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The Different Worlds of High School Biology and Physical Science Teachers

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The Different Worlds Of High School Biology And Physical Science Teachers (SLCSP 139a)

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Abstract

A science teacher not only presents scientific concepts, but tacitly creates a context in which scientific concepts are presented to the class. This context can be strongly influenced by teacher beliefs or worldview. In the current research, teacher worldviews with respect to the essence of nature were examined. Two biology and two physical science teachers individually sat for qualitative interviews. The same interview protocols were used in a concurrent study involving ninth graders at their high school. The analysis led to three assertions: (1) When compared with their students, the science teachers had a much more focused and less diverse conceptualization of the natural world. The students were much more likely to speak of aesthetic and spiritual elements of nature in contrast to their teachers who focused more on what one could know about nature. Teachers also spoke more in-depth on topics rather than the “name dropping” typical of the students. (2) The most interesting finding was that the physical science and biology teachers had considerably different conceptualizations of nature. The physical science teachers talked much more about all that scientists do know about nature and how successful science has been. (3) The biology teachers were much less sanguine about science, yet clearly enthusiastic. They showed greater concern about the environment and were more likely to speak of the aesthetics of nature.

A science teacher not only presents scientific concepts, but tacitly creates a context in which scientific concepts are presented to the class. This context can be strongly influenced by teacher beliefs or worldview. In the current research, teacher worldviews with respect to the essence of nature were examined. Two biology and two physical science teachers individually sat for qualitative interviews. The same interview protocols were used in a concurrent study involving ninth graders at their high school. This process addressed the questions, How do science teachers understand nature? What concepts have scope and power in their thinking? Where does science fit into their thoughts about nature? How is science interpreted when it has become an integral part of teacher thinking about nature?

The Teachers

The four teachers that participated in the interviews are from an upper middle class, semi-rural community in central Arizona. The community itself includes many vocal, active people that consider preservation of the desert ecosystem an important issue. There is frequent talk within the community as well as frequent articles in the local paper about the rapid destruction of the surrounding desert due to an explosion of urban development. People in the community are “outdoors” people. They hunt, ride horses, hike, camp, play golf, and ride bicycles. Living in the area and most of the students have participated in one or more of these activities. The teachers are four of six members of the science department. Sixteen ninth grade students taking courses in this department took part in an earlier study on conceptualizations of nature (Cobern et al., 1996). Two science teachers in the department were co-researchers in that study. The four teachers

reported on here were aware of the ninth grade study taking place but were not involved. The interviews with the teachers were conducted by the university researcher on the project.

Method

The basic method of this research was a modified naturalistic inquiry (Lincoln & Guba, 1990) approach using a semi-structured interview technique (Kvale, 1983; Spradley, 1979). The interview procedures are described in Cobern (1993a) and Cobern, Gibson, and Underwood (1995c), and involve three devices to elicit conversation on the topic of the natural world (for a similar approach see Bliss and Ogborn, 1987). In brief, each student while thinking aloud, sorts a set of words and sentences according to how accurately they correspond to the student's personal views. The interviewer, consistent with Spradley (1979) and Kvale (1983), asks probing questions and encourages the student to speak freely and at length. The findings are descriptive categories or codes applied to each interview transcript. These are subsequently used to form concept maps which show the qualitatively different conceptualizations of nature held by the students. The concept maps are then used as a guide for developing first person interpretative narratives on nature for each student interviewed. The narratives capture as much of the student's actual language as possible. They are interpretive in that the narratives are constructed by the research team. (For a full set of maps and narratives, see Cobern, Gibson, and Underwood, 1995a.) Such conceptualizations are called outcome space by Marton (1988) and belief space by Jones (1972). Through out the process from interviewing to coding to map and narrative production, the research team was alert for possible assertions about the teachers that stood out in the data or in various ways occurred in the research team's deliberations and thinking about the data. These tentative assertions were logged for later use.

With maps and narratives in hand, the research team began the process of sorting, comparing, and cross checking cases by major code categories. For the first analysis the cases were divided by sex and examined for internal code consistency and cross group code differences. After this comparison similar comparisons of the cases were conducted by using each of the following codes as the initial point of division: religion, aesthetics, knowable, science, order, and conservation. The gender identification along with the codes knowable, order, and science were used because of their pertinence to the research purpose. Aesthetics, conservation, and religion were added because of their frequent occurrence in the data. This process of comparing cases led to further tentative assertions which were added to the assertions gathered earlier in the research. Subsequently, the research team by consensus reduced the tentative assertions to three logical groups. Each group then became the basis for a new assertion. The penultimate step was to cross check each assertion against each case for confirming and disconfirming data. In the final step of the analysis, two qualitative researchers not involved with this study cross checked the assertions, supporting arguments, and examples against the case concept maps and narratives. This process addressed the questions, How do science teachers understand nature? What concepts have scope and power in their thinking? Where does science fit into their thoughts about nature? How is science interpreted when it has become an integral part of teacher thinking about nature?

Discussion of Assertions

When compared with their students, science teachers have a much more focused and less diverse conceptualization of the natural world. Students are much more likely to speak of the aesthetic and spiritual elements of nature in contrast to their teachers who focus more on what one can

know about nature. Teachers also speak more in-depth on topics rather than the “name dropping” typical of the students. The principle question of this research is about the extent to which science teachers will voluntarily enjoin scientific ideas (vis-à-vis other types of ideas) in a conversation only tacitly related to science. In an earlier with ninth graders study (Cobern et al, 1996), the first assertion says that ninth grade students tend to discuss the natural world using several different perspectives such as religious, aesthetic, scientific, and conservationist perspectives. Student discussion is typically characterized by a breadth of perspectives. Patricia is good example. Glancing at her narrative one quickly sees religious, aesthetic, and conservationist elements in addition to science elements.

Patricia: God created the natural world. It has many characteristics: it's powerful, diverse, changeable, and beautiful (physically and emotionally). The Bible says God created the heavens and Earth, so I think that explains to me what nature is.... Nature is the result of a purpose, and things that happen in nature are the result of a purpose. Nature and the natural world is anything made by God; all the plants and animals on Earth and the entire solar system. The natural world is very confusing and mysterious to me. Something about nature that I wonder about is “what is way out in the universe, perhaps another Earth?” Even though nature is mysterious, everything is knowable but maybe not for us now, or even in the near future. The wonderment of the world increases knowledge through science, but is limited, due to its complexity.... The natural world has many different aspects adding to the complexity of it. It's always changing, the same thing doesn't happen every day; an example would be the weather. Because of the change, it can also be beautiful in a naturalistic way. You don't have to know about such things in nature to recognize that they are beautiful, and sometimes, pure.... Some aspects of the natural world are understandable. Science provides ways for us to use resources, but also ultimately exploits those resources. In terms of religion, the natural world is knowable because we have faith in the purpose of it, even though we don't necessarily know it. There is some conflict between the Bible's teachings and views of scientists and environmentalists. Both views, scientific and religious, try to explain the hard questions, such as the origins of life; in which I believe there is no true answer. Science and religion have distinct roles in our life's teachings. Science teaches us how to conserve our resources, and how to possibly restore them, while religion teaches us the caring attitudes required to be productive members of the natural world.... The natural world also provides us with many resources such as, food, fuels, minerals, and plants that give us cures for diseases. Our knowledge of the natural world throughout science allows us to use our natural resources and at the same time exploit them. The exploitation will eventually put an end to life on Earth as we know it, if we don't start changing our way of living.... The natural world was created by God so we can serve him and care for it. We have taken advantage of it long enough. People must learn to take the time to enjoy the beauty of nature, both religiously and scientifically. (SAU.n2, Narrative, emphasis added)

In contrast, science teachers almost immediately lapse into science talk. Mr. Hess, a high school physical science teacher, provides a good example.

