

**Chaos and Order
Mystery and Knowledge, the Beautiful and Mundane:
College Student Conceptualizations of Nature**

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What do students believe about the world around them? Hawkins (1983) suggested that young students can have a difficult time understanding heliocentrism because their personal experience is literally geocentric. What this illustrates is that meaningful learning in the science classroom presupposes students who enter with beliefs about the world compatible with science as it is taught in the classroom. The study of student beliefs (or for that matter, teacher beliefs) at fundamental levels is the study of worldview (Coburn, 1991a). The research reported here was an interpretive study of beliefs about nature, a delimitation of worldview, held by women college students preparing for careers in nursing, a science-based, helping profession.

Cultural Studies

Science education researchers have shown considerable interest in high visibility characteristics such as gender, race, and ethnicity as they relate to science achievement and attitude development. These to be sure are aspects of culture, yet in science education research these characteristics are not addressed in a cultural sense. Typically, they are used as nominally assessed variables in quantitative models, e.g., $f(x) = \text{science achievement or attitude}$, where x represents designations of race, gender, or ethnicity. The model implies a diagnostic prescriptive approach to education that seeks rules of the form, "When you have type x student in your classroom use type z instructional activity." The object of research is to match x 's and z 's so that one achieves intended instructional outcomes. By comparison, cultural studies in science education seek to employ an anthropological view of culture which is considerably more holistic. Geertz (1973), for example, wrote,

man is an animal suspended in webs of significance he himself has spun, I take culture to be those webs, and the analysis of it to be therefore not an experimental science in search of law but an interpretive one in search of meaning. It is explication I am after, construing social expressions on their surface enigmatical (p. 5).

In a quantitative, behavioral model there is no Geertzian sense of culture as a web of meaning. In science education research where gender is a nominally assessed variable, there is no sense that one might be dealing with something uniquely feminine, for example. Any possibility of a feminine oriented web of meaning is collapsed into the nominal designation, f .

On the other hand, interpretive research asserts the importance of the context in which quantitative variables are embedded (Gallagher, 1991). As Geertz noted, the research objective is to explicate meaning from data that is enigmatic at the surface. Moreover, such an objective implies a very different view of instruction and instructional improvement. There is no sense that learning or attitude development is an effect that comes about by any one causal variable, or numerical combinations of casual variables. This is not to deny that such research has found some procedures more effective at producing intended outcomes than others (e.g., Clement, 1987). For limited situations this has happened. However, there are pervasive problems in science education. Of this situation Hawkins (1978) wrote:

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reasonably patient explanation is no cure... we are up against something rather deep in the relation between science and common sense; we are up against a barrier to teaching in the didactic mode which has hardly been recognized, or if recognized has been seen mainly as a challenge to ingenuity in teaching rather than as a challenge to a deeper understanding of human learning... (pp. 5-7).

Interpretive researchers share Hawkins' view and do not expect that the procedures of experimental natural science can ever be used to produce general laws of education. Rather, one must come to a greater understanding of what meaning is and how it is created. Similarly, the classroom environment is not to be composed of causal variables which the teacher manipulates to foster learning, but an environment mutually shaped to fit the members of the classroom, both teacher and students (Lincoln & Guba, 1985). Consistent with these notions, worldview is a concept that can be used to explicate meaning whether it is meaning for the teacher, students, or of the textbook. Worldview research focuses on cognitive culture as it exists in and is supported by socio-material culture, i.e., life-situation.

Toulmin (1972) wrote of the need to view thinking in terms of a conceptual ecology. Strike & Posner (in press) suggested that "anomalies, analogies, metaphors, epistemological beliefs, metaphysical beliefs, knowledge from other areas of inquiry and knowledge of competing conceptions" are entities that comprise a conceptual ecology. Logico-structuralism, a theory from cultural anthropology, provides a structural framework for the notion of conceptual ecology by postulating a set of seven universally found, fundamental worldview categories: Self, NonSelf, Classification, Relationship, Causality, Time, and Space. Logico-structuralism and worldview theory are thoroughly treated in Cobern (1991b, 1991c) and Kearney (1984), and thus the discussion will not be repeated here. Suffice it to say that the focus of the present study was the NonSelf, that is, all that one distinguishes from self. "The NonSelf can be divided into domains of... human environment and physical environment, or society and nature... Most cultures, including Western culture, have preferred Redfield's tripartite division: Humanity... Nature, and God... (Cobern, 1991a, p. 45). More specifically, the present study focused on that subdivision of the NonSelf known as nature, or the natural world.

