Worsnop, also investigating the effects of culture/science conflicts, found that certain cultural beliefs (in special creation) hindered the acquisition of science beliefs (1992). They found, in essence, that beliefs, rather than declarative knowledge, were related to the acquisition of scientific beliefs. These findings indicate that when cultural beliefs (world views) conflict in the science classroom, learning may be impeded. Okebukola and Jegede demonstrated that science instruction that deliberately involves the discussion of sociocultural views about science concepts may produce positive results.

Edmondson (1989) reports that the level of meaning students derive from their learning is affected by the degree of compatibility between students' epistemology and the epistemic principles implicit in teaching. Mainstream Western culture is based on an objectivist epistemology and a mechanistic world view (Kincheloe & Steinberg, 1993). When the cultural orientation of the students is not considered, affective as well as cognitive effects may be observed.

Worldview Theory as an Interpretive Model

> *Researcher; If you could give some advice to teachers on how to improve the education of their Kickapoo students, what would you say?*
> *Susan: ...Try to understand the child.*

World view is the way people have of looking at reality. It consists of a more-or-less consistent system of images and assumptions that may, or may not, accurately represent the world (Kearney, 1984). Cobern defines world view as the foundational beliefs about the world that support both commonsense and scientific theories (1990, p. 7).

The current theoretical model for worldview theory is based upon work in the field of anthropology by Wilhelm Dilthey and Franz Boas in the 1800's (from Kearney, 1974). Redfield (1897-1958) contributed to worldview theory by conceptualizing a model in which the cultural outlook of a group could be broken down into worldview universals. The world views of all cultures, theorized Redfield, contain the same elements (universals), although the content and organization of those elements may be unique to that group. Redfield's model contained the universals *Self* as distinct from *Other*, and *Other* as composed of *Human, Nature* and *God*. Kearney has expanded on Redfield's model, including a total of seven universals: *Self, Non Self, Relationship, Classification, Causality, Space and Time* (Kearney, 1984). Kearney's model differs from Redfield's in having a greater emphasis on the structure of world view; how the universals that make up a culture's world view are related to each other.

More recently, worldview theory has been applied to work in the field of science education (Kilbourn, 1984, Proper, Wideen, & Ivany, 1988; Cobern, 1988, 1989, 1990, 1994). Cobern (1989) suggests that worldview theory is implicit in other research important to science education. Anderson's work concerning cognitive styles and multicultural populations is an example. Anderson (1988) specifically contrasts Western and non-Western world views.

Although the application of the current worldview model has been a productive avenue in science education research, the model was not assumed for the current research. A problem existed in that the assumption of universals, a critical element of both the Redfield and Kearney models, originated from within a Western world view. For example, Redfield first assumed that "all men are conscious of a Self within them. The Self is the vantage point from which the 'world' is observed; it 'is the axis of world view'" (Kearney, 1984, p. 38). Research in cross-cultural psychology challenges this assumption, stating instead that selfhood is socially constructed, like any other concept, and as such differs among cultures. If Self may not be assumed, then of course, the division between Self and Other (or Non Self in the Kearney model) may not be assumed to exist. Other of Redfield's universals may also be questioned; for example, the division between Nature and God, or between Human and Nature. Traditional Native American cultures, for example, often do not recognize a separation between humans and nature (Deloria, 1992).

In light of current understanding, the term "universals" may be problematic in that it implies a consistency across cultures that may not be supported by the data. Perhaps it would be more helpful to refer to elements of the Redfield and Kearney models as "common transcultural categories," implying simply that these particular categories may

be appropriate descriptors of the world views of many cultures. For the present study, the models were found to be helpful as a starting point, but in keeping with the emergent design, categories were allowed to emerge from the data. None of the emergent categories were assumed to be universal.

Design and Procedures

If you are doing this research, it's a very worthy thing.
(Daniel, sixth grade teacher)

Perspective: Interpretive

The study is descriptive, from an interpretive perspective (Miles & Huberman, 1994; Lincoln & Guba, 1985; Isaac & Michael, 1981). The content of interest is the meaning-perspective of the participants within a sociocultural context (Erickson, 1986). Cognitive anthropology, a tradition that attempts to describe cultural mental patterns (Jacob, 1987), provided insights for the study.

Cognitive anthropologists believe that groups share patterns for behavior that influence, but do not determine, behavior. The way a group structures those patterns, rather than the content, are of interest to the cognitive anthropologist. The focus, as stated by Jacob, is "mentalistic cultural patterns and their organization" (1987). World view theory, the interpretive model employed in this study, is a way of understanding these cultural patterns, so it was to cognitive anthropology that the author looked for structure and strategies appropriate for the research.

Goal: Generation of Grounded Theory

The goal of the present study was the generation of grounded theory, thus ways of collecting data and categories for analysis emerged from the data itself during the process of collection. (Glaser & Strauss, 1967). The design of the study was emergent, changing in response to the data (Miles & Huberman, 1994).

Data Collection and Analysis

Figure 1 presents an overview of the design of the study. The major participants were 28 Native American students, fifth through ninth grades, who attend public multicultural science classes and two public school science teachers. Data concerning the world view projected in science education were collected from classroom observations (periodically over the course of a school year), teacher interviews, and textbook evaluations. Curricula designed by and for Native Americans were also evaluated for comparison. Data concerning the world view of students were gathered during science activities conducted with the students at the reservation, interviews with the students singularly and in groups, interviews with parents and other adults involved in the education of the students, as well as from classroom observation.

The author had opportunities to play ball with the students, share meals, teach adult as well as student classes, and visit informally in a variety of situations. A rich and serendipitous source of data was provided by the author's 800 number, listed on the original consent forms. Several calls a week from students over a two year period provided data and enjoyment.