Mr. Hess: Nature is orderly and understandable. The tides and the rotation of the earth... That the planets and the stars are governed by physical forces and any deviations are simply because we have not yet discovered the other part of nature's orderliness... As a science teacher I feel that with enough scientific knowledge all things are understandable... I think that the more we understand about matter itself, and the more we know about how to make things, the more predictable nature will be. Scientific or reductionistic thinking is very powerful. I feel that once we know enough about the minutia of the world, breaking it down by using the scientific method, scientists tearing it apart and analyzing the parts of nature and seeing how they interact, that we will be able to predict just about anything about nature. (WWC.t3, Narrative, emphasis added)

Mr. Bradford is a biology teacher. As will be discussed later, there are significant differences between physical science and life science teachers. Nonetheless, Mr. Bradford uses science terminology from the start.

Mr. Bradford: Nature is the living and non living components of the world around us - even the universe - apart from the works of man but including man. Nature has been here forever and it will always be here whether man is here or not. We are all interconnected in nature by both natural and artificial mechanisms. We, as a species, are all part of the same natural world and we all have an effect on each of the other components and species of the natural world. Nature in its natural state is pure and perfect. It can improve itself but it cannot be improved by the works of man. Purpose in nature means the struggle for survival. It does not mean there is a god who gives purpose to nature and directs nature by will. (WWC.t1, Narrative, emphasis added)

Two of the students in the ninth grade study speak about science or use science ideas in some depth. As noted in assertion two of that study, most of the ninth graders had much less to say about science and a scientific view of nature. For example, Holly's most specific comment was that "the natural world is just there, you know, fish, bugs, dirt, animals, and plants" (SAU.n7, Narrative). Similarly, Jackie offered, "Nature... is everything around us like plants and animals... These resources are essential for life and... using them leads to pollution that is destroying our ozone layer" (SAU.n3, Narrative). Even though prompted during the interview, Jackie offered no explanation nor even any examples to go with her assertion. She offered nothing further about plants and animals. She named no specific resources nor offered an account of how these resources are essential. Jackie offered no specific examples of pollutants though she did mention ozone destruction. In contrast, the teachers were much more thorough. In the following excerpt, for example, Ms. Jackson is sorting out the difference between teleological and functional purpose.

Ms. Jackson: I think things happen in nature because of purpose... this I think is a religious view... that, not necessarily a fatalistic view, that you have no control, but that there is a destiny, that there is... as an individual, I'm contributing to it, but I'm not the biggest part of it, of human kind that there is. I think there are purposes. Animals have instincts... Humans are different than animals in that we seem to be able to reason and really take control, and again I don't have a real biology background, but I observe those things, or watch shows on

them, and so they have these cycles of their life which must have some purpose and it has a purpose for the food chain and how they are all, the whole huge, inter-related processes, so I think that when one... supposedly... I think that I read this, that when one animal gets killed, it's usually the weakest one, and so that they are promoting the stronger one, so that would be a purpose, and that is one of those things that happens in nature, because of purpose.... I think that the whole inter-relatedness of us and our world, is that... like okay we do have a purpose, some bigger picture, and I think that we are playing that part, but I don't know what it is going to lead to.... I know that all things want to continue living, so that they all reproduce and that seems to be real important in nature, for plants, people, and animals. (WWC.t2, Narrative)

The broad outlines of this assertion are not surprising. These are teachers of high school ninth graders and one would expect them to have more to say (teacher narratives ran 2 to 4 times the length of student narratives) than their students and have more to say about science. It is nonetheless arresting to note how focused the teachers are on science given that no direct science questions are asked during the interview. The contrast with their students is unmistakable. This raises the question of whether the contrast between teachers and students is of any instructional significance? Does a teacher's outlook on nature influence his or her behavior in the science class in such a way as to also influence students who may have very different conceptualizations of nature? After the next two assertions, we will offer a classroom example that suggests an answer.

Physical science teachers talk much more about all that scientists do know about nature and how successful science has been. The most interesting finding of this study (in that it was unexpected) was the considerable difference between conceptualizations of nature held by physical science teachers and biology teachers. The two physical science teachers of the study show a strong sense of order and logic in nature.

Mr. Hess: Nature is orderly and understandable. The tides and the rotation of the earth, the seasons and so forth are examples of order in nature. That the planets and the stars are governed by physical forces and any deviations are simply because we have not yet discovered the other part of nature's orderliness. According to chaos theory even things that appear to happen randomly have patterns. I think that everything has patterns. (WWC.t3, Narrative)

Ms. Jackson: I think that nature is predictable. I think that it is logical. I think that it is explainable.... we can predict those things because they are orderly, there are certain patterns that we can find, and yet at times they can be very complex. (WWC.t2, Narrative)

As one might expect after hearing such strong affirmations of order in nature, these two teachers are also highly confident about our human capacity through science to gain knowledge about nature. Mr. Hess' remarks are continued in the following excerpt. Note the confidence he shows in scientific knowledge.

Mr. Hess: We haven't necessarily discovered those patterns, yet. As a science teacher I feel that with enough scientific knowledge we all things are understandable.... Scientific or reductionistic thinking is very powerful. I feel that once we know enough about the minutia of the world, breaking it down by using the scientific method, scientists tearing it apart and analyzing the parts of nature and seeing how they interact, that we will be able to predict just about anything about nature.... I think there is probably a limit to predictability in nature. I think nature has unpredictability because it is so changeable.... I think unpredictability, however, comes because we don't know enough about nature to predict everything about it right now.... Eventually, however, all nature will be explainable.... One of the reasons why we don't yet understand enough about nature, is because the extreme, complex, and diverse type of systems that are involved with it. But I am an optimist as far as it's understandability, as far as that is concerned. Our current state of being is that there are unpredictable events in nature. Our ultimate state, the end point, is basically knowing very much. Weight wise, we are probably more tilted toward unpredictableness because I think that we are in the infancy of understanding the world around us. I am optimistic that we will eventually know much more. As knowledge grows we will change the changeability and the unpredictability of nature. It all will decrease significantly. I have a great faith in man's ability to understand things and take things apart, to get to the bottom of the solutions and things. I think that with that knowledge and the yearning for knowledge, whatever is the problem, we will basically be able to know and being to predict. (WWC.t3, Narrative)

Ms. Jackson is equally confident.

Ms. Jackson: As scientists, we come up with laws of nature or theories of nature to be able to predict behaviors and therefore, based on what we know, and the experiments that we have done, we can now, either change or know that we can't change an event, but that maybe we can predict that the event is going to happen.... As scientists, we come up with laws of nature or theories of nature to be able to predict behaviors and therefore, based on what we know, and the experiments that we have done, we can now, either change or know that we can't change an event, but that maybe we can predict that the event is going to happen. And we can predict those things because they are orderly, there are certain patterns that we can find, and yet at times they can be very complex. But I think nature, you can understand it, you can know it, and you can predict it. I think that if we study it that nature is not difficult to understand. For instance, I am not a real biology type person, but I like watching those shows and they show patterns of things having these five sides, so I guess that if you are to get a new plant, then you could categorize it, because of those sides, but basically, from the physical science side, a lot of, if you are going to... gravity is, and you throw a ball, then you can predict what is going to happen because it is logical... I think that is what I'm thinking of when I think orderly... I think logical. If you were going to use lenses, and you know how light is going to go into the lenses, then let's say, with a telescope, you know that you need to use a lens to get the image and then the lens to invert the image, and so how you know how to use it, because of what it does. It is very logical to me.... I feel like we know and awful lot. I feel like, that, even though we don't have all the answers, we have so much, ways of finding out answers. I think we have

that base of knowledge, so I think, I feel that we know an awful lot. I think we would definitely be up towards the 80 percentile of knowledge. (WWC.t2, Narrative)

It is very interesting to note that both of these teachers used the phrase “taking things apart,” that is, you can learn about nature by taking it apart. Mr. Hess specifically refers to a reductionist view of nature. These are the things these teachers say about nature. They have much less to say about the aesthetics and emotional aspects of nature. Mr. Hess makes only one brief remark about the beauty of nature but even that remark is more about intellectual beauty.

