

**ASSESSING CHANGES IN HIGH SCHOOL STUDENTS'  
ENVIRONMENTAL DECISION-MAKING SKILLS:  
SOME METHODOLOGICAL CONTRIBUTIONS**

by

Anne C. Switzer

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Doctoral Committee:

Professor Joseph S. Krajcik, Chair  
Professor J. Frank Yates  
Associate Professor Michaela T. Zint  
Daniel C. Edelson, National Geographic Society

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## Dedication

I'd like to dedicate this work to several of my favorite natural areas in the world,  
for certainly they have provided much of my inspiration:

Pickerel Lake – Dexter, Michigan

Inishmore - Ireland

Umstead Park - Raleigh, North Carolina

Roatan - Honduras

The Everglades – Florida

Pisgah National Forest – North Carolina

Iztaccíhuatl – Mexico

Cape Eleuthera – The Bahamas

St. Croix River - Maine and New Brunswick

The entire Nova Scotia Coastline

Prince Edward Island

All of the country roads around Kenyon College – Gambier, Ohio

Eagle Creek – Columbia River Gorge, Oregon

And, countless other miles of rivers I have paddled and roads that I have pedaled.

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## **List of Abbreviations**

(in alphabetical order)

AAAS = American Association for the Advancement of Science

CASES = Case-Based Approach to the Study of Environmental Science

DSP = Dominant Social Paradigm

EDM = Environmental Decision-Making

GOFER = Goals, Options, Facts, Effects, Review

GOOP = Goals, Options, Outcomes, Probabilities

IOPD = Impact of Online Professional Development

NAAEE = North American Association of Environmental Education

NCSS = National Council for Social Studies

NEP = New Ecological Paradigm

NRC = National Research Council

PEV = Personal Environmental Values

PFL= Preparation for Future Learning

PISA = Program for International Student Assessment

SCDM = Stakeholders – Consequences Decision-making

## Abstract

### **ASSESSING CHANGES IN HIGH SCHOOL STUDENTS' ENVIRONMENTAL DECISION-MAKING SKILLS: SOME METHODOLOGICAL CONTRIBUTIONS**

by

Anne C. Switzer

Chair: Joseph S. Krajcik

In this study, I developed three methods for the assessment of high-school students' environmental decision-making skills. The three methods were developed based on perspectives of decision-making expertise in psychology and are named *Satisfying Results*, *Coherence*, and *Process Decomposition*. *Satisfying Results* looked directly at the choices students made, *Coherence* looked at the match between students' choices and their values, and *Satisfying Results* focused on individual steps of decision-making, with my focus being consequential thinking. With these three methods, I examined changes in 172 secondary students' environmental decision-making skills. The students in the sample studied the first unit of *Investigations in Environmental Science: A Case-Based Approach to the Study of Environmental Science* (CASES), a curriculum designed for

grades 9-12. Integrated with the science content in CASES, students were introduced to the Stakeholder-Consequences Decision Making (SCDM) process. I pre- and post-tested students who experienced the first out of three units of CASES. I used the New Ecological Paradigm scale to look at students' values, as that was necessary for the Coherence perspective. The students' results varied with the decision-making perspective as well as with instruction of two CASES teachers. Relative to instruction, classroom management and the values exemplified by the teacher were examined. The overall results reflect that the assessment methods were able to detect positive gains based on particular goals that CASES stated for teaching environmental decision-making. Specifically, there was evidence of progress with both the "Coherence" and "Process Decomposition" results, which were goals of CASES. The methodology used in this study may be useful for grounding future studies of students' decision-making skills. In particular, the methods developed here can be utilized for matching assessment methods to teaching goals, as well as to entering the realm of assessment *for* learning.

## **Chapter 1**

### **Introduction**

#### **The Challenges**

Decision-making is a powerful tool for directing our lives. Transportation, schooling, personal health and safety, food and clothing are just a few areas in which people make decisions every day. Some decisions mainly affect the decision-maker, like which toothbrush to buy, whether to bike or drive to work, and what medical treatment to receive. Other decisions have broader social, economic, and environmental consequences, such as where to locate a power plant and which candidate to vote for in an election.

Often, decisions that seem to fall into the first category—affecting only the decider—intersect the second category—affecting others—because of indirect or non-obvious consequences, or because of the aggregate effects of many decision-makers. For example, many people assume their choice of automobile affects only them. However, choosing one particular car over another creates potential indirect effects of higher or lower fuel efficiency, passenger-carrying capacity, and carbon-dioxide emissions. Because so many people use automobiles, all of these effects can influence long-term and

widespread environmental quality, which in turn can affect the health of many people and animals.

Under conditions where personal and global consequences are thus intertwined, “decision-making skills must be regarded as an essential component of every man’s (sic) literacy” (R Beyth-Marom, Novik, & Sloan, 1987, p. 218). With regard to many current environmental issues, we live in such interconnected circumstances. According to Kastens & Turrin (2006), “[e]very student will grow up to become an adult who makes personal decisions that affect the environment” (p 431). Thus, it is an important educational goal to develop in future voters, consumers, and policy-makers the literacy to contend with decisions that have far-reaching consequences.

Environmental issues abound in the United States and around the globe. Climate change, ozone-layer depletion, water and air pollution, and many other issues are regularly covered by the media. Further, people have known for many years that these environmental issues are caused by human behavior (Legendre, 2004). Some conditions such as urban smog and lead in the air have improved (Ryan & Durning, 1997), but others have remained and/or worsened. There seems to be a “disconnect” in the minds of many Americans between our behavior and the nature of environmental problems. This disconnect may be possible because “[m]ost of the production, and most of its impacts, are hidden from view—in rural hinterlands, fenced-off industrial sites, and far-off nations” (Ryan & Durning, 1997, p. 5). This disconnect also allows Americans to continue consuming 120 pounds of natural resources per person per day (Ryan & Durning, 1997, p. 5). Compared to other people on the planet, this resource use is far out of proportion (Benyus, 2005).

If we are to change the present course of natural resource depletion and degradation, we need to be better decision-makers relative to the environment. As Guber (2003) has shown, most Americans today agree that the environment is of significant concern. The issue is, as she states, “[w]e no longer debate whether to protect the environment but rather where, when, how, under what conditions, and at what expense” (Guber, 2003, p. 176). Answering these questions will require more thoughtful decisions that take into account the scientific understanding available to us today regarding the consequences of our behaviors. This statement is true at both the individual level, and at the societal level (e.g. via public policy). Both need to be transformed, though the focus of my work will be on the decision-making of individuals.

In that vein, one thrust of environmental education efforts has been to provide students with as much current scientific understanding as possible. Thus, teaching about environmental issues has been infused into school courses, most typically science courses (Lucas, 1980; NAAEE, 2001). Concepts such as carrying capacity, ecosystems, endangered species, and food webs can certainly be brought alive for students when contextualized within a local or global issue (Lieberman & Hoody, 2002). However, learning the science concepts involved in environmental issues may not be enough to equip students to make informed and thoughtful decisions (Arvai, Campbell, Baird, & Rivers, 2004). Even for adults, information is not enough, but “[w]e have been clinging, understandably, to the forlorn hope that scientific information will dictate the ‘right answers’ to our environmental concerns” (Cairns, 2002, p.86). What is necessary is to teach the skills that will allow us to use that information effectively in analyzing issues that can make a difference for the environment, and over which we have control.