The modern, Western view of nature is characteristically mechanistic, a non-organismic view of the world as a "great machine, which, once it has been set in motion, by virtue of its construction performs the work for which it was called into existence" (Dijksterhuis, 1986, p. 495). With its theistic implications this was Newton's view. The modern form of mechanicism retains the non-organismic machine metaphor but its warrant has shifted from a theology of transcendence to a philosophy of positivism. Mechanicism essentially posits the whole as a simple sum of its parts. Causal relations are linearly conceived and context independent. Key elements in this view are the "regularity, permanence and predictability of the universe" (Kearney, 1971, p. 24). With all due respect to quantum mechanics, mechanicism is orthodoxy and remains a pervasive view in Western culture, including the science classroom (Kilbourn, 1984; Proper, Wideen, & Ivany, 1988; Wilson, 1981; Woolnough, 1989).

Ogawa (1989) made the intriguing observation that while Westerners debate whether science education should be education in or about science, neither side questions the definition of

science in science education. Neither do the debaters examine the presuppositions assumed under the concept science. From his Japanese research, Ogawa argues that this is a potentially serious oversight. Ogawa noted that Japanese elementary science education reflects Japanese culture. For example, an important goal in Japanese elementary science education is the nurture of a love for nature and its aesthetic qualities. According to Ogawa (1989, p. 248) this is a goal "closely related to the Japanese traditional (or indigenous) culture." However, while elementary science is well received among students and parents, secondary science is not. Ogawa does not think it coincidental that in contrast to Japanese elementary science, Japanese secondary science is quite Westernized. Western scientific assumptions concerning the ontological status of the natural world are mechanistic, not aesthetic. The principal interest in cultural studies is the explicit examination of such tacit assumptions (Heller, 1990). As an initial step in the exploration of cultural affect in American science classrooms, the purpose of the present study was to map student conceptualizations of nature.

PROCEDURES OF THE STUDY¹

The objective of this research was to map the qualitatively different conceptualizations of nature held by the students. Such conceptualizations are called outcome space by Marton (1988) and belief space by Jones (1972). The findings are descriptive categories and brief narratives derived from modified naturalistic inquiry (Lincoln & Guba, 1985), interview technique (Kvale, 1983; Spradley, 1979), constant comparative analysis and grounded theory development (Strauss, 1987).

The data was the text of a transcribed, audiotaped interview series conducted in the summer of 1990.² An interview began with a focusing event. Informants viewed a set of naturalistic landscape photographs depicting nature at micro and macroscopic levels, including outer space, and nature as both benevolent and malevolent. After a few moments to examine the photographs, the informant was asked the grand tour question, "How would you define nature, that is, the natural world?" Without exception the informants agreed that the photographs depicted various aspects of nature, though some were less certain about outer space. There was agreement that nature is the entirety of the physical world exclusive of artificial constructions such as buildings and dams.

Subsequently, three devices were employed to elicit conversation beyond what the grand tour question and photographs could accomplish alone.³ These involved three sets of words and sentences that related ideas about nature. The elicitation devices were based on the view that conceptualizations of nature are rooted in the worldview category NonSelf, and that in Western culture there are a limited number of ways in which nature has been and is now conceptualized (Cobern, 1991b). The structure in the devices partially overlapped allowing the informants to be persistently engaged by concepts relevant to the study, thus minimizing the potential for unrecognizable insincere comments. Overlap was built into the devices allowing triangular analysis of codes to improve the trustworthiness of interpretation. While thinking aloud, each informant sorted the words and sentences according to how accurately they corresponded to the informant's personal views. The interviewer, consistent with Spradley (1979) and Kvale (1983), asked probing questions and encouraged the informant to speak freely and at length.

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After transcription, the text of each interview was analyzed by attaching codes to units of information or chunks of meaning. The interview text was approached iteratively and in hermeneutic fashion so that use of a code in any one place was constantly compared with code usage throughout the text. As the second, third, fourth, and subsequent interviews were mapped, code usage in any one place in any one text was compared with code usage throughout the collection of coded components.⁴ The research began with a set of etic codes derived from earlier research (Cobern, Ellington, & Schores, 1990). As warranted by the text, emic codes were added and the definitions of both etic and emic codes were modified. The mechanical processes involved in code mapping and the sorting of codes was done by computer (Seidel, Kjolseth, & Seymour, 1988). Consistent with emergent design, sufficient interviews were conducted to reach a redundancy of codes (Lincoln & Guba, 1985, pp. 201-202), the point at which no further emic codes emerged from the data. This was achieved within fifteen interviews.