Mr. Hess: Nature is beautiful. I see it most in the way things work so well together. I think that I see beauty in nature more with living things than with anything else. It is the vastness of things that could go wrong in a living organism, and yet it lives. (WWC.t3, Narrative)

Ms. Jackson has somewhat more to say about the aesthetics of nature. She too, however, does not venture far from intellectual beauty.

Ms. Jackson: I think because we live in the world, we have to appreciate it and I think that most people do. We all appreciate... I've lived in a variety of places. I have lived around a lot of mountains, around the Alps and I've lived in the Blueridge and Appalachian mountains of Virginia, and it has taken me a while to appreciate the beauty of Arizona... just in a natural setting, and I think nature is beautiful. I think about nature everyday in one way or another. If it's not the laws of nature, driving with my kids and I am pointing out the moon to them in Arizona, and like I've said that I have lived a lot of different places, and the sunsets here are the most beautiful sunsets, and I know why we see those sunsets, but it is just nice to enjoy them. I also think that science is beautiful in the fact that you can repeat patterns and that you can find these things that are logical and I just like that. That appeals to me. Because of the physics and the refraction of light you can understand a beautiful sunset. (WWC.t2, Narrative)

In summary, the physical scientists view nature as logical and orderly. They are highly confident that science has told us much about nature and eventually will tell us very much more, if not all. They have a muted sense of the beauty of nature but that beauty is primarily of an intellectual type. The biologists could hardly be more different.

Biology teachers are much less sanguine about science, yet clearly enthusiastic. They show greater concern about the environment and are more likely to speak of the aesthetics and mystery of nature. To begin with, the world of a biologist seems a much more complex place than the world of physicists. Note Mr. Bradford's use of the word “mysterious.”

Mr. Bradford: Due to the diversity in nature, nature is very complex. All of the various components of nature are working together, and in some cases working apart. It leads toward the complexity of nature. It makes it very hard to figure out. It makes nature mysterious. Nature is mysterious because it is so complex, the diversity of it makes it mysterious. There is a lot that is not known about nature. No one will ever know everything

there is to know about nature and that is part of its appeal; because it is so mysterious.
(WWC.t1, Narrative, emphasis added)

Mr. Conright also uses the term mysterious. Moreover, he invokes the Eastern concept of Ying/Yang to describe the attributes of nature.

Mr. Conright: Nature has many aspects. It is alive and it is always changing. It has a mind of its own and in some ways things happen, because it is alive. Just the way that the earth moves and shakes, the way that the oceans tend to move and the whole relationship between the earth and the universe. The way that living things have come out of all that, or part of it, to interact with the earth and universe. I think that the fact that it's alive really is a big part of what makes it the natural world, or at least my concept of it. I am not using "alive" in the technical living things sense, but I think in terms of how matter (nature is material as well) interacts. I think that it is alive in the sense that, even though it may not technically be alive, I think that when there is heat and there is energy, things are moving and flying - that in a way is a kind of life. Nature is dynamic... movement and change and all life, when you look down to the molecular level, it really is just non-living, material molecules that are organized in complex ways. So, it is hard to draw the line, when you get to that level, as far as what is alive and what isn't. So, that's partly what makes it mysterious. Nature is alive and it is material.... Nature is orderly and chaotic, predictable and unpredictable - these pairs are sort of needed in order to define each other. Things wouldn't be predictable if you didn't know what unpredictable was. Things wouldn't be orderly if you didn't know what chaotic was. It is sort of a Ying/Yang relationship between the two - I would call this just the dualistic nature of reality. A storm in the ocean might be considered chaotic, but then as you watch the ripples of the waves that are flowing away from it, there is a sort of orderliness to that. Weather is unpredictable. You can't predict what's going to happen, but you can predict the consequences of it.
(WWC.t4, Narrative, emphasis added)

Just as the physics teachers' confidence in the innate orderliness of nature led to a confident, positive view about knowledge of nature, the biologists' view of the complexity of nature leads to a much more muted confidence in what can be known about nature. Mr. Conright, for example, sees new discoveries as inadvertently leading to even greater complexity.

Mr. Conright: There is a lot of diversity and complexity in nature, and there is also the fact that it is just there. It's all just part of everything that is there. You can look at it all as being part of one thing, or you can look at it all as being different and complex in different aspects of it. It is incredibly complicated. The closer you look the more complicated it is and in order for it to function as simply as it appears to us, there must be a lot more to it than we know. I think that it is important to understand that there is more to nature than meets the eye. It is interesting to see how nature works and just how complicated it really is. By observation and by looking at things and watching them over a period of time, you begin to notice patterns that allow you to make predictions. But it seems like a lot of predictions, once you make them you find that they... well, the rules tend to get broken, or you get more information at a higher, finer, more detailed level and

you realize that there are other things going on that you weren't predicting. (WWC.t4, Narrative, emphasis added)

Mr. Bradford makes the interesting comment that he actually prefers that some things in nature remain unsolved.

Mr. Bradford: Not only will nobody ever know everything there is to know about nature, hopefully no one ever will.... To me, the mysterious nature of nature is one of its better qualities. Things that are completely discovered are no longer interesting. For example, you have a cube of metal that everybody knows every single ingredient in it. Well, there is no mystery to it. There is nothing appealing about that anymore because there are no questions to ask about it. If everybody knows everything there is to know about that cube of metal, it loses appeal to me and I am sure that it loses its appeal to the people investigating it. If things don't have questions associated with them, there is no mystery. If there is nothing to ask about it anymore, it loses its intrigue, its interest. The mysteries of nature are hopefully unsolvable. I don't want to solve all the mysteries of nature. I hope nobody ever does. The appeal is like being lost out in the forest, so to speak. You want to be out there away from anything that is solved, you want to be in an environment where everything is still interesting to you. (WWC.t1, Narrative, emphasis added)

Mr. Bradford's reference to the appeal of what is unknown in nature leads to another difference between the biologists and physicists. The appeal of nature mentioned in the above excerpt is similar to the intellectual appeal sensed by Mr. Hess and Ms. Jackson, though Mr. Bradford uses a word, mysterious, that was used by neither Mr. Hess nor Ms. Jackson. The two biology teachers, in contrast to the physical science teachers, have a much stronger aesthetic and emotional understanding of nature.

Mr. Bradford: Nature is beautiful, as I see it. That is what draws me to nature in the first place, how beautiful it is. The simple beauty of being pure, the kind of plants and animals that are out there, the landscape in its natural state, all kinds of simple beauty to it. Purity and diversity have an internalized beauty to me. When it is pure and when there is great diversity out there, then it is more beautiful to me. So, those things have to be in place first, possibly before I consider it to be beautiful. Nature is living. Nature is composed of living things organisms, and the living part of nature is probably what attracts me to nature in the first place. So the living part of nature is what appeals to me - plants and animals, any kind of plants or animals. Even though I would consider rocks and volcano's a part of nature, the living part of it appeals to me more. There are some beautiful rock formations and so on, but the living parts of the landscape is what is most beautiful. The appeal for me is an internal sense of peacefulness when I am around nature. (WWC.t1, Narrative, emphasis added)

Mr. Conright: I like the word beautiful. I think that there is a lot of beauty in nature, even though it is not always beautiful to man. The whole aspect of nature and I guess that I have an instinctual connection to that, that it is sacred, and just deals with something very

special, you have to respect it. I think that beauty is the more aesthetic reason to appreciate nature and I think that aesthetics can provide reasons for studying nature, too. But, I think that beauty and emotional response are more in the aesthetic realm, just pleasing to see how nature works, seeing that it is mysterious, that it allows a curiosity about how it works - to admire the beauty of nature and its simplicity, and just... Well, I enjoy nature! Some people might say they see the work of God in nature, that is to say that you see something beyond the work of man, that's even at a higher level, and to appreciate that is one of the aesthetic things that we like about nature. I have an instinctual connection to sacredness of nature. (WWC.t4, Narrative, emphasis added)

In summary, the two biology teachers appreciate the scientific study of nature, they would even say it is appealing, but they also have a much more limited confidence in what science can tell one about the natural world. The power of science notwithstanding, the natural world remains a mysterious place, and that is part of its appeal. That nature is appealing is another important aspect of how these two teachers conceptualize nature. Nature for them is a place of considerable aesthetic beauty and peace.