Data were recorded on audio tape, videotape, field notes, contact summary forms, student drawings, and other documents. Triangulation of data, peer review, and participant review provided confidence in the findings. All audio and video data were transcribed and all data coded soon after collection. Categories were selected from the initial data. As new data were added, those categories were retained that continued to fit the emerging data. Other categories were added, deleted, or modified as the data continued to emerge and previous data recoded with new codes until the researcher was

confident that the coding system "fit" the actual data (Figure 2). Codes were totaled and matrices designed for interpretation and presentation of data (Appendices 1-4).

A variable-oriented comparison was presented in narrative form, with examples and vignettes providing a rich and thick description of the participants and their world views. The comparisons of the Western texts and Native American science curricula were also presented in narrative form, with an emphasis on variables.

Findings

Worldview variables expressed by the texts

Quote from a mainstream text:
"...most of the ocean water cannot be used by living things because it contains salt."
(Earth Science, p. 240)

The mainstream texts were examined because research has shown that textbooks are often used as the primary source of information in the science classroom (Harms & Yager, 1981; Stake & Easley, 1978; Yore & Denning, 1989). Yager (1983) has documented the textbook dependence of science instruction, reporting that more than 90% of all American science teachers use a textbook 95% of the time and that generally the curriculum is guided by a single textbook. A sixth grade general science text and an eighth grade Earth science text were examined. Worldview variables were clearly identifiable in the texts (Figure 3). The mainstream texts contain worldview expressions that are dominant in perspective, reductionist in content-methodology, competitive/authoritative in organization-methodology, positivist in epistemology, and linear in time/space orientation. The basis for validation of knowledge expressed in mainstream texts is somewhat more authoritarian than empirical, but both variables are commonly expressed.

The Native American curricula were examined as a means of comparison. None of the students in the sample expressed having ever used materials prepared specifically for Native American students. The worldview expressions in the Native American materials are harmonistic in perspective, holistic in content-methodology, cooperative/authoritative in organization-methodology, relativistic in epistemology, and circular in space time.

An example of a dominant expression of perspective from a mainstream text is:
"People need resources to survive. Thus, resources must be protected and conserved." (Earth Science, p. 360).

Native American texts expressed a harmonistic perspective in such statements as:
"..to capture for a moment the joyous fecling of many creatures living together in balance and harmony is the objective of this unit. "

An expression of reductionist methodology from a mainstream text:
"Different parts... have different jobs" (Discover Science, p. 418),

may be contrasted with the holistic statement from Native American materials:
"Look at the total picture."

Mainstream positivist epistemology:
"A scientist uses these methods [and] finds truths about nature....
These truths are called facts." (Earth Science, pp. 12, 13).

may be contrasted with Native American relativistic epistemology:
"A door in your mind opened, a light came on, and the truth was revealed in ways you never expected so simply ."
[discussing omens as a way of knowing].

It was interesting that although the mainstream texts often refer to cycles, the "cycles" they give as examples are generally linear. For example, one text speaks of the life cycle of a star, from life to maturity to death. The linear description of this "cycle" is also illustrated linearly (Earth Science, 1987). The human life cycle is also presented in linear form. Even cell division, clearly a cyclical sequence, is presented in linear form (Discover Science, 1991). The

Worldview Variables of Teachers and Students

Passive resistance versus active participation

Researcher: As far as answering questions, do they the Indian students: seem to take longer to answer questions?
Barbara: They don't.
Researcher: You mean they just don't answer questions at all?
Barbara: That's right.

One of the first facts to be noted in working with the students was that the students behaved totally differently in school than they did at the reservation. The students exhibited almost total passive resistance in a school setting and active interaction in a reservation setting. This effect held even when the same lesson was taught by the same teacher in the two settings. A particular student, whom I will call James, was totally passive resistant in the classroom. The teacher told me that it was believed that James had a learning disability and that his language problems prevented him from understanding what went on in the classroom. James, I was told, would receive a social promotion that would not reflect his failing level of achievement. On Friday, when I taught in his classroom, James kept his head down and was silent and inattentive. On Saturday, at the reservation, I taught again. James volunteered 22 answers during the course of the day. During the first hour, when I retaught Friday's lesson, James answered correctly so many times that I finally invited him to teach with me. This finding is consistent with the suggestion that it may be a cultural factor, rather than a lack of interest or ability, that produces the passive resistant behavior observed in the classroom, a behavior that disappears in a different cultural setting.

Social worldview variables

My friends, when they hear I teach Indian children they just don't believe it. Everyone knows, they say, that Indians are savages.
(Barbara)

Six categories emerged during the study that are social, rather than philosophical, in nature. Five subcategories—language (the social aspects of language), intercultural feelings (empathy versus intercultureal antipathy), knowledge (factually informed versus facturally uninformed), rules for behavior (shared versus not-shared) and cultural experience (shared versus not-shared)—were grouped under the general category of ethnography. The sixth, concerning shared versus not-shared values, was considered to be a subcategory of perspective and will be discussed separately.

Figures 4 and 5 illustrate how culturally different the students and teachers are in four of the five categories. The category in which there is the greatest congruence is in intercultural feelings. Students and faculty agreed that within the community there is strong antipathy for the Indian students. As Stacy, a sixth grade Kickapoo student said, "*No one just defend us.*" Between the staff and the students, however, a warm empathy was expressed.

> *Researcher: Do you like your teachers?*
> *Olivar: Un-Huh.*
> *Researcher: Who's your favorite teacher?*
> *Olivar: Mr. [B.)*
> *Researcher: What does he teach?*
> *Olivar: Math. No, Reading.*
> *Researcher: Reading? What do you like about him? What does he do that is different from your other teachers?*
> *Olivar.:...[unintelligible)...friend.*
> *Researcher: He's your friend? Mr. [B.) is your friend? Ah....*
> *How do you know he's your friend?*
> *Olivar: He told me.*

As Figure 5 illustrates, however, the teachers are factually uninformed about the culture of the Indian students. Although both teachers were raised in the area, neither could remember knowing an Indian until they began to teach the Indian students. Neither had ever visited the reservation.