Informants

It was important that the research be done with a distinct group, thus allowing for replication with the same group but different members. It also allows one to replicate the study with a distinctly different group. In this study, the group was Caucasian women college students preparing for a career in nursing, a science-based, helping profession. At the time of the interviews, the students were enrolled in a college level anatomy and physiology course at a metropolitan community college. All successfully completed the course.

To what extent is this a distinct group? Gender is clearly of interest in educational research, yet there remains the question of to what extent gender defines culture. In some societies, it could be argued that gender in fact does not at all demarcate a subcultural group. However, the feminist scholarship in the West makes a strong case for the existence of a feminine culture vis-a-vis the traditional Western culture of science (e.g., Whatley, 1989). Furthermore, there are science-related helping professions dominated by women. Women in these professions are neither scientists nor were they science majors, yet in preparation for these professions women must successfully complete college level science courses. Other than commonsense, there are no rules for determining whether this or any other group is distinctive. It is obvious that the group of all men subsumes an enormous amount of variation. The group of all men seven feet tall or more is certainly distinct but of no particular interest in science education. In this study, there are three characteristics that combine distinct identity and science education relevance: gender (female), professional goal (nursing), and current situation (successful participation in a college science course).

Trustworthiness

Throughout the study, care was taken to assure trustworthiness as advocated by Lincoln & Guba (1985). On this matter, Smith (1989) wrote:

objective is a term that simply refers to the fact that there has been an agreement among inquirers. Likewise, to be subjective is not to represent things as influenced by one's personal taste, personal opinion, or emotional reaction, but ...it is to introduce considerations others find strange or beside the point (p. 9).

The issue is credibility. To this end the interview narratives were subjected to member checking and the interpretive work to review by colleagues not directly involved in the research.

Conceptualizing Nature

The findings of the study are a set of non-exhaustive descriptive codes which Figure 1 shows as a composite conceptual map. The conceptual map is a visual of student belief space regarding nature and provides a view of the rich expanse of ideas that students bring to the classroom. By virtue of text volume and emphasis, subsequently supported by member checking, it was found that ten codes could be used in five bi-polar code sets, or categories, to describe salient aspects of student belief space. The bi-polar codes viewed as opposing vectors delimit a section of an individual's total belief space and are to be seen as presuppositions regarding nature. These are discussed below with extensive quotes from appropriate narratives. The order of presentation is intentional as shall be discussed. In brief, the order represents decreasing breadth of impact upon less fundamental beliefs and increasing focus.

Naturalism and Religion

Naturalism and religion represent deeply held views of considerable personal significance for the informants over a broad range of experience. Carla⁵ quite voluntarily and emphatically states, "I'm an atheist;" but for Flo it is "I believe in God." Naturalism is a naturalistic view of nature that focuses on materialist causes and forces. It rules out theistic or pantheistic supernatural involvement in nature, but does allow weak deistic views. Jackie, for example, displayed a clear naturalistic view of nature that involved scientific understanding, and yet emotionally was moved to speculate about religion.

Jackie: When I am outdoors... the beauty and the mysteriousness of it all... its sort of a religious feeling to me... I'm not a set person in one religion but nature does make me feel that there is a God...

Listening to Jackie one has the feeling that she would approve of Carl Sagan standing with the mystery of outer space in the background saying solemnly to the television audience, "The cosmos is all there is, all there ever was, all there ever will be." While the words are materialistic, the tone of Sagan's voice and the visual imagery evoke a religious response.

Logically, of course, there can be little middle ground between naturalistic views and religious views which allow for direct supernatural involvement in nature. Indeed, the findings were that informants fell in one group or the other. Carla is a good example of the six informants

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(including Jackie) who espoused naturalistic views, though Carla was the only one who specifically referred to herself as an atheist.

Carla: I think of nature as everything that pertains to the planet. It arises from the planet. That involves the air we breathe, the oceans, the earth itself, the land, the living organisms that inhabit it... animals... flora... fauna... minerals... weather phenomena... I think it's everything. A religious person would say nature is there for a purpose. God put it there for a purpose? I don't think so. I'm an atheist.