## Evidence of the Challenges

Unfortunately, decision-making instruction and practice has not been a part of the education most young citizens receive in the US. This omission shows itself in test results such as the Program for International Student Assessment (PISA). The 2006 PISA results in science show that only 1.5% of 15-year olds in the U.S. have reached the level that is described as, “[s]tudents...can use scientific knowledge and develop arguments in support of recommendations and decisions that centre on personal, socio-economic, or global situations” (PISA, 2007). Although this percentage is slightly higher than the Organization for Economic Co-operation and Development (OECD) average of 1.3%, it is still behind nine of the OECD countries. Why might these results be so low? There are likely many reasons our young citizens achieve so poorly in this critical area. I discuss two possibilities here.

First, students’ exposure to decision-making in many U.S. school textbooks may be quite unsophisticated. Allen (2000), in an article on decision-making in Civic Education notes that students tend to read about historical decisions that are so simplified they completely distort the decision-making reality. For example, students might read that “President Roosevelt decided to impose a bank moratorium” or “the mayor purchased park lands” (Allen, 2000, p. 5). These decisions are presented without recognition of the likelihood of inadequate information or the full social, political, or scientific context in which they were made. Deletion of critical information that would illuminate historical decisions may be a symptom of many areas in the school curriculum and likely reflects the current focus on breadth of coverage (e.g., a multitude of standards) rather than depth (Sadler & Fowler, 2006). Many have come to call this

phenomenon the “mile wide and inch deep” curriculum (Schmidt, McNight, & Raizen, 1997).

Second, decision-making –and especially environmental decision making, a term I define specifically in Chapter 2—has not been a part of the traditional science education that many students receive. Kastens & Turrin (2006) completed an analysis of the available state science educational standards (49 out of the 50 states). They looked for standards that addressed any human/environment interactions and classified them in three ways: (1) the environment impacts humanity; (2) humanity impacts the environment; or (3) individuals impact the environment. What they found is that while the first two are well represented, the third is not. The average number of standards (or parts of standards) they coded that fell into this category was two per state, as compared to 8.8 and 14 for the first two categories (p. 426). This imbalance may relate to the fact that looking closely at people’s behavior—as individuals—opens the door to looking at their values. This is true because at some point in making choices about their own behavior, people choose based on valuing something over something else.

Traditionally, science teachers have shied away from dealing with values in their classes. Instead, their charge has been to teach the process and content of “pure” science. Many science teachers see opening the door to students’ values as “a minefield of relativism where anything goes” (Ratcliffe, 2007, p. 123). Knapp (1983) describes the issue this way: “A ‘don’t rock the boat’ message is conveyed to some teachers by parents and administrators...Some teachers are not clear on their own values or the objectives of values education in the community and find dealing with the topic difficult” (p. 24).

Continuing to operate this way will not serve to prepare students with the decision-making skills necessary to become future citizens.

Many organizations with a stake in U.S. education are recognizing this and calling for students to learn decision-making skills, however. They believe that decision-making skills are prerequisite to being both scientifically literate and a good citizen (Lehr, 2007). One organization of note is the Partnership for 21<sup>st</sup> Century Skills, a relatively new advocacy organization with its eye on helping young people succeed in an increasingly global economy. The Partnership has developed a framework that includes “making complex choices and decisions” as a goal for 21<sup>st</sup> century learning (“Framework for 21st Century Learning,” 2004). This call is also echoed by specific discipline-related organizations, such as those concerned with science, social studies and environmental education. Following is a discussion of these organizations and their specific goals.

### **Calling for Education re: Decision-making**

The American Association for the Advancement of Science (AAAS) claims that “[b]y emphasizing and explaining the dependency of living things on each other and on the physical environment, science fosters the kind of intelligent respect for nature that should inform decisions on the uses of technology” (Rutherford & Ahlgren, 1989, p. vi). Additionally, the high school section of the National Science Education Standards advocates decision-making skills as an important educational objective in multiple standards. Shown here is a small selection of those standards included in Content Standard F: Science in Personal and Social Perspectives:

- Science and technology are essential social enterprises, but alone they can only indicate what can happen, not what should happen. The latter involves decisions about the use of knowledge.
- Individuals and society must decide on proposals involving new research and the introduction of new technologies into society. Decisions involve assessment of alternatives, risks, costs, and benefits and consideration of who benefits and who suffers, who pays and gains, and what the risks are and who bears them.
- Many factors influence environmental quality. Factors that students might investigate include population growth, resource use, population distribution, over-consumption, the capacity of technology to solve problems, poverty, the role of economic, political, and religious views, and different ways humans view the earth. (NRC, 1996, p. 198-199)

The National Social Studies Standards (NCSS, 1994) include the following for their discipline, again at the high school level. Each begins with the phrase “Social studies programs should include experiences that provide for the study of”:

- people, places, and environments so that the learner can propose, compare, and evaluate alternative policies for the use of land and other resources in communities, regions, nations, and the world (ibid., p. 36).
- how people organize for the production, distribution, and consumption of goods and services, so that the learner can compare how values and beliefs influence economic decisions in different societies (ibid., p. 41).
- global connections and interdependence, so that the learner can analyze the causes, consequences, and possible solutions to persistent, contemporary, and emerging global issues such as health, security, resource allocation, economic development, and environmental quality (ibid., p. 44).

One environmental education organization, the North American Association of Environmental Education, has Guidelines for Learning: Pre K-12 (NAAEE, 2004) that emphasize skills related to understanding and addressing environmental issues. In particular, Strand 3.1 (Skills for Analyzing and Investigating Environmental Issues) states

that “learners are able to evaluate the consequences of specific environmental changes, conditions, and issues for human and ecological systems.” Additionally, Strand 3.2 (Decision-Making and Citizenship Skills) states that learners should be able to “articulate a position on an environmental issue” and to “justify the position based on an analysis of information from a variety of sources, personal beliefs and values, and clear reasoning.”

The organizations AAAS, NRC, NCSS, and NAAEE, to which many curriculum writers and educators look for guidance, are recognizing that students’ decision-making skills are an important target of education in today’s world, particularly as related to the environment. Furthermore, teaching decision-making in the context of Environmental Science courses will give students valuable skills for using their knowledge (Arvai et al., 2004). Edelson (2001) in his description of the Learning-for-Use framework, which builds on the work of Anderson (1983) and others, states “[t]o apply declarative knowledge, an individual must have procedural knowledge that enables him to apply that declarative knowledge, or he must be able to transform it into procedural knowledge” (Edelson, 2001, p. 358). Thus, procedural knowledge (like decision-making) is one way that declarative knowledge (scientific understandings) becomes useful. Other potential outcomes of teaching decision-making in a contextualized and applied way include:

- (1) Students are more likely to make connections among the various subjects they learn in school, as well as between school and real life (R. S. Gregory, Clemen, Satterfield, & Stone, 1996; Sadler & Fowler, 2006);
- (2) Students who learn these skills will be learning authentic practices (Brown, Collins, & Duguid, 1989) of our democratic society, and also “moving those practices forward” (Lave & Wenger, 1991). As more and more people learn better skills to be responsible citizens, and model these skills to the next generation, they create and feed a positive cycle of growth.

- (3) Students will be armed with skills that will help them respond to issues in the future (R Beyth-Marom et al., 1987, p. 215; NSTA, 1990).

This last point highlights the idea that the decisions we face now and those that our students will face later are likely different, thus the learning of decision-making skills (e.g. as one form of procedural knowledge) is as important as that of learning science content. Similar to the skill of argumentation (another form of procedural knowledge) discussed by Kuhn (2005), little attention has been paid to the path from making decisions to making decisions *well*. There is not necessarily agreement on how to go about doing this. What is needed, however, is to have teachers go beyond the fact-based model of teaching science. If students are to learn skills, such as EDM, we need teachers to teach those skills. To inform that teaching, there is a need to face the additional challenges which focus in this area inherently involves.