> *I personally have never been to the reservation, so I don't know...My concept is just from what I read, like the Navajos they make pottery, or whatever. I don't know what they do there today. Do they work on something? Do they try to sell something? Things like that? I don't know? (Daniel)*

Kickapoo students are often trilingual, speaking Kickapoo, Spanish, and English. Others speak only Kickapoo, or Kickapoo and either Spanish or English. Kickapoo is typically their first language and the language in which they feel most comfortable. Three categories of language problems were noted in the data. The first is simply vocabulary problems related to the fact that the language of the classroom is not the language of the home. Although this may be a problem for the students, it is not a problem specifically related to world view. A second category concerns the tendency of the students to "stall" when asked a question. This tendency may be related to the fact that English is not the language of choice. An alternate hypothesis is that it reflects cultural values, such as proficiency before performance or cooperation rather than competition. It should be noted that students answer more often and more quickly when they are allowed to answer in a group voice. This is a question that is only suggested, but not answered, by this study.

The third category of language problems noted in this study concerned the narrowness of scientific terms. Scientific language is precise, and scientific communication requires precision. The holistic methodology expressed in Native American texts and by the Kickapoo students is reflected in Kickapoo language. Words are meant to communicate an experience, and are thus deliberately multi-faceted. Scientific words seem lifeless, like bones without flesh. The students have difficulty in expressing themselves in such words. In expressing the frustrations students experience with scientific words, Susan explained:

> *The details! It's hard to explain the details when we try to explain that one word.*

Even ordinary, unscientific English often leaves the students without enough "details" in the spoken word, and students often supply sounds and actions to go with a word.

Olivar: Maybe it's a bird?
Researcher: Maybe it's a bird?
Olivar: Like a [unintelligible]? You know, he goes "Kerrack!" Like that?

Researcher: How does that little schronnie snake eat a big old toad?
Greg: Swallows it. GWARK!

Lane, who prefers Kickapoo although she speaks and understands English well, described a fight in this manner:

Except them like, they are, this is help, like the arm go, like we're go, and they start arguing and go...poo, poo, poo..

Philosophical worldview variables

Five philosophical worldview variables emerged from the data—perspective, epistemology as it concerns the nature of knowledge, epistemology as it concerns the validation of knowledge, methodology as it concerns content and methodology as it concerns instruction. Within each of the five categories, two opposing views could be discerned (Figure 6).

Perspective was defined as dominant or harmonistic. A dominant perspective holds that nature is hierarchical, with humans at the top of the hierarchy. A dominant perspective often includes as strong sense of stewardship. As the most capable of nature's beings, humans have unique responsibilities. It is common, when one holds a dominant perspective, to be anthropocentric. The teachers were strongly dominant in perspective.

Researcher: How would you describe the relationship between humans and nature?
Barbara: Humans should take advantage of nature. There is a shifting balance in nature of which humans should be aware.
Researcher: How would you describe the relationship between humans and animals?
Barbara: Humans should respect and protect animals.

Researcher: Why is pollution bad?
Daniel: Because it is affecting our lives.

The students, however, expressed a strongly harmonistic perspective.

Researcher: What do you think about people and animals? Should we hunt them, should we protect them, should we eat them, should we not eat them?
Students: Eat them...eat them....eat them...hunt them. Hunt them.
Stacy: Hunt them, eat them, protect them.
Researcher: Carolyn, what do you think?
Carolyn: Hunt them.
Researcher: Hunt them?
Stacy: Eat them.

Researcher: Eat them.
Doug: Wear them!
Researcher: Wear them! What do you think about people who say we shouldn't eat any animals or that we should wear any animals?
Doug: What do we think of them? I think they got a lot more money, that's why they want to keep that up.
Researcher Is it alright to hunt animals for fun?
Students: [mixed voices, all of them saying "No!"]
Researcher: Why not?
Students: 'Cause!
Doug: Because you don't want to be hunted.
Researcher: Because you don't want to be hunted? Do animals have feelings.
Doug: Yes.

As is congruent with a harmonistic perspective, the students expressed a relationship with animals of mutual respect, but not stewardship. When cautioned to take care of the birds, a student replied, *"The birds will take care of themselves."* When asked what would happen if fish became extinct, a student replied, *"We'd miss them."* When students were encouraged to specify the differences between humans and other animals, a student finally offered, *"Their habitat is different."*

In methodology, students and teachers were diametrically opposed. Teachers almost exclusively used reductionist methodology; students, when given a choice, preferred to handle content holistically. In organization, the teachers were strongly authoritarian and used competitive strategies in the classroom. The students were strongly cooperative, both in expressed opinions and actions. Many of the students, for example, will not attend school sporting events because, as a third grade student explained, *"It's not right to try to beat somebody."* Students prefer to work together and often share answers on work. Grades are not highly valued.

Researcher: What about grades? Do the kids want to make good grades?
Susan: Well...some do...well, they think grades are just there; it's not important to them .

Researcher: How do they feel about competing against each other?
Susan: The little ones...they like it. But the older ones think it is very childish. They just won't do it, because it is childish and they are growing up.

In epistemology, more congruence between students and teachers was observed. Students demonstrated a slight preference for empirical methods over authority as a basis for validating truth. Teachers, although expressing empirical epistemologies, did not demonstrate empiricism in the classroom. Thus both teachers and students tended to have mixed epistemologies, the students tending more to empiricism, the teachers to authority. In the nature of knowledge, students and teachers expressed positivism exclusively. Facts, to all participants, were facts.