Flo and Kelly are good representatives of the nine informants who expressed religious views. Flo is particularly noteworthy because, she exemplifies one who holds compatible religious and scientific views.

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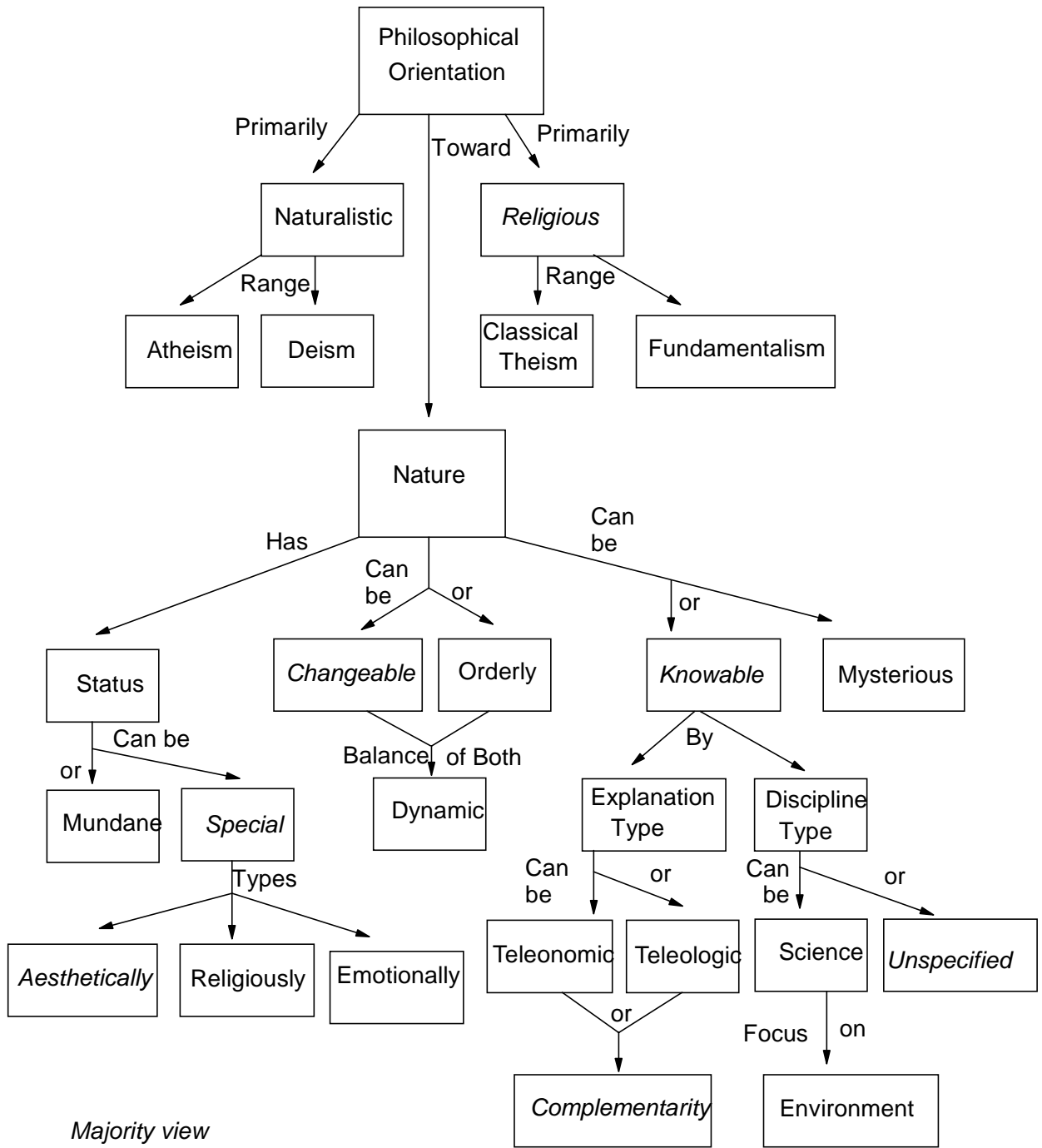


Figure 1

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Flo: I believe in God and I believe that He created nature, but nature is not religious. If you see a sunset, you see God... but I know there is a reason for the sunset... I see, for example, biological reasons for things, not the work of God.