### **Potential Solutions Bring Additional Challenges**

As part of science education, teaching environmental decision-making provides a few areas of challenge compared to traditional science practices. First, as has been mentioned, all decision-making involves values, which can be a challenge in any classroom. Some environment-minded individuals and organizations might believe that explicitly teaching a specific set of values is fine (the Guidelines for Learning of the NAAEE could be construed this way). Others might think it is best to influence values indirectly by providing information (the NSES and AAAS benchmarks could be construed this way). Yet others might strive to help students distinguish but incorporate both values and scientific information in their decision-making (the CASES curriculum

states this). Given these different ideas about how to handle values, the teaching and assessment of students' work in this area is not immediately apparent.

A second challenge in teaching decision-making to adolescents is that adolescents, like the rest of us, have many demands on their time and attention. As such, their minds are inherently limited by “bounded rationality” (Gilovich & Griffin, 2002; Simon, 1957). Bounded rationality refers to the notion that we can only keep so many things active in our minds at one time. Thus, we are limited in how rational we can be. This bounded rationality means that it is much easier to make decisions by using shortcuts, which save time and energy. These shortcuts are commonly known as “heuristics” (Gilovich & Griffin, 2002; Kahneman, Slovic, & Tversky, 1982). Decisions that use heuristics typically happen without the decider being entirely conscious of their own thinking, and can be called “intuitive” decisions (Yates & Tschirhart, 2006). To improve the environmental decision-making of future citizens, we need to help students slow down and deliberate the long-term consequences of their choices, rather than accepting quick, intuitive decisions as the best people can do. Thus, with this work, we are “swimming upstream” a bit because all people tend to use heuristics, and fighting that tendency is difficult. However, I believe I have argued that this is an important effort for both scientific literacy and for the environment. To be clear, I am not arguing for slow, deliberate decision-making across the board, as many of our heuristics serve us well in daily life. However, we are in a unique and original situation whereby our behaviors are having a progressively negative impact on the world. Rather than becoming paralyzed by deliberate thought in all areas, we need to at least become deliberate in some key areas until more updated and appropriate heuristics can become part of our routines.

A third challenge is the role that instruction by teachers with different instructional styles and practices might play in the development of decision-making skills. Certainly teachers will vary in their willingness and ability to teach in ways that support students' work with the interplay of scientific knowledge and values. For example, in Ratcliffe's (2007) study of two teachers explicitly teaching about socio-scientific issues (i.e., those that deal with scientific evidence and individual and social values—like environmental issues), there is evidence that even when teachers have the willingness to address value-laden material with their students, they lack the skills to frame and scaffold students' discussion. So, Ratcliffe argues that we need to provide teachers with the tools to deal with values—such as *decision-making processes* (ibid., p. 130)—so that they are not afraid, so that having “one right answer” is not always expected, and so that students learn how to explicitly incorporate scientific thinking and value-based thinking together in a larger and more authentic application.

Within the discussion of this particular challenge, it is important to acknowledge that there are always differences between an *intended* curriculum, an *implemented* curriculum, and an *attained* curriculum (Gunstone, Corrigan, & Dillon, 2007). The intended curriculum is the collection of lessons (meant as both the set of directions and materials as well as the set of understandings) that the curriculum writers had in mind while writing it. The implemented curriculum is the actual delivery of the intended curriculum by any given teacher. This could differ from the intended curriculum in a myriad of ways: teachers add, delete, and amend curricular materials constantly to fit their own beliefs, style, students, school, etc. Ultimately, the implemented curriculum is experienced by many students, who all have their own filters—including likes, dislikes,

and background knowledge—that affect which parts of the implemented curriculum actually become internalized. It seems logical that the differences between these three types of curricula may be exacerbated in curricula that include values as compared to those that include only scientific information. Teachers’ own values potentially have a large role to play when controversial issues are actively being brought to the forefront of classroom discussion. Although “understandings based on teacher authority are no longer automatically privileged in comparison to other understandings in the science classroom” (Rogers, Erickson, & Gaskell, 2007), teachers play a large role in the implemented and thus, the attained curriculum. The extent to which teachers’ values make a difference in that process is not yet well understood.

Lastly, given that decisions, by definition, offer options which may meet any outcome criteria to various degrees –meaning that there is not necessarily a “right” answer—it cannot be treated the same way that traditional science content has been treated when it comes to assessment. There is a need for new methods of assessment which takes this into account. It may be that by making decision-making an assessable part of the science curriculum, it would become more teachable. I say this due to the current “accountability” structures of education today. Teachers are held accountable for what they teach, and accountability relies on assessment. Thus, one way to potentially encourage the teaching of environmental decision-making in schools, which I have argued is important in this chapter, is to develop assessment methods for it. This is one area relative to environmental decision-making which is underdeveloped in the literature.

To advance the state of art of assessment of environmental decision-making, these areas of discussion lead me to introduce the two main research questions driving my work:

1. Given that organizations and educators have various goals for teaching environmental decision-making, by what methods can it be assessed?
2. How well do these methods work in assessing the environmental decision-making resulting from high-school students' experience with a specific curriculum that has specific goals?

In essence, this research was first concerned with determining sound and flexible methods for the assessment of EDM which could be the beginning of some common language in this area of education and research. Second, this research included a case-study application of these methods to a particular environment- and decision-making-focused high-school science curriculum to see if I could document any changes in the decision-making outcomes. In other words, I used *Investigations in Environmental Science: A Case-Based Approach to the Study of Environmental Science (CASES)*<sup>1</sup> (Edelson, 2005a) to operationalize my assessment methods to investigate their usefulness and sensitivity. Lastly, within the case-study work, I have formulated a sub-question that acknowledges that this decision-making content is different in that it deals with values:

3. Are the decision-making outcomes impacted by the values exemplified by the teachers (keeping in mind differences in classroom management)?

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<sup>1</sup> Published by It's About Time in Armonk, NY in 2005.

Given some of the limitations of the case-study that will be enumerated later, my ability to answer this question definitively is low. I include it because it did contribute to some interesting findings which others might use to launch future studies. However, it should be considered exploratory; which is why I list it separately from the two main questions above.

### **Overview of Methods**

For this study, I developed three methods of EDM assessment. These methods were developed based on the decision-making expertise perspectives discussed by Yates and Tschirhart (2006). The three methods were named as direct descendants of those of Yates and Tschirhart – these are Satisfying Results, Coherence, and Process Decomposition. Discussion of each perspective comes in Chapter 2, and the specific analytical methods relative to each perspective are outlined in Chapter 3, thus I do not detail them here.

To achieve the case study application of these methods, I collected data from students who experienced CASES. CASES is a year-long, reform-oriented curriculum, designed for grades 9-12. Integrated with the science content, students learn the Stakeholder-Consequences Decision-making (SCDM) process (Edelson, Tarnoff, Schwille, Bruozas, & Switzer, 2006), which includes five specific steps to be elaborated on in the next chapter. These steps are: listing constraints and considerations, narrowing options, drawing a “cascading” consequences diagram, analyzing the effects on stakeholders, and making tradeoffs. SCDM is general in its format and so could be used by students throughout their lives, for many types of decisions. In CASES, students use

SCDM multiple times to make recommendations in cases related to land use, energy generation, and water management. With the first unit of CASES serving as the study period as well as the intervention, I pre-tested and post-tested approximately 170 students, divided between two teachers in a large urban high school in the Midwest. Both teachers were first-year users of CASES and were teaching in the same school.