Implications

...us Americans, you know, we have beliefs in the American dream, in the American ways and all that. [but] they [the Kickapoo] tie in with their beliefs and culture ...

"But as I understand, it's because they don't want to change. ..They wanted to keep the old ways." (Daniel)

Although values was subcategory under perspective, I chose to discuss values with implications. It is in values that other worldview variables interact and are expressed in actions. It is here that worldview variables "walk their talk." In comparing values, it is far easier to identify value conflicts than shared values. When values are shared, interaction flows smoothly and ripples are not made in the stream of life. Such shared instances may easily go unnoticed. When values conflict, that conflict is often very apparent. For example, Indian students may attend classes for days at a time, but because that is the expected behavior, it may not be asked whether this represents a valuing of education—a value shared with the mainstream culture. When Indian students are suddenly absent for a month in the middle of a term because they value a religion that is not shared by the mainstream culture, the conflict is obvious. A deliberate effort was made to note instances of shared, as well as conflicting values. Over half the instances noted, however, (60%, Figure 5) were conflicting.

Value differences were strongly interwoven with rules for behavior. For example, teachers were constantly baffled and frustrated by the refusal of the Indian students to contribute—to answer questions and turn in assignments. The Indian students however, may be simply exercising their values of noncompetition and listening-to-learn.

A conflict of value may result in science courses specifically in such incidents as dissection and the treatment of other life forms. The strong Kickapoo values of harmony extend not only to other people, but also to other life forms as well. Thus "Science as a means to control," the definition on the wall of a science classroom, may result in a value conflict for the Kickapoo student of science.

On one occasion, a discussion in class concerned migrant workers. The teacher, in response to student discussion, tried to encourage the students to make something of themselves. Before the transcript of this discussion is read, certain information about the Kickapoo people should be recalled.

- Kickapoo's have traditionally chosen a migratory lifestyle. It has been theorized that they prefer such a lifestyle because it affords a degree of freedom that other occupational lifestyles do not, a quality they highly value (Comprehensive Report, 1981). In addition, it provides opportunity for them to take the time to travel to Mexico for religious holidays that, as Susan says, *"[is] something we all do... it's important to us..."*

- The first Kickapoo to graduate from high school did so in 1988. Yet they have managed to preserve their culture and remain together as a people for over 400 years without Western education. To equate lack of a Western education with a lack of success may seem, to some, a bit presumptuous.

- There are no Kickapoo doctors, although some of the students said that they would like to become doctors or vets. Traditionally Kickapoo people have relied on holistic medicine and eschewed medical science; however, evidence indicates that this is changing.

- Kickapoo are traditionally nonmaterialist. No student that I talked with at anytime expressed a desire for material gain when they discussed future goals. Rather, they expressed a desire to somehow

be of service, especially to their people, and to remain near or return to their traditional lands.

- Grades are not motivational for Kickapoo students. As Carolyn, a sixth grade student told me, *"That's her ([he teacher's] grade; not mine."*

Transcript—Class Discussion
Your parents, or maybe your grandparents, came from Mexico, and they've been here 4 or 5 years—you're ten or twelve years old—and you have to go up North to work, and maybe some of you don't like it. Well, it's up to you to change it. I'm not going to change it; you're going to change it. You know, while ago I made the comment, two-three months back, when we go to the library, how many books do you see related to, that are role models, that have important people who have made something of themselves? Very good, that's an important point right there. Not everybody is a criminal; not everybody is uneducated, a dropout.
...All of you..all of you have the opportunity to make something of yourselves, to become a doctor or a lawyer or an engineer. It's more feasible, than in the time when I was in school. You have more resources to financial aid and opportunities that can help you out financially. It's up to you. If you want to drop out of Junior High, maybe get married at fourteen or fifteen, you want to do migrant work with your parents the rest of your life, hey, it's up to you. All of you people, you're smart enough.. You can make good grades. I try to teach you. If you want to take advantage of that, or not, well, it's your life. Along in life, some of you are going to make it and some of you aren't .

Summary

Worldview differences do apparently exist between Kickapoo Indian middle school students and the instruction they receive in the science classroom. Those differences create frustrations for teachers and for students. None of these differences relate to the nature of science as it is currently understood, except in the area of epistemology. In epistemology, students, teachers, and texts were congruent. All three reflected more seventeenth century Newtonian philosophy than a contemporary understanding of science. None of the differences, if mitigated, would be inconsistent with effective scientific teaching. Philosophically, the Native American perspective is more consistent with current understanding of science. Pedagogically, Native American preferences for cooperative and holistic methodologies have been demonstrated to be highly effective in the classroom.

The research left me with one important question. In a world that has learned to value diversity, the goals the students have for themselves and the goals their parents have for them must be respected. The picture on the next page was drawn by a student when I asked him to draw a picture of what he wanted to be when he grew up. My final question is, how can science education help him achieve this goal?