Though both have religious views, Kelly stands in marked contrast to Flo.

Kelly: I believe in the creation theory... I think that God created everything... when I think of things He has created I think of beauty and goodness... there's a lot of beauty and goodness in nature.

Kelly appears to have singularly religious outlook with little of the complementary thinking displayed by Flo.

Change and Order

The preceding vector pair is associated with a broad range of experience. Change and order are more specific to the natural world. This vector pair marks the extreme positions of order and change, with the middle ground being a rational synthesis of nature as a dynamic system involving both change and order. Whether nature is fundamentally chaotic or orderly is a question that dates to the ancient Greeks. While the modern Western mind sees both change and order in nature, order (whether realistically or perceptually understood) is presupposed by science and the view that nature is knowable. This study, however, found six persons (all expressing weak to strong religious views) who saw rather more chaos in nature than order.

Denise: Manmade things are orderly... but not nature. Nothing is really solid, nothing is really for sure, you know... an earthquake or something... you're not sure tomorrow's going to come. Things don't always happen the way we think they're going to happen, so it is not orderly the way manmade things are.

Elizabeth also sees change in nature but it is a less chaotic and disconcerting type of change.

Elizabeth: I think nature is always changing. Nature adapts... As nature is settled by man the animals and nature still survive somehow... they change their habitat and find ways to coexist with us. Change can be good, but it depends on which way its changing. You might have a drought... but I don't think that's as big a problem as man himself.

In contrast to Denise and Elizabeth, for example, for Helen and Carla nature is predictable. Here one finds a theist and naturalist in agreement, but for quite different reasons. For Helen, the theist:

Nature is pretty predictable. It's orderly and you know what you can expect. If you do such and such, you can expect such and such to happen... it is because it all kind of works together. We have to have certain chemicals in our body... or, there may be salt in the earth because we need it for our body. I believe everything's orderly but it's for a reason... our

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survival... but it was through a divine thing that everything happened to be that orderly. I don't think it was happenchance.

By comparison, Carla, the naturalist:

I'm a science major and... it's everything I've been taught that everything has an order to it... a system to it.

Religion undergirds Helen's view of order and, as will be seen, supports the practice of science. For Carla no such external support is apparent and presumably not needed.

The middle position on change and order is nature as a dynamic system of both. Consider Amy.

Let mother nature do her thing. If we two-legged creatures can keep our nose out of her way, nature is very orderly. There's a reason for it all. I feel there is an orderliness in nature being left untampered... Where there is a flood or forest fire or something it's normal. It's just nature's way of taking care of itself. I don't think there's anything chaotic in nature. Individual phenomena might be viewed as chaotic by we humans but I don't think in the field of nature that there is anything chaotic involved. But nature is constantly changing. It's not necessarily going to be the same tomorrow or next week or next year as it is right now.

Altogether, eight informants saw nature as orderly or as a dynamic system. These included both naturalists and theists. In contrast, the informants who saw nature as fundamentally changeable were all religious.

Mystery and Knowledge

The third vector pair describes the extent to which one believes nature to be fathomable. People who find nature knowable, as the code is used in this study, clearly believe that one can have significant teleonomic understanding of events in nature even though that knowledge may be somewhat limited. Those who find nature mysterious are clearly more impressed with what is not known than what is. The middle ground for this vector pair is the expression that significant, but limited, knowledge is possible.

Logically, one could predict that viewing nature as fundamentally changeable would lead to a view of nature as mysterious. Likewise, viewing nature as fundamentally orderly would lead to a view of nature as knowable. In fact, only three of six expressing the changeable view said that knowledge of nature was limited at best. The others clearly indicated that while nature was changeable, one could still have knowledge of nature. Consider Denise. Her view of nature as changeable was quoted above, but for religious reasons she rejects the nature-as-mystery viewpoint.

Denise: Nature is not mysterious to me because of the fact I believe God really made things. It's not always puzzling, I mean... there's a reason for everything...

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The prediction fares better elsewhere but ultimately fails again. Of the eight informants expressing the orderly or dynamic view, seven found nature knowable. The eighth person, Kelly, is of interest. Like the two other informants who saw nature as mysterious, Kelly was religious. Unlike them, she saw nature as orderly. Here is a person who sees order in nature but does not make the move to confidence in knowledge. Instead, Kelly sees a religious mystery.