I obtained three classes' worth of data from each teacher which included two open-ended decision-making tasks and a personal environmental values survey. These were administered at the beginning and end of the first unit of CASES. The values survey I used was a previously devised and published survey instrument that will be described in the Methods chapter. The decision-making tasks were developed by me with help from other members of my research group. We developed two tasks; one regarding shoes and one regarding cars. Half the students were asked to respond to one task at pre-testing and the other task at post-testing; vice-versa for the other half of the students. Each scenario included a broad range of information, including a variety of environmental, personal, and social effects of the three options given. I determined changes in decision-making skill three different ways based on the decision-making expertise perspectives already mentioned. Via several classes' worth of video data collected during enactment of the curriculum, I was able to explore the impact of the values exemplified by the teachers and the impact of their classroom management. Although classroom management is not explicitly part of one of my research question, research shows that it can have a large effect on what the students attain (Kempler, Blumenfeld, Geier, & Krajcik, 2008).

## **Potential Implications**

The decision-making assessment research presented here has the potential to support the standards-generating organizations mentioned in the first section of this chapter by giving them specific methodological recommendations to assess the decision making that they urge. From various standards-espousing documents, it appears that the educational organizations in the U.S. may have different goals for teaching decision-making. My research demonstrates three distinct approaches to assess students' environmental decision-making and each may be appropriate depending on the goals people have for teaching it. Relative to the goals which the developers of CASES had for teaching environmental decision-making, the assessment methods I developed showed good measurement sensitivity. Further, because the three methods are independent they can be used in various combinations to match with the goals that other curricula and/or organizations have for teaching environmental decision-making. This methodological exposition is the main contribution that my research makes to the literature in this area. It has the potential to begin the development of common language and methods which may be important as environmental decision-making becomes more critical and more prevalent in educational efforts.

## **Limitations of Study**

Important assessment methods were developed by this work, as just discussed. However, there are a few issues that need to be acknowledged in the case-study. The issues I discuss here originate from one central problem: attrition of teachers. Originally seven teachers—and several hundreds of students—were expected to participate in this

study. Because of teacher (and thus student) attrition over the six-month period of data collection, the statistical power of my results is low. Of the students that remained there was also a great deal of movement among class sections, dropping of the course, or of school altogether, etc. This loss of students from pre- to post-testing limited my ability to glean as much information from the data that I collected because I could only utilize matching pre- and post-tests. Considering that I was looking for changes from pre- to post-testing, I could not use results from students who took a pre-test but not a post-test (or vice-versa).

In addition, with the reduction in teachers from seven to two, the student population was reduced to those attending a single school. The population at this school is largely of Hispanic descent. The personal environmental values of Hispanic adolescents may or may not be representative of American adolescents in general. Thus, generalizations based on my results will not be as strong as I would have liked. More studies with a wider array of student background would be necessary to gain in this respect.

Lastly, “teacher effects” could only be analyzed and discussed in a qualitative fashion rather than a quantitative one, as was planned for the original larger sample. Other methodological issues arose during the dissertation work, and those will be discussed in the appropriate later chapters so that they are contextualized for the reader.

## **Overview of the Dissertation**

This dissertation is divided into four additional chapters that expand on the information included in this introductory chapter. Chapter 2 contains the Theoretical

Background for this research, including important definitions, the distinction between decision-making and its close relation: problem solving; a deeper discussion of values in general and as part of science education; a discussion of the three perspectives about decision-making expertise that are used to assess students; and a detailed discussion of CASES curriculum and its goals. Chapter 3 presents the design of the study, including details about the school context, the students in the case study, and the instruments used for data collection, and the analytical methodologies developed. Results are presented in Chapter 4, followed by a discussion of their implications in Chapter 5. This final chapter suggests several future directions for research related to these issues.

## Chapter 2

### Theoretical Background

In this chapter, I explore the research base so as to lay the groundwork for this study more deeply than in the introductory chapter. I delve into more detail regarding decision-making and values—clarifying what these ideas both are and are not in the context of my study. I also describe in detail the *Investigations in Environmental Science: A Case-Based Approach to the Study of Environmental Science (CASES)* curriculum that includes both decision-making and values as focus material through its case study applications of the science content. Other curricula that focus on these constructs provide points of comparison. In addition, I explain the reasons why decision-making is challenging to teach and to assess. Lastly, I describe the three perspectives on decision-making expertise which I developed into the assessment methods and utilized for the case study.

#### **Decision-making: What It Is and What It Isn't**

Acknowledging that decision-making and problem-solving are both important citizenship skills (Kuhn, 2005), it is worth distinguishing them from one another.

Although the two are often equated or confused, my research concerns decision-making specifically. According to Klein (1999),

[s]ome prefer to treat problem solving as a subclass of decision-making (called upon when the person needs to formulate a new course of action). Some prefer to see decision-making as a subclass of problem solving (called upon when the person has to compare several courses of action). There is more overlap than difference (p. 141).

Other thoughts on this issue include Wheeler (1991) and Beyth-Marom, Fischhoff, Quadrel, & Furby (1991), who suggest that in problem solving people seek one correct solution, whereas in decision-making, multiple alternatives may meet the outcome criteria to differing degrees. This distinction is made clear by our cultural definition of a problem as a puzzle (Wheeler, 1991), where puzzles generally have one right solution. In contrast, decisions usually contain one or more options to choose among. Thus, attending to trade-offs (or numerical weighting in cases where probabilities are known<sup>2</sup>) between possible solutions is a necessary step in the decision-making process; with problem solving, once the solution is found, the process ends.

The following example illustrates the difference between decision-making and problem solving, and shows that the two processes may work in tandem—perhaps contributing to some of the confusion between the two. Suppose that a woman moves to a new city and is having trouble finding her way around to buy groceries, mail letters, and get to work. Problem solving would lead her to buy a road map of the new city as a solution. But when she arrives at the store, she discovers that there are many kinds of city maps. Some maps show the “big picture” of the city without much detail; some show key

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<sup>2</sup> This condition is known as decision-making under certainty. However, in this study, I only deal with decision-making under uncertainty or where such probabilities are not introduced. Instead of mathematical probabilities, personal values are used to weigh alternatives as exemplified by the Stakeholder-Consequences Decision-Making process.

areas such as the downtown and airport; and others focus on biking routes or historical features. Now she must make a decision: which map to buy? To determine the best choice, she must clarify her priorities and weigh the various features of each map against those priorities. What she values in a map will help her determine which map is the best one for her to buy. This example highlights two things: first, there is one solution to the problem (obtain a map), while there are multiple options to decide among (which map?). Second, a person's values become involved in decision-making, while they may not in problem solving.

Both decision-making and problem solving are important forms of “critical thinking” (Wheeler, 1991, p. 309) and can be considered different *psychological* processes. In much of the *educational* literature, however, problem solving and decision-making are used as examples of critical thinking skills without much differentiation between the two. Thus, in my writing I include citations from individuals who use both terms, unless it is very clear that problem-solving is being used to talk about finding the (singular) solution.