Implications

This report is about a small case study involving only four teachers. An obvious research implication of the study comes in the form of a question. Are these results repeatable among other science teachers or is what one sees here the idiosyncrasies of these particular teachers? In our view, there is enough in the literature on science course selection to suggest that in further research, Assertions 2 and 3 of this study will stand. Students generally prefer biology over physical science. Women students in particular tend to prefer biology over physical science. Typically one looks in the curriculum for the reasons for this difference. We suggest that there are teacher differences as well.

An incident that occurred during one of the ninth grade interviews is suggestive of this very point. Ann is a good overall student and also one who in the past has been a good science student. In her interview, Ann emphasized that nature is something enduring and inclusive. Her sense of inclusiveness drew together knowledge of nature, the natural beauty and purity of nature, nature as God's creation, and the conservation of nature. In addition, she clearly spoke about nature as something one can know about through science.

Ann: Nature is knowable... We can learn to understand many things about nature through personal experience, school and science. Science itself provides us with technology which in turn increases our scientific knowledge. Technology helps provide us with many wants which, of course, increases our pleasure. It also uses resources. (ATG.n6, Narrative, Cobern et al., 1996)

This appreciation of science, however, is not where her narrative begins.

Ann: Nature is something that is always out there and it will always be out there. Everything that exists is a part of nature including you and me. To me, nature is beautiful and pure because it is God's creation. Nature provides both aesthetic and

emotional pleasure and I need it for self renewal. I like to go where you can't see any influence by man. When I'm out in nature I feel calm and peaceful. It is a spiritual feeling and it helps me understand myself. I also get a spiritual feeling from nature. Sometimes, when I'm out in nature and I have time to think, I start to wonder about things. This leads me to ask questions that I'd like to find answers to. The pleasure I get from nature is enhanced by the mysteries I see in it.
(ATG.n6, Narrative, Cobern et al., 1996)

Ann's conceptualization of the natural world has significant aesthetic and religious elements. Quite serendipitously during the interview, Ann mentioned her displeasure with the physical science class she was currently taking I asked her to explain and she made it quite clear that the class was not about nature as she had been discussing nature. As one can see from the extended quote above, nature for Ann is something friendly that you can joyously be part of. What impressed her about the physical science class was the teacher's warning about the dangerous chemicals they would be handling during the course. The reasons for her displeasure with the class then became clear. She and her teacher had very different views of nature.

One might be tempted to dismiss this young lady's aversion to dangerous chemicals as temporary and solely a result of insufficient conceptual understanding. She does not yet understand that there is danger in nature, but with proper understanding and technique this danger need not be viewed as a threat. That may be, but the question is how will this come about? Currently, Ann's aversion is rooted in an aesthetic sense of nature that has more scope and force than her science teacher's assurances and explanations. It is critical that one note that Ann's problem is not with science but with the context her science teacher chose to give science. Ann's mind not a map dominated by canonical scientific thinking. The thinking represents a coherence view of nature where not one but several themes or large concepts have scope and force. We have borrowed the concept of coherence from Thagard (1989, 1994) who suggests that a person accepts a belief or proposition as knowledge on the basis of coherence with other beliefs. Moreover, Aaron Wildavsky (1987) has argued persuasively from his cultural studies of people's political behavior that people are often able to make a broad range of quick assessments or decisions because these are consistent with a few strongly held cognitive elements. Unschuld (1995) comes to a similar conclusion in a study of how people make decisions about medical care.

Ann likewise is able to quickly assess her teacher's remarks about dangerous chemicals because these remarks are at odds, they do not cohere, with fundamental beliefs she holds about nature. Ann has a sense of wonder about nature that leads her to ask questions about nature and thus adds to her understanding of nature, including scientific and technological understanding. During the interview Ann volunteered some information from science and technology as part of her discussion of what one can know about nature. She showed an interest in scientific concepts but her foundation, the metaphysical frame that gives meaning to that interest, is in conflict with the classroom frame provided by the teacher. Ann has a sense of wonder about nature but it is grounded in her fundamental view of nature as beautiful and pure. If Ann continues in science I suggest it will be because she has found her own way to accommodate what for her is an alienating view of science. On the other hand, she may well become one of Costa's (1995) "other

smart people” who take and pass high school science courses only because this is required for college entrance - a science class is simply one more hurdle one must jump in the school game. It is instructive to point out that Ann’s science teacher at the time was Mr. Hess. Mr. Hess’ conceptualization of nature emphasizes knowledge and science. In contrast to Ann, his conceptualization of nature is essentially monothematic as can be seen in the excerpts given earlier in this paper.

As one can see these are very different people and the difference could be characterized as that between an expert and a novice. Mr. Hess is the expert whose knowledge of science is “an environment in which there is located a collection of resources for knowing, understanding, and reasoning” (Lampert and Clark, 1990, p. 22). He knows when to draw on this environment and how to get around within it. The difference between the two, however, goes beyond the mere fact that one is an expert adult with considerable scientific education while the other is an adolescent and a novice with comparatively much less scientific education. Each has a very different orientation toward nature, a different worldview, and one sees in their individual conceptualizations of nature the roots of their actions in the classroom. The teacher’s action is a rather matter-of-fact warning about dangerous chemicals. The student’s action is a refusal to see this as legitimate talk about the natural world. Mr. Hess speaks quite naturally about the world using comfortable language for his lessons, all grounded in his fundamental view of reality. Similarly, Ann on entering the science classroom does not drop her other ideas, especially those with scope and force. Indeed, it is that background that provides meaning for what she learns just as Mr. Hess’ worldview provides meaning for what he teaches. This suggests that although Mr. Bradford, Mr. Conright, Mr. Hess, and Ms. Jackson are all considered effective science teachers, Ann would have preferred either Mr. Bradford or Mr. Conright over Mr. Hess or Ms. Jackson. (In making this suggestion, we are aware that other factors must be assumed equal.) The implication of this research is the suggestion that there are potentially influential factors in how teachers teach science that what would otherwise be considered no more than subtle background or idiosyncratic differences among science teachers.

Summary

A science teacher not only presents scientific concepts, but tacitly creates a context in which scientific concepts are presented to the class. This context can be strongly influenced by teacher beliefs or worldview. In the current research, teacher worldviews with respect to the essence of nature were examined. Two biology and two physical science teachers individually sat for qualitative interviews. The same interview protocols were used in a concurrent study involving ninth graders at their high school. The analysis led to three assertions: (1) When compared with their students, the science teachers had a much more focused and less diverse conceptualization of the natural world. The students were much more likely to speak of aesthetic and spiritual elements of nature in contrast to their teachers who focused more on what one could know about nature. Teachers also spoke more in-depth on topics rather than the “name dropping” typical of the students. (2) The most interesting finding was that the physical science and biology teachers had considerably different conceptualizations of nature. The physical science teachers talked much more about all that scientists do know about nature and how successful science has been. (3) The biology teachers were much less sanguine about science, yet clearly enthusiastic. They

showed greater concern about the environment and were more likely to speak of the aesthetics of nature.