Kelly: Nature is mysterious... I think most spiritual things are kind of mysterious... I mean... just being overcome with a feeling of... like a godliness or something like that and then I think that everything... that you relate to as something holy is something mysterious... like everything in the Bible is kind of mysterious. Things just... sometimes they just happen. I mean... everything can be fine and great one moment and then a tornado can hit and just everything can be destroyed and it can be just fine one moment and then the clouds... all come and bring the storms... things happen but you don't know why... I mean... like the seasons all come at a certain time and it seems like bears hibernate in the winter and it's just these things that happen... they're so, like weird sometimes. I mean, you don't understand why... you look at the stars and you think... how can those stars be just out there hanging? Or you think that there is some life out there... well, if it's possible here then why can't it be possible some place else and that's like mysterious. I mean, you know things about nature but... I just can't comprehend... like why does this happen or, you know, why does that happen? I know... how it happens... but why does it happen? You know, I just can't grasp some things.

Kelly indicates that some knowledge of nature is possible, but her emphasis is one of religious mystery.

Like Kelly, Helen is a religious person. In contrast to Kelly, she is one of the eight who view nature as fundamentally knowable. The difference between the two is that Helen holds a complementary view of nature involving both religion and science. Helen on religion:

I have a strong faith in God and I believe that all this real stuff was made by God. Nature is God's work not man's work... whatever is natural as far as God making it before man touched it. I believe nature is real...

Helen on science:

Nature is the real physical world... we can test it and see what cells are in it or we can physically deal with it and learn about it so that's real to me... it's not an abstract thing necessarily. We have to dig down to get to it... through chemistry or biology or, you know, scientific methods... scientific study. We're finding out more things all the time. I mean, there are a few things we don't know but we have an inkling of why they are that way and we're getting closer and I don't think nature is such a mystery anymore as what it used to be. Through research we're finding out so much and I don't think there's too much that's going to be left unknown eventually.

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Religious conviction supports Helen's view that nature is knowable. Carla also views nature as knowable.

Carla: You can study nature and learn about it. I've had a lot of science classes I understand and chemistry. I understand the chemical principles of a lot of things. I understand how bacteria work in the ecosystem now that I've studied it. It's coming together for me. I understand what I've learned so far. I'm interested in anatomy, physiology... interested in how the body works... It's like a machine... I'm interested in nature. I enjoy microbiology, understanding how things work, not just on an molecular level, but, you know, on a higher level, too. I like to know how things work out there.

Recall that Carla was given as an example of one having a naturalistic view of nature. In contrast to Helen, she appears simply to assume that nature is knowable, an assumption probably bolstered by her studies of science.

Function and Purpose

The focus of this research was ontological conceptualizations of nature. However, as worldview theory indicates it is difficult to separate categories cleanly. A good example in this study was the issue of function and purpose. These are causality codes and refer to explanations of phenomena in nature. Function refers specifically to teleonomic or structure/function explanations while purpose has to do with teleology. The middle ground involves a complementary association of the two views of causality. Clearly this vector pair is closely related to the naturalism/religion and mystery/knowledge vector pairs. For example, codes for naturalism and teleonomy tended to co-occur, whereas codes for naturalism never occurred in a text along with teleology. Linda is typical.

We know a lot about nature but we haven't really even scratched the edge. There's stuff out there that we don't even know that's there... as to how things work and stuff... I know people in the science area, there's a lot of stuff they don't know and I know even less; but it's important to understand how things work in nature because we'd more or less be dead if it wasn't for people researching... and, to bring up the rain forest again... they should realize that that's there for a reason and they're screwing up the rest of the earth by removing it... things work together like that... that's why we need to understand... Those trees are there for a reason and we need to understand what their function is.

The relationship between religion and teleonomy is not as simple. While a purely teleological position was held by two religious informants, three of the religious informants took middle ground positions. In other words, religion does not rule out teleonomic thinking in the same way that naturalism seems to rule out teleology. As noted above, Flo is one who believes both that God created nature and that science helps one to understand nature. This complementary view was continued with regard to function and purpose.

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Flo: You don't know the reasons why some things happen, like natural disasters. You can question all you want. You can find out through biology and all the rest of the sciences but it's still a mystery to the people in those areas. There is a way to find an answer to the majority of your questions... like a stomach illness isn't mysterious because all the questions are answered, but if you have a question like why it rains on a particular day... well, it's just your own religious belief.