Draw what you want to be when you grow up:

A Kickapoo Indian For Ever

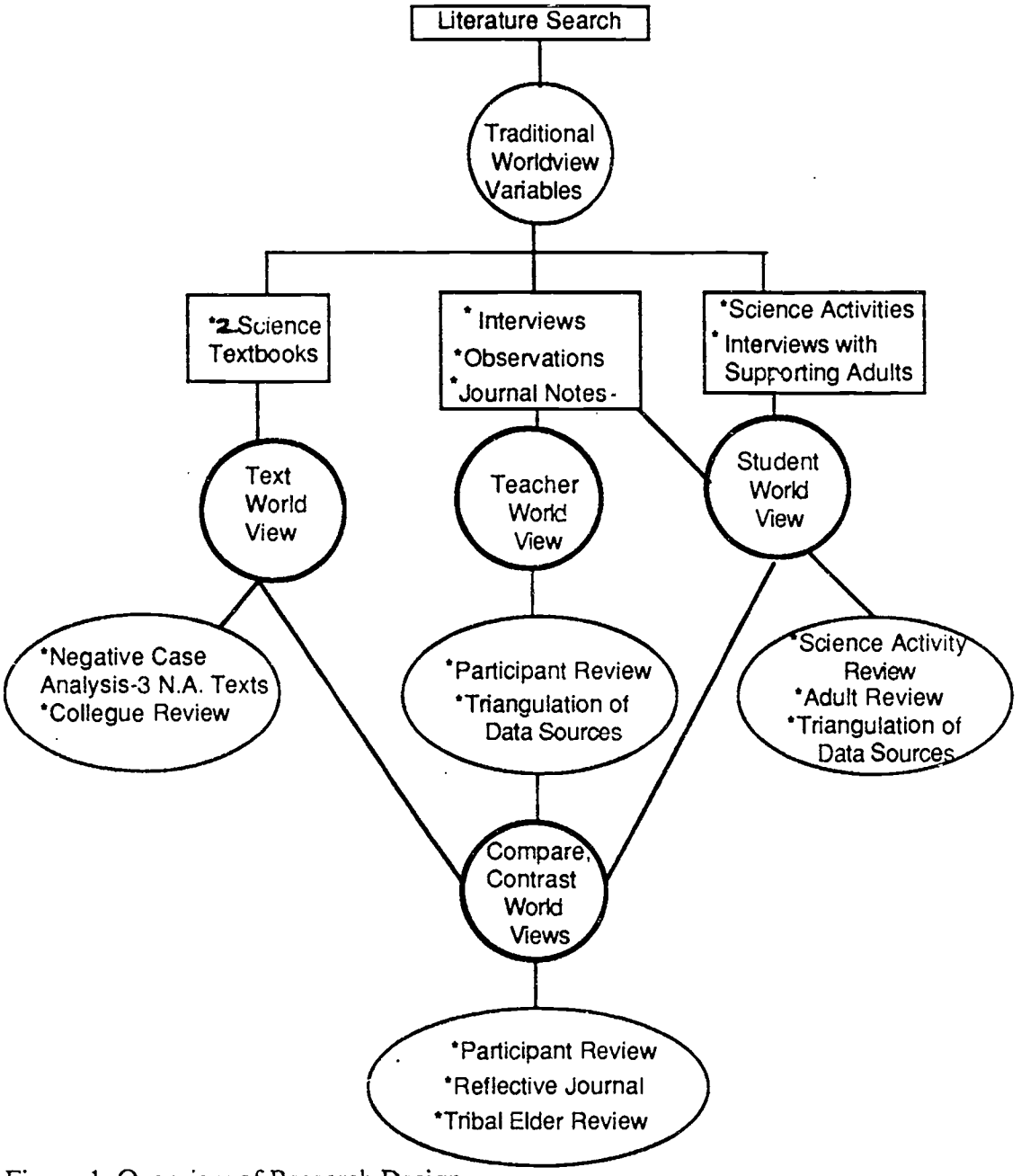

Figure 1. Overview of Research Design

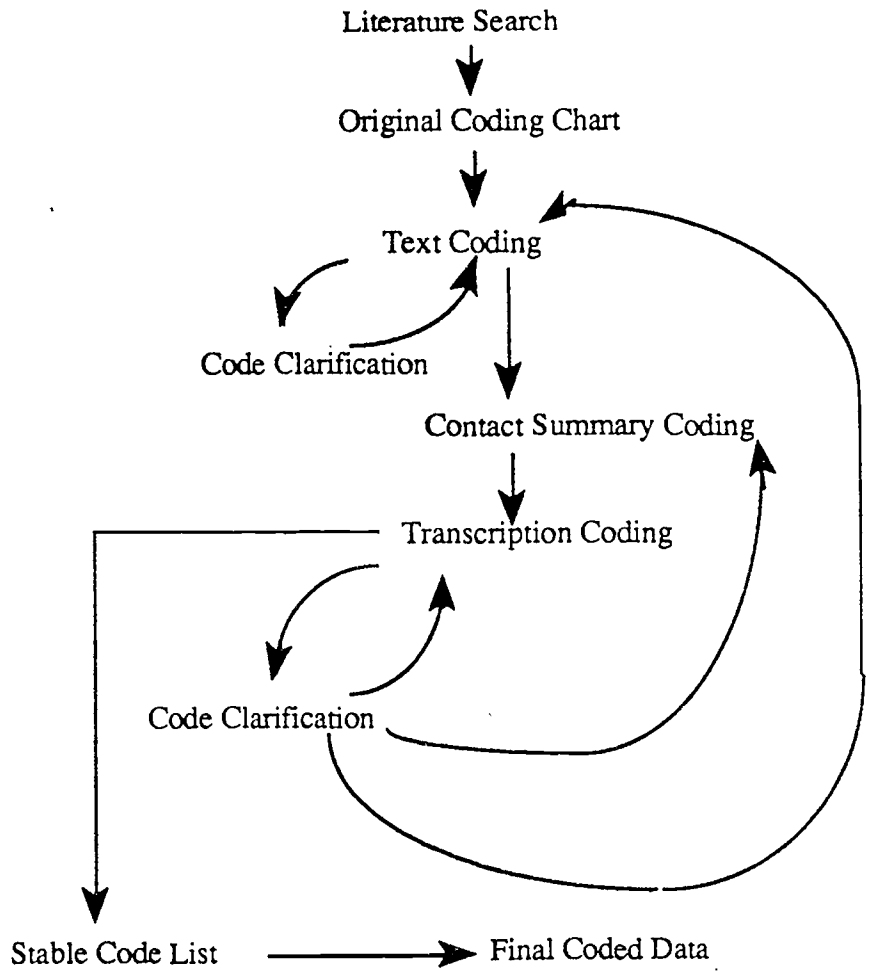

Figure 2. Process of Code Generation and Data Coding

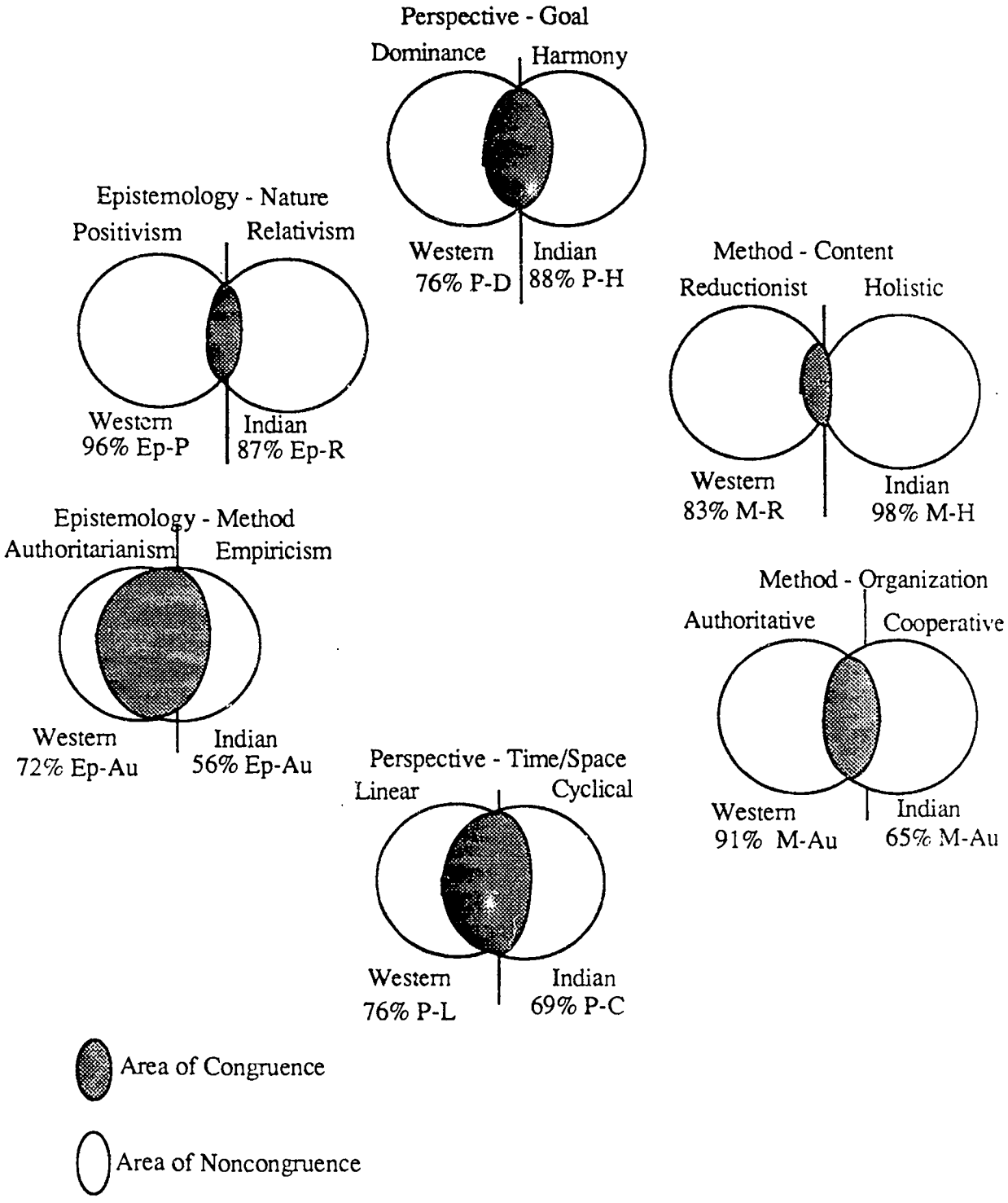

Figure 3. A Comparison of Worldview Variables in Texts

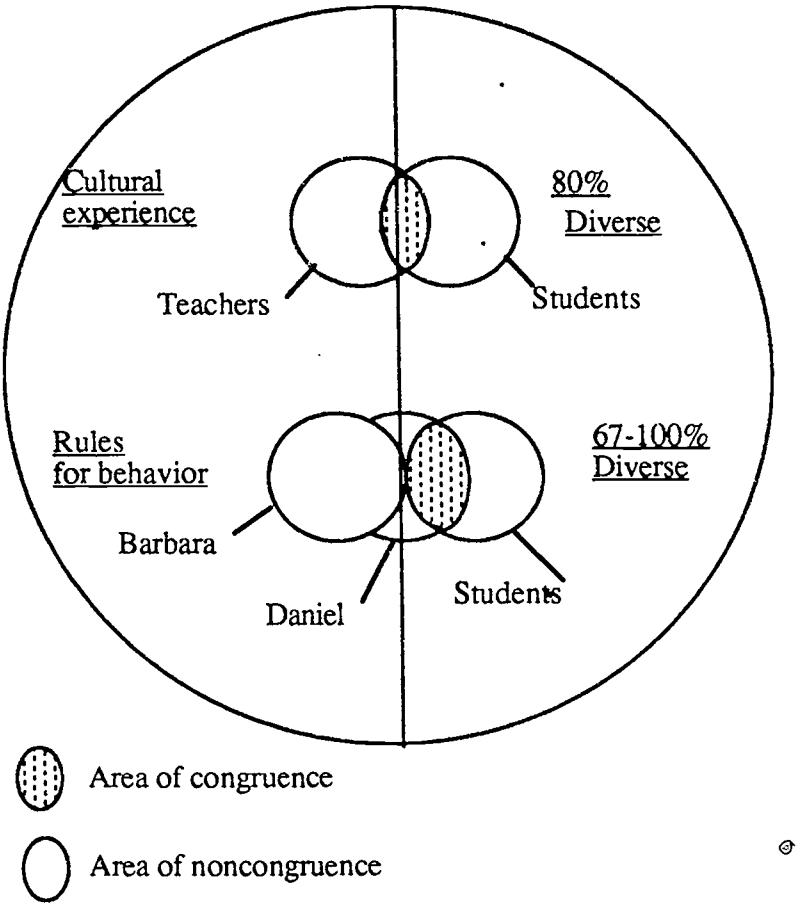

Figure 4. A Comparison of Cultural Experiences and Rules for Behavior

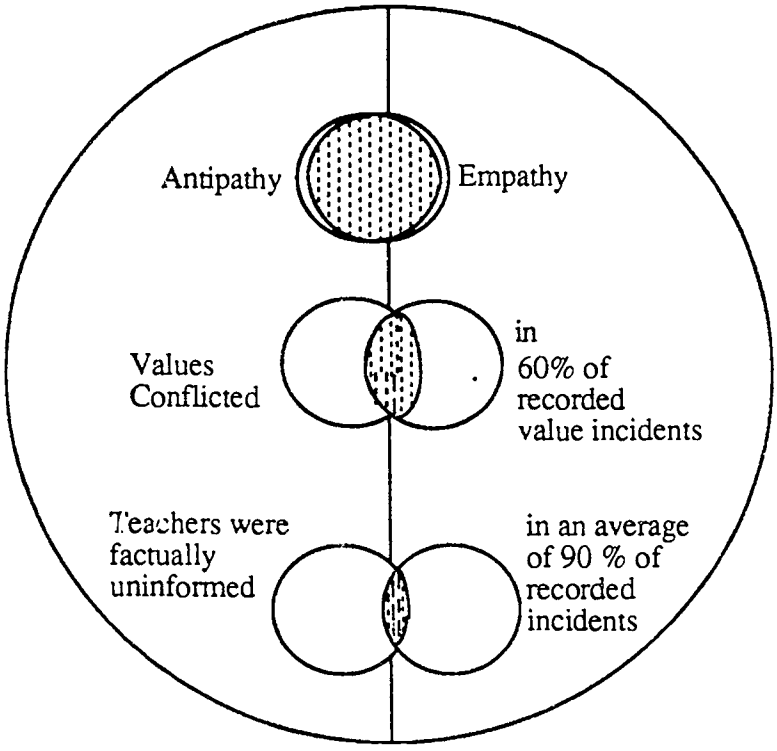

Figure 5. A Comparison of Intercultural Feelings, Values, and Knowledge

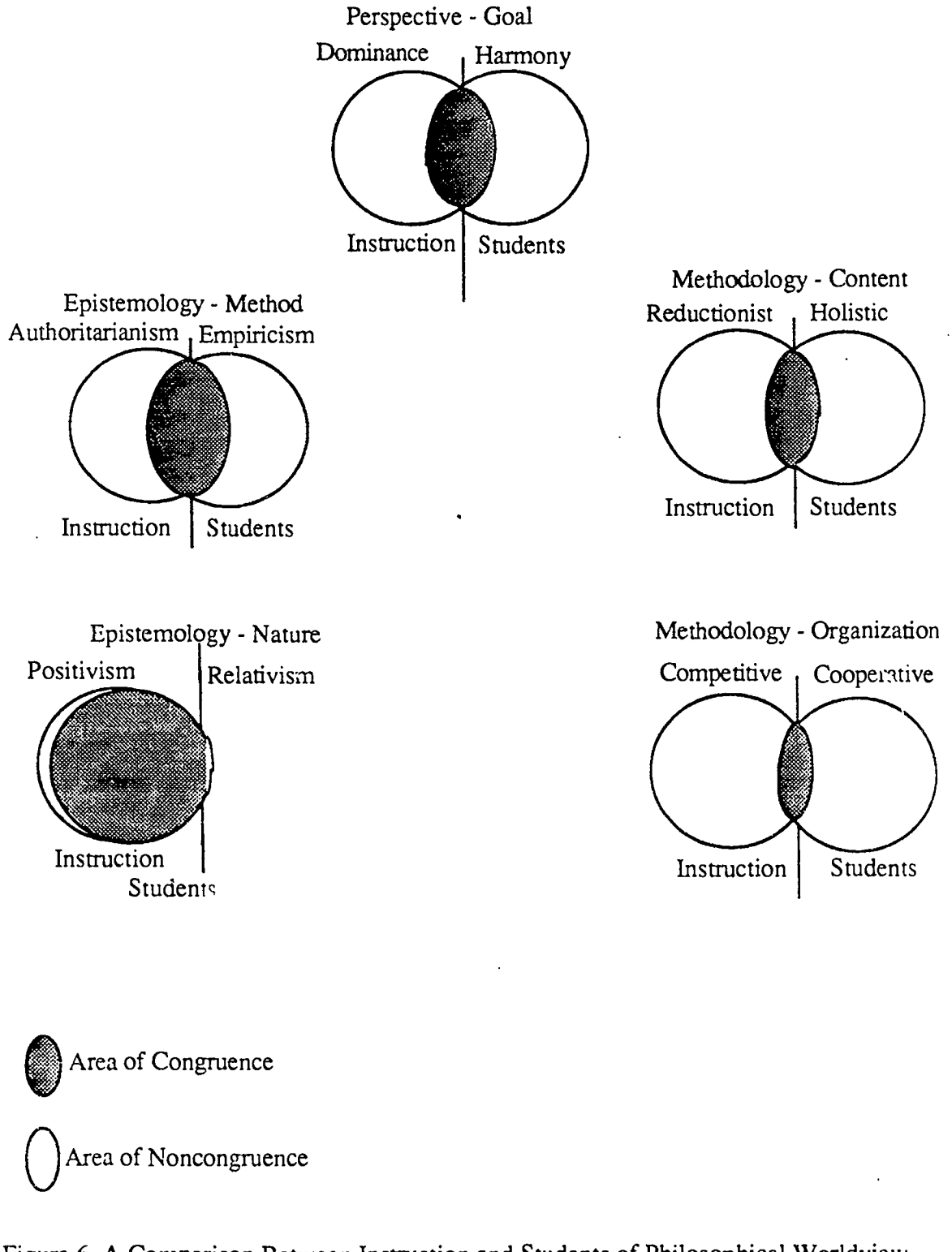

Figure 6. A Comparison Between Instruction and Students of Philosophical Worldview Variables

Appendix 1

Table 1

Student Worldview Profile in Percentages

Code	Reported	Observed	Journals and Contact Summaries	Total
Perspective-Harmonistic	76%	71%	97%	95%
Perspective-Vales	51%	50%	90%	60%
Methodology-Holistic	Low data	75%	100%	88%
Methodology-Cooperative	100%	100%	100%	100%
Epistemology-Empirical	Low Data	67%	No Data	57%
Epistemology-Positivism	ND	100%	No Data	100%
Ethnology-Diverse Cultural Experiences	81%	96%	94%	81%
Ethnology-Antipathy	77%	Low Data	77%	74%
Ethnology-Diverse Rules of Behavior	81%	94%	100%	92%