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Appendix

Mr. Bradford
Narrative on Nature
March, 1995

Nature is the living and non living components of the world around us - even the universe - apart from the works of man but including man. Nature has been here forever and it will always be here whether man is here or not. We are all interconnected in nature by both natural and artificial mechanisms. We, as a species, are all part of the same natural world and we all have an effect on each of the other components and species of the natural world. Nature in its natural state is pure and perfect. It can improve itself but it cannot be improved by the works of man. Purpose in nature means the struggle for survival. It does not mean there is a god who gives purpose to nature and directs nature by will.

Aspects of Nature: Nature is ever-changing. If man weren't there, beavers, for example, would still change nature! Plants invading the land have changed nature. There are many different aspects to nature. The more diverse nature is the more it is the way it should be. For example, in the ideal forest, in my mind, there is a wide variety of plants and animals, all different kinds of trees. Whenever that ideal forest is altered by man, there seems to be less and less diversity among those types of organisms in nature. Nature, however, is more powerful than the minds of people who are trying to conquer it. Eventually, nature will win out and so far it has won out, because man has yet to conquer all of nature and I think that... because of its complexity, because of its mysteries, because of its unsolvable nature, it remains to be powerful, more powerful than man. Glenn Canyon Dam is an example. The dam has permanently altered an aspect of nature. Man conquered that section of that river, but he has not conquered the entire river. Eventually the water will flow over that dam and destroy it, so nature will be more powerful than man, in the long run.

Complex and Mysterious: Due to the diversity in nature, nature is very complex. All of the various components of nature are working together, and in some cases working apart. It leads toward the complexity of nature. It makes it very hard to figure out. It makes nature mysterious. Nature is mysterious because it is so complex, the diversity of it makes it mysterious. There is a lot that is not known about nature. No one will ever know everything there is to know about nature and that is part of its appeal; because it is so mysterious. Not only will nobody ever know everything there is to know about nature, hopefully no one ever will.

To me, the mysterious nature of nature is one of its better qualities. Things that are completely discovered are no longer interesting. For example, you have a cube of metal that everybody knows every single ingredient in it. Well, there is no mystery to it. There is nothing appealing about that anymore because there are no questions to ask about it. If everybody knows everything there is to know about that cube of metal, it loses appeal to me and I am sure that it loses its appeal to the people investigating it. If things don't have questions associated with them, there is no mystery. If there is nothing to ask about it anymore, it loses its intrigue, its interest. The mysteries of nature are hopefully unsolvable. I don't want to solve all the mysteries of nature. I hope nobody ever does. The appeal is like being lost out in the forest, so to speak. You want to be out there away from anything that is solved, you want to be in an environment where everything is still interesting to you.

Knowing & Conserving: We know some things about nature. We know, for example, that in nature you will find examples where the progression of an organism is a direct result of the purpose of that organism - where the purpose of organisms is just to survive or to carry on their genetic traits through generations. Certain laws of physics can be applied to just about any part of nature so there is some predictability in nature. Water *will* evaporate. It *will* rain. You can predict certain population outcomes based on certain criteria like the amount of rainfall. We know these things from science. A scientist makes observations and collects data. He experiments with controlled experiments. He makes observations without experiments. He experiences nature. He lives in it. There are a number of ways to study nature. Scientists, in general, probably do more of it than anybody else. I think there are a lot of biologists who have made it their life's work to study nature. They do it better than anybody else. I think everybody should do experiments, either in their head or scientifically - on paper, in nature, wherever. It should be done. Does everybody actually do it? No, they don't, and that is part of the problem of why nature is being destroyed.

It is important, therefore, to understand how things work in nature because we are effecting nature all the time. For example, we effect one thing and it effects several other things that will have an effect on me or other parts of nature. This indirectly affects me again. It is important to me to have people understand how nature works so that they can prevent effecting it more than they do. Nature is difficult to understand - remember, it is very diverse. People think that they understand nature and so they go ahead and affect it the way that they want to. They predict that they won't affect anything else, but in fact, they do. So, I think that it is important to understand how nature works, as best we can, so as not to destroy it. I think everybody should study nature, I am not sure that everybody does do it. Scientists probably do more of it than anybody else.

Nature, however, is really not knowable. If nature were knowable it would mean that you would be able to predict anything about nature. You would know all the components of nature, what effects it has on other components. Well, you can predict a certain amount of nature's outcome, but overall, nature is unpredictable. If we destroy this insect, for example, because it is hurting some tree or some plant that we care about, I don't think that we will ever be able to predict how we have effected nature as a whole. You can't predict what effect one aspect of nature will have on all of the other components of nature. So it is unpredictable in that regard.

Human Influence on Nature: In my mind the work of god is pure. It is perfect and it can't be improved by man in anyway. It can be improved by the works of nature itself. God-like things are perfect. They can't be improved by works of man, but can be improved by the works of nature itself. Nature is pure and diverse, that is, *unaltered* nature. Pure nature is nature unaltered, and so the more diverse nature is, the more unaltered it is. Unfortunately, there are a lot of cases where that isn't true, but the ideal nature should be pure and diverse. Because man has shown that he can change certain components of nature, I am concerned about pollution and the damage that it does to nature. Right now there is overwhelming damage being done to nature - the effects of man on nature in our lifetime are pollution, destruction of rainforest, the damming of rivers, the dredging of the oceans, and the pollution of our oceans, the killing of species, and so on.

Peace of Mind: Nature is beautiful, as I see it. That is what draws me to nature in the first place, how beautiful it is. The simple beauty of being pure, the kind of plants and animals that are out there, the landscape in its natural state, all kinds of simple beauty to it. Purity and diversity have an internalized beauty to me. When it is pure and when there is great diversity out there, then it is more beautiful to me. So, those things have to be in place first, possibly before I consider it to be beautiful. Nature is living. Nature is composed of living things organisms, and the living part of nature is probably what attracts me to nature in the first place. So the living part of nature is what appeals to me - plants and animals, any kind of plants or animals. Even though I would consider rocks and volcano's a part of nature, the living part of it appeals to me more. There are some beautiful rock formations and so on, but the living parts of the landscape is what is most beautiful. The appeal for me is an internal sense of peacefulness when I am around nature.

Ms Jackson - Teacher 2
Narrative on Nature
1996

Nature is the living world that we live in and it is more of the man-made kind of things based on what we understand about the laws of nature. I think that nature is predictable. I think that it is logical. I think that it is explainable. As scientists, we come up with laws of nature or theories of nature to be able to predict behaviors and therefore, based on what we know, and the experiments that we have done, we can now, either change or know that we can't change an event, but that maybe we can predict that the event is going to happen. And we can predict those things because they are orderly, there are certain patterns that we can find, and yet at times they can be very complex. But I think nature, you can understand it, you can know it, and you can predict it. I think that if we study it that nature is not difficult to understand. For instance, I am not a real biology type person, but I like watching those shows and they show patterns of things having these five sides, so I guess that if you are to get a new plant, then you could categorize it, because of those sides, but basically, from the physical science side, a lot of, if you are going to... gravity is, and you throw a ball, then you can predict what is going to happen because it is logical... I think that is what I'm thinking of when I think orderly... I think logical. If you were going to use lenses, and you know how light is going to go into the lenses, then let's say, with a telescope, you know that you need to use a lens to get the image and then the lens to invert the image, and so how you know how to use it, because of what it does. It is very logical to me.

There are limits to knowledge, however. We don't know a lot about genetics. That seems to be real prevalent today. What they are trying to find out, like pre-birth testing. How can we find out if you are going to have a disease or even if you are alive, are you going to be predisposed to having cancer or to having diseases... so, we don't know everything, but we have enough information to keep trying. And I think that we have the space shuttles that go out, we have the satellites that go out and we try to learn more about space, but there is still a lot that we don't know, but based on what we do know, we have a direction that we can go in. The future is an interesting question. I am a fan of Star Trek. It would be nice to know that we could have space travel and that we could actually achieve that, but I think, I don't know, I feel like we know an awful lot. I feel like, that, even though we don't have all the answers, we have so much, ways of finding out answers. I think we have that base of knowledge, so I think, I feel that we know an awful lot. I think we would definitely be up towards the 80 percentile of knowledge. This knowledge, I think, has come from a variety of sources. I think that there have always been scientists studying things and that has been formally or informally, and I think that, for instance, on this sort of thing, like how to reuse energy, or how to get restorable energy, I think that's coming from scientists, but it is also coming from business, because they need to find a way. So, they're a source. They are using scientists, they are using people that are engineers, along those lines, but they're the ones that are promoting as well as the government. So, I think that the sources are coming from, and I think that people may be in their own houses, if they can come up with something that works a little better. So, I think that it is kind of a variety, but I think that science has a lot to do with that.