The contrast between Flo and Kelly noted above is seen again with respect to function and purpose. Though both are religious, in contrast to Flo, Kelly has a rather strict teleological view of nature.

Kelly: As you go through the Bible... Christ had to do everything that he did... he had to do this thing and he had to do this next one and it was like all in order... it needed to be done and it was done... Likewise, everything has to be done in nature,... the big animals have to eat the little animals... little animals have to eat... the little bugs and they have to do that to survive so it... it has to be done.

At this point one might predict that the naturalistic/teleonomic students are more likely to volunteer positive comments about science than the religious/teleological students. That only held true for Kelly who clearly thought first in religious terms. Yet, she also spoke of the need for scientific investigation.

Kelly: Nature is something that should be studied so that we can learn more about it. [For example], acid rain... I think we need to study and not only to figure out... is it man destroying nature or is it just nature [producing acid rain]... [also], I think we need to study and not only to figure out... how we can get more resources out of nature, you know, with helping it to not drain it at the same time, you know, but to get more out.

This awkward example of science and religion invites one to ask questions about possible relationships between science, religion, and philosophy. There are significant qualitative differences between religious views as there are between philosophical views. Caution is suggested when drawing conclusions about the relation of religious beliefs to science as has been done in some quantitative studies (e.g., Lawson & Weser, 1990).

Mundane and Special

Is nature a work of art or a lump of clay? In this vector pair, the code special subsumes aesthetic, emotional, and religious descriptions of nature. The opposite is nature as mundane and prosaic. Of the fifteen informants, only Irene expressed the latter view.

You deal with nature every day even though you don't think about it. It's like a grasshopper I killed in the bathroom. You know, that's just everyday nature. In nature there really isn't an answer to why questions. Sometimes things just happen because they happen and you can't rationalize why they happen and no matter how much information you get... some things just happen. Sometimes there is no rhyme or reason...

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Amy typifies the several informants who found nature special for aesthetic reasons.

I don't think nature is ordinary. Nature might be orderly and routine but it's not ordinary, but extraordinary. You know, good or bad, even a tornado, is beautiful from afar, nature can be beautiful when... it's not so much fun.

For some like Georgia, nature is special for religious reasons.

I don't feel that nature is always beautiful or pleasant... it's not always delightful... but it's a place that you can always feel spiritual... close to God and close to your own feelings. It's a special place that God made. It's relaxing and helps you put things in perspective.

For Jackie, the sense of religion and mystery are mixed.

There are a lot of unknown things about nature. I wonder about all of them. I wonder about the little insects in the forest and things like that so it's a mystery to me how it's things all fit together and works together... I get this feeling it's like a special place... it's kind of holy... nature just gives me a very special feeling, I mean, when I'm like out in the woods... the beauty and the mysteriousness of it all and it's sort of religious to me. I mean, it's like a special place. I'm not a set person in one religion but nature does make me feel that there is a God when I see how things are created and what is happening.

The presence of aesthetic views was strong. One is reminded of the role of beauty in Japanese elementary science education and Ogawa's inference based on the difference between Japanese elementary science education and secondary science education. The sentiment is echoed in the West by poet e. e. cummings (1959, p. 66), "I'd rather learn from one bird how to sing/Than teach ten thousand stars how not to dance."

Acknowledgement of Science

As a study in science education there was of course an interest in any voluntary mention of science and any indication that science significantly informed a student's view of nature. Only four students offered emphatic comments about science. These included naturalists (e.g., Carla) and theists (e.g., Mindy). Carla the naturalist:

You can study nature and learn about it. I've had a lot of science classes I understand and chemistry. I understand the chemical principles of a lot of things. I understand how bacteria work in the ecosystem now that I've studied it. It's coming together for me. I understand what I've learned so far. I'm interested in anatomy, physiology... interested in how the body works... It's like a machine... I'm interested in nature. I enjoy microbiology, understanding how things work, not just on an molecular level, but, you know, on a higher level, too. I like to know how things work out there.

Mindy the theist:

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There are mysteries but they're not infinite mysteries. Eventually we'll figure it all out. I believe nature was created divinely for our use and for us to learn and understand and be able to use the laws... As I continue my education, the more real [nature] becomes... the less mysterious it becomes... the more I enjoy learning more about it... As I'm forced by requirements to learn more in college about like physiology and anatomy... and it becomes more understandable and more real, like the synapsis are real now where they were nothing before... I didn't even know they were there... it makes me want to learn more...