Now that decision-making has been distinguished from problem solving, it is important to explore a few variations in how people think and talk about it specifically. “Everyone knows what decision-making is” writes Gregory, et al (1996). These authors use this statement to somewhat sarcastically illustrate that many people “know” what it is, but that it is actually not very easy to articulate. In a number of the articles and curricula I read, it was never defined explicitly. With more probing of the text I could find implicit definitions such as “making smart choices” (Hammond, 1999, p. xi) or the slightly more detailed, “choosing an action based on some goal(s) that is used as a

criterion to evaluate different possibilities” (R. Gregory, 1991, p. 276). These two definitions highlight the fact that in making a decision, one is choosing among alternatives based on some criteria. There are numerous others whose implicit definition of decision-making mirrors these (see for example, R Beyth-Marom et al., 1987; NSTA, 1997; Snyder, Dockterman, & Lewbel, 1991). A slightly different angle is given by Gonzalez (2001), who describes decision-making as “a process which connects a particular situation to a course of action” (p. 365). This definition highlights that there is a process involved in making decisions and that by following the process, one can respond to situations in life. Several other definitions include the idea that someone’s interests are at stake. For example, Gregory, et al. (1996) describe “think[ing] through your options and improve[ing] your chances of satisfying your goals and concerns” (p. 1). Here the “stakes” of importance are those of the reader. Yates & Tschirhart (2006) expand on this by stating clearly that decision-making is “a commitment to a course of action that is intended to yield results that are satisfying for specified individuals” (p. 422). Thus, rather than just having the decision maker’s “stake” in mind, this definition widens the possible circle of influence of any decision.

I have chosen to work with this last definition for two reasons. First, because I find it to be the most complete in terms of combining the key aspects of the others (even though it does not explicitly state that choices must be made, one can imagine that “a course of action” needs to be selected from among several possible courses). Second, because these same authors provide the three perspectives on determining expertise in decision-making that I utilized to develop the assessment methods in this study, this

definition leads to a smooth transition into the assessment of decision-making that will be of major emphasis in this study.

### **Environmental Decision-Making**

The research that I completed is not focused on decision-making in general; it focused on decision-making relative to the environment. I call this Environmental Decision-Making or EDM. One way to distinguish this type of decision-making is that in the Yates and Tschirhart definition given above, one “specified individual” could be the environment itself. Another way to state this is that, as with other types of decisions, “critical thinking about environmental issues involves the ability to combine factual and values information and, where appropriate, to structure a situation as a decision problem and recognize that an opportunity exists to choose among alternative actions” (Gregory, 1991, as cited in Fortner, Arvai, Froschauer, & Malinowski, 2003).

As mentioned in the introductory chapter, humans make the majority of our decisions in an “intuitive” way. In other words, our decision-making process tends to be unconscious, relying on **heuristics** so as to be efficient (Yates & Tschirhart, 2006). Another way to picture intuitive decisions is that they occur as an interpretation of a “gut reaction” and the justification of that reaction with whatever ideas are on hand to do so (Adams & Feehrer, 1991; Laskey & Campbell, 1991). Rather than looking at evidence on many sides of a decision, intuitive decision-makers decide without much awareness, control or insight (Yates & Tschirhart, 2006). Further, if justification of a decision is requested, intuitive decision-makers tend to rely heavily on moral reasoning (Bell & Lederman, 2003; Grace & Ratcliffe, 2002; Sadler & Zeidler, 2004) rather than on

scientific evidence. Ross (1981) would consider this attachment to the most immediate alternative to be at the lowest of five levels of decision-making.

When we look at how this plays out relative to everyday decisions that affect the environment, it is my belief that the heuristics we Americans commonly employ have been handed down from generation to generation and seem out of date or inappropriate at this point in time. These heuristics might include ideas such as, “more is better,” “bigger is better,” and “there is always more where that came from.” Gardner & Stern (1996) outline these and other beliefs as part of the Western worldview, and I assert that they act as heuristics in many of our current intuitive decisions. These particular time- and energy-saving ideas have become problematic in that the combined effects of many people using them to buy more and bigger items without thinking about the consequences include multiple and significant forms of environmental degradation. Moving away from using these heuristics requires that people slow down and use more analytic forms of decision-making. Analytic decision-making requires effort and is necessary “when the situation is unfamiliar” (Yates & Tschirhart, 2006, p. 430). While many of us might think that our decisions occur in familiar situations, I would argue that decision-making in a world where global climate change and other issues with long-term and widespread impact loom is not actually familiar to us as individuals or as a nation. We have lived as if the consequences of our actions are insignificant or don’t make a difference for far too long. We must come to see that analytic decision-making, in which the consequences of our actions are taken into serious consideration (among other things) is a necessary step toward better global outcomes. This type of decision, where multiple options and their

varied effects on stakeholders (including the environment) are considered, is what I have termed Environmental Decision-making (EDM).

### **Environmental Science Curricula with Decision-making as Focus**

Many authors espouse the explicit teaching of decision-making skills to adolescents. Specifically, Baron & Brown (1991) believe that this important skill should be taught in content areas such as science and history, among others. Sadler & Fowler (2006) and Beyth-Marom (1987) would agree that contextualization of decision-making learning is critical. They espouse that students who learn decision-making within a subject area will be much more able to use it later than those who learn it in a separate, context-independent course. This idea is replicated in Bransford and Schwartz's (2001) discussion of Preparation for Future Learning (PFL), where it is considered to be particularly important for people to learn how to integrate knowledge gained from various traditional school subjects, religion, and real-life experiences.

Coming back to environmental issues in the context of science class however, "strategies for engaging science students in the analysis of issues are not well established in science teaching" (NSTA, 1990, p. 4). Since the National Science Teachers Association published that statement in their curriculum Decisions Based on Science, there has been quite a bit of work accomplished. In the intervening 20 years, numerous curricula have been developed that contain decision-making as a significant component. For example, see Beyth-Marom, Fischhoff, Quadrel & Furby (1991), Dockterman, Snyder, & Lewbel (1990), Edelson (2005a), Fortner, Arvai, Froshauer & Malinowski (2003), Gregory, Clemen, Satterfield, & Stone (1996), Johansen & Harris (2000), and Science

Education for Public Understanding Program (SEPUP, 1995). Most of these curricula outline a particular process for making decisions. Although they vary in terminology and sequence, these processes commonly include the following components for the student/decider: clarification of the issue, definition of relevant dimensions to determine alternative options, and weighing of alternatives to achieve the best outcome.

My case-study focused on a process called Stakeholder-Consequences Decision-Making (SCDM) (Edelson et al., 2006) which is an integral part of *Investigations in Environmental Science: A Case-Based Approach to the Study of Environmental Systems* (CASES) (Edelson, 2005a). CASES is a case-based, high-school environmental science curriculum. It consists of three units that are intended to span a whole school year. These units focus on land use, energy generation, and water management. In each unit, students are presented with dilemmas that exist based on the tension between a growing human population and limited resources. Students learn science content (covering national standards and benchmarks) that helps them make their decisions in the complex cases. In addition to the science content, students also learn the SCDM process and are given the opportunity to use it multiple times. As mentioned briefly in the Introduction, SCDM includes the following steps:

- I. Establishing *constraints and considerations*....where constraints are essential outcomes [needs] while considerations are desired outcomes [wants].
- II. Narrowing *options* based on the constraints and considerations.
- III. Identifying *consequences* ...using a diagram to map out chains of causes and effects stemming from a particular option.
- IV. Assessing impacts on *stakeholders*...which can be people, other organisms, and even inanimate objects.

- V. Weighing impacts on stakeholders and making *tradeoffs*...based on the decision makers' values (Edelson, 2006, p. 40).

The SCDM process, as mentioned before, is similar to other decision-making processes prescribed for students by various curricula. However, it is important and useful to understand how SCDM maps on to a wider view of what decision-making entails. For this purpose, I utilized the ten “Cardinal Decision Issues” that are originally outlined by Yates (2003). These cardinal issues are described as the ten fundamental issues which “in some form or another, almost every practical decision problem poses” (ibid, p. 12). These are summarized in Table 1, below.