We use the resources of nature. We use trees. We use coal. We use oil. We eat plants. This is why we study nature, because... that we do use it for so many things... resources each day. It's the things that we use. It's the things that we interact with. Without the things of nature we cannot enjoy the lifestyle we have today. I think that a lot of things that we make... I don't know all about what materials things are made of, but I know that a lot of things come from... we have leather, we have wool, so I think that because we know and understand the laws of nature, we can now build all of this electronic equipment that we use. This is more for the laws of nature, like radio waves, TV waves. That is why it is important to understand how things work in nature... so that if you want to grow something, that you understand how to grow that better. If you want to use any laws of nature, for instance how to make... a lot of these are man-made materials, but then you are using laws of nature, of how to get solid-state equipment and get the electrons to move, or get the radio signals to go. So, nature is something that should be studied so that we can learn more about it. This is what scientists do. Lots of scientists are doing that. I think little kids do it, and I don't know if they really add to our understanding, but I think that it is a natural thing for kids to do to just start looking at the world around you, and then taking things apart at your house, and finding out how they work. So, I think that it starts with kids... and everybody has a little bit of it, but then some people make it their formal career like scientists.

We need to be aware of what is around us and how we fit into the whole thing. I am a scientist, for one thing, and with so much new knowledge, with so much resources, with genetic engineering that is going on, I think that we need to be better equipped citizens to be better to make decisions on whether or not this is something that we want to do or not do, and if we don't know, where we, as mankind, fit into this... then what is the good of making better people, more people,

if there are no resources for all of these people? I mean everyone wants to live longer, but there is a purpose for dying. So, that sort of thing... so that we have new people! You know what I'm saying... it's just that we need to see where we fit into all of this, and we can use all of the laws of physics to go travel everywhere that we want to go, but why would we want to do that? Do we want to have more people so that we can live other places, you know... do we have room for them... but where do the resources go? I don't know if this is true or not, but somebody just told me yesterday that when you used to be able to eat one apple and get all of the minerals you need, now you have to eat five. I don't know if this is true or not. It was an interesting comment, so it made me think. Their theory was that there is not as much nutrients in the soil. So, this goes into the fact that we're (we are all part of nature) endangered. We're full of resources. We're exploiting it. We're not either using what we have properly. We're over-using other things and obviously pollution is a problem. Resources are exploited. Nature is polluted and endangered because of those reasons.

But we have all those resources, this material (or matter which is just what, everything that has mass is), and hopefully we can restore it and then we'll have all this matter that will matter to us! I just went to an energy seminar about restorable energy sources, and they are talking about trees, and how we could plant trees, and with the science that we know now, how we can make trees grow really fast or really tall, and how we can use more trees. I think that nature is reliable. I think that you can count on having what we have, at least for in the short term. That sounds like... and I do, I have hope... and I guess that I have hope that there is... I think that there is a large awareness of what is happening with nature. So, I don't have this fatalistic kind of attitude about nature being doomed. I don't know if it is human nature, or not, or optimism, or... I don't think that I am a necessarily optimistic person. I try to be realistic, but I'm not... I don't know... I would hate to feel doomed, to think that down the road, somewhere, that all is going to blow up! I think that people... I can't help but feel that people will try and preserve nature, but I don't know that nature will always be as it is now. I don't know what to do. I don't think in my lifetime... I think in my lifetime that it will be the way it is. But I also think that I don't know enough as a citizen, exactly what is going on. I know that there is a concern about ground water, for example, and whether it is being regenerated enough for us. I don't really know what the studies there are about our increasing population and what we are using of water, and how exactly we are restoring it. Nobody is really yelling real loud about it, so that gives me hope. We would be in trouble if our water was polluted. We would have severe problems. If we were running a plant that, not necessarily a nuclear plant, but something that had highly explosive chemicals, and it blew up, it would hurt people. So you need to know that this is not only pollution, but anything that you are dealing with that could be harmful to nature. Hopefully by knowing about nature, you are protecting it and you know what it needs to thrive in the living kind of sense. In the technical kind of sense, the laws of nature, you are not abusing it, so that you end up destroying what it is that you are trying to promote, which is hopefully life on earth. So, I think that people like to know things about nature. The scientists come up with stuff and then later on somebody finds a use for it that could be harmful, but that is why you need to protect it. I think that people are always going to know dangerous things. So, I am hoping that there is a balance between use of resources and protection just because this awareness of nature keeps being raised, and people keep coming up with solutions.

I think because we live in the world, we have to appreciate it and I think that most people do. We all appreciate... I've lived in a variety of places. I have lived around a lot of mountains, around the Alps and I've lived in the Blueridge and Appalachian mountains of Virginia, and it has taken me a while to appreciate the beauty of Arizona... just in a natural setting, and I think nature is beautiful. I think about nature everyday in one way or another. If it's not the laws of nature, driving with my kids and I am pointing out the moon to them in Arizona, and like I've said that I have lived a lot of different places, and the sunsets here are the most beautiful sunsets, and I know why we see those sunsets, but it is just nice to enjoy them. I also think that science is beautiful in the fact that you can repeat patterns and that you can find these things that are logical and I just like that. That appeals to me. Because of the physics and the refraction of light you can understand a beautiful sunset.

But I think that nature itself is pure. I think that if there is nobody that is interfering with it, that it seems like it takes care of it's self. There is a cycle that it goes through. I think that it can be very peaceful, on one side, and of course, like that one picture of a volcano erupting, it can be not so peaceful. But, I think that it is sacred and holy, just because we should take care of it, and we should respect it. Nature brings out emotions and I think that because of that we should respect it, definitely from a religious side as well. And I think that, you know, and that goes for our own bodies... everything. That's because that's more of a religious side, that we should take care of everything. I think that we should protect nature... you know there is that saying that we are just borrowing the earth from our children, they're not giving it to us. There are other aspects of nature. I think that there is a lot of living things in nature. Not everything about nature is living, especially if you are talking about laws of nature, that is something a little bit different, but nature is all centered

around living things. I think that it is exciting to study nature. It is very diverse in terms of, if you look at the chemistry of it or the physics of it or the biology of it or the enjoyment of it, just how those things tie together. Nature is not always peaceful. That is things like earthquakes, things like... and these are things that we can maybe predict but not control, maybe minimize damage. Things like, maybe something falling out of the universe, the sky, like a meteor. Things that are frightening and they're dangerous because they could hurt people. They are powerful enough to have that kind of effect, and I think that the confusion comes from the fact of why, especially when someone that you like is hurt. If it is a devastating thing, you just wonder why that happened. So an earthquake is not confusing in the sense that it happened, because you could be able to predict that, but just... Oh gee....you have this disaster and that is sad.