Actually, these remarks are atypical. Instead, comments were about environmental knowledge or knowledge in relation to the aesthetics of nature. There appeared to be more interest in relating to, rather than knowing about, nature. Most striking of all was that the students interviewed had successfully completed several science courses, yet talk of science was more conspicuous for its absence than presence. As Charron (1991, p. 686) recently reported, "most students assigned science a minor role in their lives."

Summary

Imagine the first day of a science class. A student walks up to the teacher and says, "Science is about the natural world, right? So before we start let me tell you what I believe about the natural world. After all, everything you say in this course, I will hear first through the filter of my own viewpoint." In effect, this research is about giving voice to student worldviews. The research is predicated on the assumption that the learning environment of the science classroom can be improved, especially with regard to students who typically do not do well or who do not like science, if the teacher is more aware of student worldviews as related to science. Developing awareness can be approached using a logico-structural theory of worldview, specifically the universal categories NonSelf, Relationship, Classification, and Causality. At a minimum, this translates into questions concerning student views about nature, relationship to nature, and causality in nature. What is reported here is the first step in such a project. The research sought to give voice to student beliefs about the essence of the natural world.

For this group of students, college women studying science in preparation for a science-related helping profession, belief space concerning nature can be described using five vector pairs: naturalism/religion, change/order, mystery/knowledge, function/purpose, and mundane/special. Breadth and inclusiveness of concepts related to nature characterize this belief space. Though at this time no formal comparisons are possible, one can surmise from existing curriculum and classroom research (e.g., Kilbourn, 1984; Proper et al., 1988; Settle, 1990) that students such as those in this study bring to science class a belief space that is general and inclusive, there to meet a learning environment that is narrow and exclusive.

The data, as summarized in concept maps and narratives, features richness and rationality. Yet within the richness of these explications, little is about science, and only one student's conceptualization reasonably matched the standard naturalistic-mechanistic view of nature. More intriguing is the fact that the informants had all successfully completed several college science courses, yet it appears these courses had little influence on structuring their fundamental

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understanding of nature. The goals of science education include content and processes, but science educators also expect that students will adopt the attitude that science provides an important way of understanding the world. The teacher's tacit assumption is that if content and process are well taught, attitude will follow as a matter of course. To the contrary, student views in this study suggest that one can pass the exams and still not have had one's basic views of the world changed. This suggests that current assessments of conceptual change are insufficiently sophisticated.

One can make sense of this apparent paradox by invoking a semiotic triangle of sign, object, and interpretant. The student (or interpreter) when confronted with science (the object) and a standard science curriculum (the sign) does create meaning by interpretation. However, for these students, meaning with regard to the natural world was dominated by concepts of religion, relationship, aesthetics, and purpose. It appears that this group of students has the maturity and motivation to take a subject matter clothed in alien garb and reclothe it after their own fashions. What one sees is not another set of misconceptions, but a different contextualization of science quite distinct from anything in the classroom. Jacques Monod (1971) once remarked that science has established its place "in practice, but not in the hearts of men... modern societies have accepted the wealth and power that science has opened up to them, but have not heard, much less accepted, science's most profound message -- that it represents a new and unique source of truth." While Monod's statement is undoubtedly extreme, his basic position is widely shared by science educators. But perhaps people are more aware of science than given credit for; and it is not science per se that they reject, but particular contextualizations of science.

This study was an exercise in hermeneutic interpretation within an emergent design. The objective was to come to a better understanding of the cognitive culture of a particular group. The research also raises new questions. To what extent can the belief space described in this research be attributed to the particular characteristics of the group? For example, would women accounting majors or male nursing majors view nature differently? To what extent is maturity and motivation a factor in the recontextualization of science? For example, do younger and/or less motivated students fail to take an interest in science because they do not, or cannot, recontextualize science? The stage is now set to address these questions and the associated issues of relationship to nature and causality in nature.

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Notes:

1. For a complete description of elicitation devices, code lexicon, individual informant conceptual maps and narratives see Cobern (1991b).
2. Informants were encouraged to speak freely and for whatever length of time they wished. This varied from approximately 30 to 60 minutes.
3. The procedure employed is similar to Ogawa's (1989) quantitative approach to the study of conceptualizations of nature.
4. For a similar coding procedure see BouJaoude (1991, p. 692).
5. All of the informant names used in this article are fictitious.