Issue	Description
Need	Why are we (not) deciding anything at all?
Mode	Who (or what) will make this decision, and how will they approach that task?
Investment	What kinds and amounts of resources will be invested in the process of making this decision?
Options	What are the different actions we could potentially take to deal with this problem we have?
Possibilities	What are the various things that could potentially happen if we took that action – things they care about?
Judgment	Which of the things that they care about actually would happen if we took that action?
Value	How much would they really care – positively or negatively –if that in fact happened?
Tradeoffs	All of our prospective actions have both strengths and weaknesses. So how should we make the tradeoffs that are required to settle on the action we will actually pursue?
Acceptability	How can we get them to agree to this decision and this decision procedure?
Implementation	That’s what we decided to do. Now, how can we get it done, or can we get it done, after all?

**Table 1: The Ten Cardinal Decision Issues (Table 1.1 in Yates, 2003, p.13)**

The first three issues (Need through Investment) together form the “Preliminaries” to making a decision; the middle five issues (Options through Tradeoffs) are the “Core”; and the last two (Acceptability and Implementation) are the “Aftermath” (Yates & Tschirhart, 2006, p. 428).

To compare SCDM and other high-school curricular decision-making processes to this list of cardinal issues, I created the table shown in Appendix A (too large to be imbedded here in the text). The column headings are the ten cardinal issues (with one exception), and the rows are the various curricula with decision-making process prescriptions. The columnar exception is the “Pre-Options” or seventh column from the left. I added this column because all of the curricula I reviewed prescribed a step that seemed not to be included as a cardinal issue. I call it “Pre-Options”. SCDM is a good example, whereby students are asked to describe their “Constraints” and “Considerations” (loosely translated as “needs” and “wants”, per Step I. on the previous pages) before generating a list of “Options.”

The decision-making curricula I reviewed have been divided into two general categories, which are delineated in the first column on the left (again, see Appendix A). There were two main “Focus” categories that seemed useful: “General” curricula or those that were not contextualized by any particular subject matter, and “Environmental,” which were contextualized by environment-related subject matter. Each step outlined by a curriculum is matched as well as possible to the cardinal issues. Note that these process steps may be given in a curriculum in a different order than those laid out in the cardinal issues. Some curricular process steps may also represent the thinking in more than one cardinal issue. Thus, the boxes have been expanded to indicate the overlap. Blank spaces in the table indicate that the Decision Moniker (e.g., acronym) or Cardinal Issue was not addressed as part of the given curriculum identified.

I will now identify a few important points that I gleaned from comparing these curricula to the Cardinal Issues outlined by Yates and Tschirart (2006) in this way (again,

see Appendix A for a visual summary of how the various curricula “map” onto the cardinal issues):

- Only two of the “General” curricula and none of the “Environmental” curricula addressed either the Need or Mode preliminaries.
- Two of the “General” curricula addressed the “Mode” preliminary.
- The bulk of the decision-making steps addressed in all of the curricula fall into the “Core” area identified by Yates and Tschirhart (2006).
- Three “General” curricula and one “Environmental” curriculum addressed the “Acceptability” cardinal issue.
- One of each type of curriculum addressed the “Implementation” cardinal issue.
- All three of the “Environmental” curricula focus their attention on the “Core” section of the cardinal issues.
- Of the “Environmental” curricula, only SCDM explicitly deals with the “Value” cardinal issue.
- Of the “Environmental” curricula, only SCDM extends some effort into the “Acceptability” cardinal issue.
- Of the “Environmental” curricula, only that by Tom Snyder Productions (Snyder et al., 1991) extends into the “Implementation” cardinal issue.

Thus, as I stated earlier, SCDM is similar to many of the other environmentally-focused decision-making processes prescribed as part of a science curriculum. One important difference may be the explicit handling of values, as just noted. SCDM explicitly encourages students to use their values to make tradeoffs between various outcomes, whereas other curricula do not do this explicitly.

Additional advantages of CASES and of SCDM as compared to these others include that the curriculum is designed to be a year-long experience. Schwartz, Bransford, & Sears (2005) explain that when encouraging the development of expertise,

long-term learning processes are beneficial. Further, students learn about and practice SCDM in widely varying scenarios, both as individuals and in groups. These aspects of CASES might enhance the changes that are seen with students learning and applying sound decision-making practice, as compared to other curricula. After a more thorough discussion of values, more specifics about how students are introduced to and practice the SCDM steps are discussed.

## Values

Given that decision-making involves values, as has been mentioned, and that SCDM provides a unique opportunity for students to explicitly apply their values (per the third to the last bullet point above), it is worth delving more deeply into values and especially environmental values. The definition of values that I have most utilized in my thinking is that of Halstead (1996): “the principles, fundamental convictions, ideals, standards, or life stances which act as general guides or points of reference in decision-making or the evaluation of beliefs or actions and which are closely connected to personal integrity and personal identity” (p.5). In essence, values express what is important to a person and come into play when evaluating various courses of action. However, Halstead’s definition is not the only definition in the literature, and others are worth looking at so as to more clearly delineate my work. Rennie (2007) states that there is no single agreed upon definition, “[h]owever, it is undisputed that values are linked to beliefs and attitudes and guide our behavior” (p. 197). This brings to bear one other specific definition that I will discuss because some readers may have questions or concerns about the distinction among values, attitudes, and beliefs. While those three

words may conjure the same essential idea, in the field of psychology they tend to be distinguished from one another.

According to Glenn (1980), attitude is simply the “evaluation of an object” (p. 597), where an object can be a material thing, people, categories, organizations, ideas, etc. Defined in this way, it is somewhat difficult to distinguish values from attitudes, considering that *evaluation* is itself used in the definition. However, Glenn clarifies that it might be useful to think of values as a special case of attitudes; one where the object is highly abstract or general. Using the environment to exemplify a highly abstract or general object, we could think of our values about the environment as a whole and our attitude about trees in the backyard. To include beliefs in the discussion (which Webster’s defines as “the acceptance of something as true” and as “an opinion; expectation; judgment”), Glenn provides this example:

Value: Personal freedom is good.  
Belief: The law enhances personal freedom.  
Attitude: The law is good.

With this example, it is easy to see that the three ideas of values, attitudes, and beliefs are certainly related, almost to a confusing degree.

I have chosen to work with the term “values” in my research and writing because it seems to be most appropriate when talking about “the environment” in general terms (e.g., from Glenn above) and when looking at how it plays out in decision-making. This latter point is important, as it moves the argument from a theoretical platform to an operational one. Essentially, in performing the operation of making a decision, people

must at some point distinguish what they value more and value less in order to choose between options. Additionally, all of the curricula that I am familiar with that address this type of mental construct as a part of decision-making use the term values in their materials rather than beliefs or attitudes. (See R. S. Gregory et al., 1996; Hungerford, Volk, Ramsey, Litherland, & Peyton, 2003; NSTA, 1990.; Snyder et al., 1991) For these reasons, I have chosen to use values as opposed to attitudes or beliefs. Further, I have specifically focused on the subset of a person's values—those relating to the environment. They are the guiding principles that people use in making decisions relative to interactions with the environment. I will call these Personal Environmental Values or PEV, though I most often simply use “values” for ease of writing and reading.

Bixler, Floyd, & Hammitt (2002), Chawla (1998), Gardner & Stern (1996), and Kempton, and Boster & Hartley (1995) have looked at the origin of people's environmental values and find that there are many bases for personal environmental values. These include time spent outdoors, parents or other role models, teachers or classes, witnessing the loss or degradation of a valued place, religious teachings, care for our descendants, utilitarianism, aesthetics, and feelings of oneness with nature. Additionally, “A person's values are most influenced by the ‘microsystem,’ which is comprised of the immediate social net—family, neighbors, peer-groups, etc.” (Kollmus & Agyeman, 2002, p. 251). Schreiner & Sjoberg (2007) widen this influence to the general culture: “young people's values....are products of the culture in which they are growing up” (2007, p. 242). Given that our culture's awareness has been changing since the 1970's and several large environmental catastrophes such as the Exxon-Valdez oil spill

and Chernobyl explosion, our societal environmental values and thus our individual environmental values are not necessarily fixed.