Classroom behavior - Passive	92%	100%	100%	98%
Reservation behavior - Active	No Data	98%	87%	97%

Worldview profile summary:
Perspective on the place of humans in nature: strongly harmonistic.
Learning methods: Holistic and cooperative
Epistomology: Positivistic in the nature of knowledge (unsupported by triangulation).
A slight preference for empirical versus authoritative validation of knowledge.
Student response: Strong passive resistance in a classroom setting;
strong interaction in reservation settings and casual settings.
Dimetrically opposed behavior in and out of classroom setting.
Cultural congruence: Cultural experiences and rules for behavior strongly diverse between student and those involved in the educational experience.

Appendix 2

Table 2

Percentages of Worldview Variables From Texts

	Western		Native	
Perspective:	Dominant	76%	Harmonious	88%
Methodology:	Reductionist	83%	Holistic	98%
Methodology:	Authoritative	91%	Authoritative	65%
Methodology:	Linear	76%	Cyclical	69%
Epistemology:	Authoritative	72%	Authoritative	56%
Epistemology:	Positivism	96%	Relativism	87%

Appendix 3

Table 3

Barbara's Worldview Profile: Percentages

Code	Reported	Observed	Journal - Contact Summaries	Total
Perspective - Dominant	100%	100%	100%	100%
Methodology - Reductionist	100%	100%	100%	100%
Methodology - Competitive	+	83%	100%	88%
Epistemology - Authoritarianism	33%	100%	71%	73%
Epistemology - Positivistic	100%	100%	100%	100%
Ethnology - Factually uninformed	+	No Data	100%	100%
Ethnology - Diverse Cultural Experiences	82%	100%	100%	88%
Ethnology - Antipathy	100%	No Data	100%	100%
Ethnology -Diverse Rules of Behavior	100%	100%	100%	100%
Student behavior - Passive	100%	100%	100%	100%

+: low data, but data support other findings.

Reports of value conflict - 5

Reports of language problems -3

Interpretation:
Perspective on the place of humans in nature: strongly dominant.
Teaching methods: Authoritative and reductionistic.
Epistomology: Strongly positivistic in the nature of knowledge; in the validation of knowledge a moderate preference for empirical was reported, but a preference for authoritative was observed.
Student response: Strongly passive resistance in the classroom setting.
Cultural congruence: Rules of behavior and cultural experiences are strongly diverese . A strong antipathy between Hispanic and Indians reported and observed. Teacher is uninformed on the culture of the Indian students.

Appendix 4

Table 4

Daniel's Worldview Profile: Percentages

	Reported	Observed	Journal - Contact Summaries	Total
Perspective - Dominant	94%	100%	100%	95%
Methodology - Reductionist	100%	100%	100%	100%
Methodology - Competitive	80%	89%	100%	91%
Epistemology - Authoritarianism	66%	80%	80%	78%
Epistemology - Positivism	100%	100%	100%	91%
Ethnology - Factually uninformed	68%	No Data	100%	76%
Ethnology - Diverse Cultural Experiences	89%	67%	33%	80%
Ethnology - Empathy	86%	No Data	Low Data	77%
Ethnology - Diverse Rules of Behavior	67%	No Data	No Data	67%
Student behavior - Passive	80%	100%	100%	92%

Reports of value conflict: 13

Reports of language problems: 10

Interpretation:
Perspective on the place of humans in nature: strongly dominant.
Teaching methods: authoritative and reductionistic.
Epistomology: Strongly positivistic in the nature of knowledge.No strong preference is observed in the empirical versus authoritative validation of knowledge.
Student response: Passive resistance in a classroom setting.
Cultural congruence: Strong empathy of teacher for Indian students,
Greater misunderstanding than understanding of Indian culture by teacher.

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