On the other hand, I think things happen in nature because of purpose... this I think is a religious view... that, not necessarily a fatalistic view, that you have no control, but that there is a destiny, that there is... as an individual, I'm contributing to it, but I'm not the biggest part of it, of human kind that there is. I think there are purposes. Animals have instincts... Humans are different than animals in that we seem to be able to reason and really take control, and again I don't have a real biology background, but I observe those things, or watch shows on them, and so they have these cycles of their life which must have some purpose and it has a purpose for the food chain and how they are all, the whole huge, inter-related processes, so I think that when one... supposedly... I think that I read this, that when one animal gets killed, it's usually the weakest one, and so that they are promoting the stronger one, so that would be a purpose, and that is one of those things that happens in nature, because of purpose. Now, when man seems to get involved, I don't know that their purpose is to only... we help all our sick people, and then we... through other things... maybe through nature, but maybe through our own design, then we harm them as well. It's not everywhere that we see that, but I think that it is the way it is meant to be. I think that the whole inter-relatedness of us and our world, is that... like okay we do have a purpose, some bigger picture, and I think that we are playing that part, but I don't know what it is going to lead to. There is no "lead-to" where we are all taking care of each other and we are somehow living in a balance, or are not. I don't know how it will end up. I do know that... I know that all things want to continue living, so that they all reproduce and that seems to be real important in nature, for plants, people, and animals. I know that we need to use our resources wisely, that is real important, and that is about all I can think of now.

Mr. Hess
Narrative on Nature
17 November, 1994

Nature is orderly and understandable. The tides and the rotation of the earth, the seasons and so forth are examples of order in nature. That the planets and the stars are governed by physical forces and any deviations are simply because we have not yet discovered the other part of nature's orderliness. According to chaos theory even things that appear to happen randomly have patterns. I think that everything has patterns. We haven't necessarily discovered those patterns, yet. As a science teacher I feel that with enough scientific knowledge we all things are understandable. I think it is very important to know how matter interacts with matter, and therefore how that influences everything else around, for example, how living things work, how it rains, how the stars are made, and how they are formed, the whole thing. I think that the more we understand about matter itself, and the more we know about how to make things, the more predictable nature will be. Scientific or reductionistic thinking is very powerful. I feel that once we know enough about the minutia of the world, breaking it down by using the scientific method, scientists tearing it apart and analyzing the parts of nature and seeing how they interact, that we will be able to predict just about anything about nature.

I think there is probably a limit to predictability in nature. I think nature has unpredictability because it is so changeable. Weather is a prime example of that. We can't predict the weather more accurately more than, at the most, two days ahead of time. That is because there are so many things that change within this thing that we call weather, that effect local weather patterns. I think that it is probably the best example of something unpredictable. I think that nature is always changing and that is why we are having a lot of natural disasters. Nature is changeable and we just can't predict that too well - when a hurricane will strike or when a tornado will strike.

I think unpredictability, however, comes because we don't know enough about nature to predict everything about it right now. This has emotional consequences. We have emotions of fear and peace and I think that fear stems mainly out of the unknown. Man is frightened when he perceives what is going on around him and he doesn't understand it. If events are predicted then there is a very peaceful type of feeling. I don't think that nature is inherently dangerous or confusing either, because that is man's definition of what is maybe the unknown part of it. What's dangerous about nature or about the natural world is that we can't predict when things are going to happen, when we are going to die, for example. Eventually, however, all nature will be explainable.

One of the reasons why we don't yet understand enough about nature, is because the extreme, complex, and diverse type of systems that are involved with it. But I am an optimist as far as it's understandability, as far as that is concerned. Our current state of being is that there are unpredictable events in nature. Our ultimate state, the end point, is basically knowing very much. Weight wise, we are probably more tilted toward unpredictableness because I think that we are in the infancy of understanding the world around us. I am optimistic that we will eventually know much more. As knowledge grows we will change the changeability and the unpredictability of nature. It all will decrease significantly. I have a great faith in man's ability to understand things and take things apart, to get to the bottom of the solutions and things. I think that with that knowledge and the yearning for knowledge, whatever is the problem, we will basically be able to know and being to predict.

It is important to study Nature for three reasons. First, the mere fact of knowing things about nature is worthwhile itself. Nature is an everyday part of life and I think about it a lot and how things work and how things interact with each other. Nature is beautiful. I see it most in the way things work so well together. I think that I see beauty in nature more with living things than with anything else. It is the vastness of things that could go wrong in a living organism, and yet it lives. Nature is made of matter. That matter gives us the resources we need whether it is living resources or material resources. Material resources are the raw materials that we can use to build things or to develop technology. Thus, the second reason to study nature is that the more we know about nature, the more we can control it and use it or exploit it. The third thing is the more that we can do that, the better our lives are going to be - and, this is sort of a tribute to Man's intellect. You know, how to use what's here.

I don't think that the natural world will ever be any of these things, endangered, restorable, or doomed. It will never be endangered. It will never be restorable because there is nothing to restore. It can't be doomed because, whatever doomed means, the natural world will exist. Whether man continues to exist or not, it really doesn't matter too much. I think that the natural world will always be there, whatever form it is in. No, nature doesn't, as an entity, and there is no such thing

as nature as an entity, need protection. It doesn't need protection. That is man's need in life. We need to protect nature so that nature can provide us with the materials we need. So, if you put man into the equation, like if the equation says that man needs to be on this planet, then this is what we need to do. If we are not concerned with that, then we shouldn't really worry about what we do with nature.

I think that it needs to be protected, however, simply because I think that there is enough enjoyment in nature itself, or different parts of nature, that the beauty of nature needs to be protected. I think there is a bigger story, though, about why we need to protect and know about nature. This is such a bigoted statement, but we need to protect the human race. We need to know enough about the ecosystems, so that we can say, "yes, these animals can become extinct because they are not really important." So, those two sides of myself battle each other because I think that there is a lot of beauty in nature and I think that it is very enjoyable to have these diverse animals. But, I also think that we also need to be realistic and know that we are not going to be able to protect all of the animals. We need to know what animals are necessary for us to enjoy the same quality of life that we now know.

I also have some other thoughts about nature that are really completely separate from what I have said so far. These thoughts are extremely important because I think that there is a need in man's life for a purpose. Nature or the natural world is everything. Well, it's the universe, including man, and everything man does, and everything in the universe; but, the natural world is not everything that exists. I think God exists and He is part of the natural world, but at the same time, not part of it. I think that the natural world is a subset of God, and not the other way around. I think that nature can remind us of the spirituality, our own spirituality... I don't think that nature has a spiritual quality in itself. I don't think the world around us or the universe has any spiritual qualities. So, God is sort of the wrench in that perfect definition, nature or the natural world is everything, but a necessary part. It is a necessary wrench because the rest does not work without that. Basically, I am talking about this unknown variable called Man and all his ideas. Divorced from pure science and pure fact there is also something called faith which is what defines sacred and holy and mysterious. Although I think we will eventually understand a great deal about nature, I also don't think that we can every discount the idea that there will always be a need in human lives, where things are sacred and holy, with holy perceived as mysterious, as well. Even if things aren't mysterious any more, I think that man will invent new things to have as mysterious.

I definitely think that there are parts of everything that are separate from, not nature, or the natural world, but definitely from what I perceive as what science can uncover, and maybe part of that has to do with man's need and wanting for, and maybe personal discovery of things that are holy and sacred, or mysterious. That is sort of an unknown variable, that sort of sits out there. These aren't products of man's interaction with that part of the natural world. Things become holy because they are a part of the natural world that doesn't fit into a nice little formula, but is somewhere out there that we haven't tapped into. Maybe that is knowable, maybe that is predictable, eventually, but it can't be broken down by using the scientific method.

Mr. Contrite
Narrative on Nature
1996

The natural world is the environment and world around us that is here naturally, without being effected or changed by man. The natural world is what is here that hasn't been changed or influenced by man. I think it is sort of the raw material that we've come upon in our activities. It is sort of altered and changed, but I think the natural world, by calling it natural, you're saying that it is something that has not been altered by man. So when I think of the natural world, I think it includes everything that was here, that we come in contact with, or that we are in contact with. Its all just part of everything that is there. Now that I think about it, I would consider the natural world to include the world, the physical part that we see, and whatever it is that may be behind it, that is created or is driving it - all the parts of it, the parts we understand and the parts that we don't understand. Some might say that they see the work of God in nature. I would say that you see something beyond the work of man, that's even a higher level.