Thus, one question that arises in this discussion is whether secondary students' values are malleable. Glenn (1980) writes, "that young people tend to change and that older people are less likely to change is a part of the folk wisdom that most people would never challenge" (p. 602). This is corroborated by Gardner and Stern's (1996) discussion that values are hard to change in adults. But, what is the line between younger people and older people; or those with malleable values and those with stable values? When do values stabilize? One suggestion that Glenn makes is that people's values are developed by their accumulated experience. Thus, when a person is growing quickly and frequently having new experiences, their values might change a great deal. Once a person settles into a particular location, occupation, and way of life, they experience fewer new things on a regular basis, and their values tend to become less challenged. In fact, their values are likely to become more reinforced by the decisions they have made as they settle into neighborhoods, groups, and organizations that share their values.

Although high-school students are nearing adulthood, and the point at which their ideas may stabilize, most are still at a point of exposure to new ideas through school. We might assume that their values are still somewhat malleable. However, most have also likely been exposed to certain consistent experiences that have provided 15-18 years worth of messages about what to value. These messages come through parents, but also through the culture in which the student lives (Schreiner & Sjoberg, 2007). Thus, in my estimation, the high-school age group seems to fall in a questionable place on the continuum between "younger people" and "older people." Thus, a minor aspect of this

research is to discern whether high school students' values relative to the environment are still in a malleable state or whether they have stabilized. In the next section, I describe the case-study curriculum and its goals for teaching environmental decision-making.

### **Decision-making and Values in CASES**

CASES was developed at Northwestern University in Evanston, IL over a period of years, and went through extensive review by education experts as well as science experts. It also underwent extensive pilot testing, and revision with input from teachers. A graduate student in the learning sciences devised SCDM as scaffolding for students as they worked on the cases in the curriculum (Tarnoff, 2001). Three units comprise the curriculum. The first unit focuses on land use, the second unit focuses on electricity generation and the third on water resources management.

What sets CASES apart from other curricula with a similar focus is its integration of several innovative pieces in the curricular design. Specifically, it offers contextualization of all science studied and integration of technology through modeling of earth processes and manipulation of authentic GIS-based data. An example of the contextualization is the presentation and study of the concept of food webs. Food webs are examined in detail in the context of the Land Use unit and the effect that building a school building on the site would have on the plants and animals already present. An example of the use of authentic data is the study of human population in the U.S. and how it has changed over time. This study is accomplished with the use of a software program called My World GIS, also developed at Northwestern University as part of the GEODE Initiative (Edelson, 2006). In addition, CASES emphasizes learning and

applying content understanding and skills in the context of authentic cases, which comes from the Learning-for-Use design framework (Edelson, 2001). Each case contains a project-based scenario to which the students apply SCDM; thus, decision-making runs as a strand throughout the curriculum. Finally, the curriculum encourages the social construction of knowledge—through group decision-making projects—which provides social interaction and is thus one of the most powerful ways for people to learn (Vygotsky, 1978).

Relative to decision-making, CASES has three inter-related goals for students: 1) to participate openly and respectfully in debates about both scientific policy controversies in environmental science; 2) to distinguish between the role of scientific evidence and values in making decisions; and 3) to be systematic about taking into account the impacts of a decision (Edelson, 2005b, p. xii). The SCDM process which has been outlined earlier in this chapter gives an indication of how CASES attempts to achieve that goal. Essentially, the SCDM process provides a structure for combining students' thoughts which are drawn from the science content and those which are drawn from the students' life experience and personal values. Next I will describe how the first unit of CASES, focusing on land use and also introducing the SCDM process, scaffolds the learning of that structure.

On the first day, students are given a letter that introduces a school in Florida that needs to expand because of an increasing student population. They also are given a map of the land and three building “footprint” cutouts to place on the map (see Appendices B1 and B2 for this letter and map, respectively). The map shows a small river going across one corner of the site as well as multiple burrows for a population of gopher tortoises that

lives on the land. The footprints represent the academic, extra-curricular activity, and parking spaces needed for the school. Thus, the students are faced with balancing the needs of a growing human population with those of another species. They can locate the buildings based on whatever ideas they have, and upon arriving at a decision are asked to glue their buildings to the map to record their thinking. In this task, teachers ask students to make a decision but provide little guidance on how to do so, which provides a powerful point of comparison for the end of the unit. After gluing down their buildings, students are asked what additional information they wish they had had in making their decisions. With their questions as lead-in, the teacher introduces the rest of the chapters in the unit. These are: Populations, Resources, and Ecosystems.

The Populations chapter provides the context for the students' first experience with SCDM. They are introduced to a fictitious woman, Anna, who is trying to decide whether to have one, two, or three children. Anna explicitly walks the students through each step of her "Sample Decision" (Edelson, 2005a, Student Edition p. 54-61). Each step is explained with the SCDM terminology, and the students are in the role of observers or witnesses to her process. A second time students see SCDM, they have moved on to the Resources chapter. They are asked to use the technique themselves for a "Protein Dilemma" (p. 120-134). The decision involves what type of diet to follow, recognizing that ingesting protein is an important criterion. Students are highly scaffolded<sup>3</sup> (Bransford, Brown, & Cocking, 1999) in the process at this stage, and use information from their own life situations to work with SCDM. They list their own constraints and considerations, brainstorm their own three options for protein intake,

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<sup>3</sup> Scaffolding, in education, refers to supporting the students to do more than they could on their own. Over time, the scaffolding is slowly removed and students should be able to perform the skill without it.

create “cascading” consequence charts (see Appendix C for an example from Anna’s decision about children) and stakeholder charts (see Appendix D, also from Anna’s decision) for each of those three options. To conclude, they decide what types of foods they will eat to meet their protein and other requirements. At the end of the unit, as a culminating project, students come full circle to re-make the building location decision for the school, this time working in groups.

In working with SCDM, the parts of the process which I believe are most germane to the goal of structuring the combination of scientific information and values are the Consequences and Tradeoff steps. In the consequences step they graphically lay out the potential chain of events from having chosen a given option. From there they look at who is affected in this chain of events, and finally they decide for themselves, based on their own value system what consequences and stakeholders they value most and least. They make tradeoffs between these in order to make their final choice.

This gives a brief description of the *intended* CASES curriculum that provides the case study opportunity for me to operationalize my methods of assessing environmental decision-making skills. Another area of research in the case study is the implemented curriculum, which acknowledges that teachers play a role in the *attained*—and thus, the assessed—curriculum. I will discuss the importance of the teachers’ role before I more fully describe the challenge of assessment in the area of students’ decision-making.

### **Instruction by Different Teachers Plays a Role**

The intended curriculum is only one part of the attained curriculum; teachers have a large influence on how the curriculum is experienced by students. Therefore, my

research also looked at how certain aspects of instruction may affect student decision-making. This look at potential “teacher effects” was also a way by which I could determine some basic legitimacy of the assessment methods, given that differences in teachers are always expected and perhaps more so given the nature of this curriculum—namely, its inclusion of material which doesn’t fit the “one right answer” version of science. In the case of teaching SCDM—and other similarly focused curricula—science teachers must go beyond their traditional role “that focuses on explaining and ‘transmitting’ the canon of established scientific knowledge” (Ratcliffe, 2007, p. 124). Teaching non-traditional and challenging material may often feel more difficult and threatening for teachers. Some of the many challenges include: modeling what we want students to be able to do, accepting students’ independence, dealing with ambiguity, and explicitly acknowledging a variety of student values.