Nature has many aspects. It is alive and it is always changing. It has a mind of it's own and in some ways things happen, because it is alive. Just the way that the earth moves and shakes, the way that the oceans tend to move and the whole relationship between the earth and the universe. The way that living things have come out of all that, or part of it, to interact with the earth and universe. I think that the fact that it's alive really is a big part of what makes it the natural world, or at least my concept of it. I am not using "alive" in the technical living things sense, but I think in terms of how matter (nature is material as well) interacts. I think that it is alive in the sense that, even though it may not technically be alive, I think that when there is heat and there is energy, things are moving and flying - that in a way is a kind of life. Nature is dynamic... movement and change and all life, when you look down to the molecular level, it really is just non-living, material molecules that are organized in complex ways. So, it is hard to draw the line, when you get to that level, as far as what is alive and what isn't. So, that's partly what makes it mysterious. Nature is alive and it is material.

Nature is orderly and chaotic, predictable and unpredictable - these pairs are sort of needed in order to define each other. Things wouldn't be predictable if you didn't know what unpredictable was. Things wouldn't be orderly if you didn't know what chaotic was. It is sort of a ying-yang relationship between the two - I would call this just the dualistic nature of reality. A storm in the ocean might be considered chaotic, but then as you watch the ripples of the waves that are flowing away from it, there is a sort of orderliness to that. Weather is unpredictable. You can't predict what's going to happen, but you can predict the consequences of it. The resources that nature contains is kind of unpredictable, because we don't really know what resources are there. The fact that you use the resources of nature means it is more predictable. But, it is so powerful that we can't really always predict what nature will do or control it. You can predict that you are going to have certain consequences, however. It is also powerful. In relation to man, nature is powerful because it controls whether life can exist on this planet or not, or any particular place. And we are real limited in our environments that we are able to occupy and so in that sense, nature has a lot of power over us.

There is a lot of diversity and complexity in nature, and there is also the fact that it is just there. It's all just part of everything that is there. You can look at it all as being part of one thing, or you can look at it all as being different and complex in different aspects of it. It is incredibly complicated. The closer you look the more complicated it is and in order for it to function as simply as it appears to us, there must be a lot more to it than we know. I think that it is important to understand that there is more to nature than meets the eye. It is interesting to see how nature works and just how complicated it really is. By observation and by looking at things and watching them over a period of time, you begin to notice patterns that allow you to make predictions. But it seems like a lot of predictions, once you make them you find that they... well, the rules tend to get broken, or you get more information at a higher, finer, more detailed level and you realize that there are other things going on that you weren't predicting. I don't see these aspects of nature as being balanced. I think that it is just different aspects of the same thing and that the pairs both have to be there in order for nature to be what it is, to define what it is.

I like the word beautiful. I think that there is a lot of beauty in nature, even though it is not always beautiful to man. The whole aspect of nature and I guess that I have an instinctual connection to that, that it is sacred, and just deals with something very special, you have to respect it. I think that beauty is the more aesthetic reason to appreciate nature and I think that aesthetics can provide reasons for studying nature, too. But, I think that beauty and emotional response are more in the aesthetic realm, just pleasing to see how nature works, seeing that it is mysterious, that it

allows a curiosity about how it works - to admire the beauty of nature and it's simplicity, and just... Well, I enjoy nature!

Some people might say they see the work of God in nature, that is to say that you see something beyond the work of man, that's even at a higher level, and to appreciate that is one of the aesthetic things that we like about nature. I have an instinctual connection to sacredness of nature. It just deals with something very special about nature, and you have to respect nature. As I said before, I think that it is important to understand that there is more to nature than meets the eye. We need to treat it as being sacred, because of that. I think that nature is our home and it gives us life, and everything, that people consider it to be very sacred and holy, and those are definitely the perceptions that we have as being a part of nature, and it kind of grows out of that, I think. These ideas are religious and philosophical and emotional, all three! I think that people have real strong emotional ties to nature, in a lot of ways. There is a lot of variations on how people consider it to be sacred or holy, but I think everybody does, in some sense. Everybody has a sort of innate appreciation for life and for the natural world. I think that a lot of our religious belief has to come from this aspect of nature, its beauty and mystery and sacredness, which is that part that we can't... or we don't understand at this point, and that it makes us think that there must be something beyond our level of understanding, from where nature must have come. You wonder about how it all got started and where it all came from? Its very religious, emotional, and philosophical too.

I am look at the natural world as something that is physical, more physical, and it is happening around us, but if there is a God behind it, that is creating it, then that might be something that is at a different level, that I don't understand in my own reach. From what we know about energy and physics and everything, I think that there is potentially other realities or perceptions, or things that are happening, that are beyond this natural world that we are perceiving. I think that there could be things that I just don't know about. I do think nature is more than material. I think that there is something driving nature and causing it to evolve the way it has changed, and to say that nature is only the stuff that you are looking at, is... may be missing part of it. I think that there must be some purpose for things to become what they become, in terms of living organisms. But, what is driving it? I don't know. To say that everything is driven by a purpose is, I think, sort of a human perspective. I think that it is an assumption to say that everything results because of a purpose. I think that is possible that things happen because of chance, too. Purpose sort of denies the whole role of fate and chance, that things can happen just because they happen to work out that way! So, I think that you have to have an element of chance in nature, it is just not purpose. Maybe in terms of any purpose that there might be, there is God, but in terms of being exclusively because of purpose, I just don't think that nature is playing out according to some divine purpose or that it is all laid out. I think that there is a definite element of chance.

I do think about nature quite a bit. Just wondering about how things work. When I see a bird fly around, I wonder how its eyes are so quick, how it's wings can move that fast, how quickly it perceives the world as it moves around. I wonder where crickets come from or cockroaches... something that I am in contact with constantly, everyday, and I tend to think about it because of that. Living, mysterious, and exciting. These are terms I closely associate with the natural world and how it appears. It's alive. It's mysterious and we don't understand it, and it's exciting. I tend to look at the natural world as being mysterious - that there is a lot that we don't know about it. It is exciting. I guess just because it is interesting to see how nature works, and just how complicated it really is. I think that the more we know about it, the more enlightened we will be about ourselves and the world we live in, and the better chance we will have that we will be able to be more reasonable about our decisions that we make, and I think that kind of knowledge is hopeful and peaceful. And just from the basic scientific reasons, you never know what you're going to find when you go to study something, and just from past experiences, we've found that by looking closer, and with more detail, we discover more about how we, as humans, are constructed and how we relate to nature and we're able to improve our quality of life because we are understanding nature better. So, you can study it, I think, in many ways, and it is so amazing and interesting, to see and to experiment, that any curiosity that we have about it is a good enough reason to go and study it. There are aesthetic reasons. It is just pleasing to see how nature works. I think that scientists are most involved in the study of nature, as far as observing and trying to measure what is going on in the world, in turn to predict how things will change and what will happen. I think that is one of the functions that science really fulfills as far as a human enterprise. The studies themselves, I am optimistic about. How the studies are used, they are subject to all the human shortcomings and problems, but as far as doing the studies I am optimistic. I think that we have always got more to learn and that we can learn a lot from nature.

Because of our dependence on nature, just our existence, we need to study nature, to learn more about it. We need to understand how things work in nature because it is an important resource for us, to get our water, energy, food, and

materials for making things from nature. The resources that nature contains is kind of unpredictable, because we don't really know what resources are there, that we can use. Because of that, we need to understand it as much as we can, so that we can protect it. It needs to be protected... and keep it so that it can maintain us and maintain civilization. Man has an impact on the natural world. Because the world is full of resources and powerful, man has also polluted and exploited it, even though it is powerful, and has taken the resources and used them for his own purposes and things. Although I think everybody has a sort of innate appreciation for life and for the natural world, when people have self-interest at stake, they tend to meet their own needs.