First, in order for students to gain decision-making expertise, teachers must be able to model the skill (Mann, Harmoni, & Power, 1991) for their students. Second, they need to be willing to “accept the greater independence and questioning of authority that invariably accompanies the growth of students’ decision-making skills and confidence” (Mann et al., 1991, p. 73). Third, for the decisions introduced in the curriculum there are no “correct” answers. The focus is more on the process and justification used in achieving an answer than on the answer itself. Last, the students might express values that the teacher doesn’t agree with. As much as science education in the past attempted to be value-free, teachers as humans are never free of values. Whether science teachers can manage varying value systems in their classrooms will relate to how much conflict they can accept in their own minds (Hildebrand, 2007).

In fact, the teachers' "worldview" can be an important variable when it comes to instruction. "In school, students are exposed to a variety of different worldviews reflected in science curricula, or texts, in the science education reform efforts....or in an individual teachers' worldview" (Lynch, 2000, p. 69). One way that this presents itself in classrooms is that teachers may vary in their ability and willingness to teach the curriculum as it is intended. Their own biases or values may creep into the classroom, with or without their awareness. This is one of several common issues when introducing reform-oriented curriculum into traditional schools and subjects (Schneider, Krajcik, & Blumenfeld, 2005). To reflect the potential of this as an extremely important influence on the attained curriculum, my research also attempted to identify the values that teachers exemplify in their teaching to determine if it influenced the students' attained curriculum. This is one aspect of the "teacher effect" at which I looked, and more detail on this is provided in the next chapter.

In addition, it has been shown that classroom management plays a large role in the attained curriculum. It is considered a highly important foundation, setting the stage for student learning (Kempster et al., 2008). Without good classroom management, students may not actually be effectively exposed to the curriculum. Thus, this is the other aspect of "teacher effect" which I explored. It is not specific to decision-making, values, or any particular curriculum, but needs to be part of the analysis so that the student results are interpreted in context of this foundation.

## Teaching Means Assessing

We live in a time with high alignment between the mandated standards, curricula taught in schools, and the tests students take. Thus, it is important to recognize that teaching EDM to students is only one aspect in a suite of concerns that needs to be addressed if we hope to improve students' citizenship skills and the environment around us. We also need to be able to assess EDM so that proof of progress toward the educational standards listed in the introductory chapter can be attained. One place to look for guidance on this is the other environment-focused curricula for high school students already discussed. How do they recommend assessment of EDM?

The Tom Snyder Decisions, Decisions curriculum (Snyder et al., 1991) recommends looking mainly at whether the students themselves were satisfied with their decision. In the teachers' edition, it is described that students receive a score based on how well they achieved their (four) goals. However, this seems inadequate to me, given that there are many potential stakeholders in any environmental decision (including the environment). Also, it seems that the skills that students used to reach their decision should be taken into account as well.

Decision-making for The Great Lakes (Fortner et al., 2003), is an online curriculum comprised of 14 different issue-related lessons. Each lesson contains recommendations for the evaluation of students within its "Teacher Pages." One lesson (Who Owns the Water of the Great Lakes) recommends looking only at student participation during the lesson. Another lesson (How can we revive the Lake Erie "Dead Zone?") recommends mainly looking at students' content knowledge about nutrient dead

zones. A third (Cormorant Management) recommends evaluating students on their ability to justify their position with scientific information. The recommendation for assessment of these first two lessons does not really touch decision-making skills at all, as “participation” is not defined, but left up to the teacher. The last one seems to encourage the use of the “intuitive” decision-making process previously mentioned whereby the decision is made without a particularly explicit or conscious process and then is justified with whatever evidence can be found. Specifically, it is recommended that the teacher examines “students’ ability to support their position with the scientific data and information found within the websites” (see Teacher Page).

Laskey and Campbell (1991) describe a thorough set of analysis as to the effectiveness of the GOOP (Goals, Options, Outcomes, Probabilities) decision-making process, which includes numerical probabilities rather than values for weighing trade-offs. Although intended for intermediate school students rather than high school, their methods seem much more rigorous than the two examples just described. They use two forms of a pre-test/post-test that are given in a “balanced” design. However, because they are looking at decision-making under certainty, the tasks they use for assessment are not completely open-ended. They score students on both their qualitative analysis and their numerical analysis. For the qualitative analysis, they report having analyzed students’ ability to (a) Construct own analysis of a decision; (b) Analyze decision using a GOOP chart; (c) Think of arguments against own view; (d) List outcomes (pros and cons); and (e) Distinguish goals from options. However, there is no rubric available to understand exactly what they looked for and scored in each of these areas, despite the fact that statistical significance of gain in each of these areas is reported. For the quantitative

analysis, they are able to assess whether students conducted the numerical analyses correctly to obtain the right answer.

If we are to move forward the understanding and instruction of high school students' decision-making skill in general, and EDM more specifically, I think it is important to work toward common language and methodology in the assessment of it. Doing so will allow more discussion and comparison across curricula and research efforts. The shortcomings and inconsistencies found in the research literature impelled me to explore other assessment perspectives and methods. If educators are going to invest time and energy into teaching decision-making, there ought to be better descriptions of what it is and what changes might be expected over time and with instruction. We need to move beyond general terms such as “good” and “informed” decisions (Manzo, 2005), “better” decisions (Arvai et al., 2004), and “defensible” decisions (R. Gregory, 1991), and be explicit about what we want students to be able to do. This desired explicitness is part of my motivation to look for other approaches.

### **Three Perspectives on Decision-Making Expertise**

With several goals in mind, including the explicitness just mentioned as well as the flexibility that was touched on in the first chapter given the multiple possible goals that educators/organizations have for teaching decision-making, I sought for resources and ideas outside of the field of education. Given that decision-making is a psychological process, I found and utilized the three perspectives on decision-making expertise discussed by Yates & Tschirhart (2006). This move was an important one in that it grounded my decision-making assessment work in a field outside of education, and

specifically the field in which much of the decision-making research has been conducted. In their work, Yates and Tschirhart attempt to identify, explain, and provide direction for the development of decision-making expertise. Related to these questions, if only implicitly, is the question about how to measure or assess decision-making expertise. Their hypothesis is that neither of the two common perspectives—Satisfying Results and Coherence—regarding this task is perfect, so they propose a third: Process Decomposition. I decided to utilize all three, as they each potentially provided a unique way to look at EDM of high-school students. I wanted to see whether these might provide better ways to think about the development of decision-making skills for high-school students. The three perspectives are Satisfying Results, Coherence, and Process-Decomposition. I elaborate on the meaning of each one in turn.

**Satisfying Results.** To begin, I reiterate the definition of decision-making discussed in Chapter 2 for reference: “a commitment to a course of action that is intended to yield results that are satisfying for specified individuals” (Yates & Tschirhart, 2006, p. 422). The Satisfying Results perspective simply requires the determination of whether the “specified individuals” experience satisfaction, given the chosen “course of action.” This would be the perspective utilized by the Decisions, Decisions (Snyder et al., 1991) curriculum mentioned in the last section, for example. They recommend evaluating students based on their own satisfaction with the results. However, in the context of EDM in the school setting, there are other potentially important “specified individuals.” We could also consider the teacher, as a representative of the larger educational and cultural institution. And, as such, there are several potential approaches that a teacher of environment-related material could take that become important in this discussion.

Teaching regarding the environment could be looked at as teaching *in* the environment (e.g., traditional outdoor education), teaching *about* the environment (traditional environmental science education) and teaching *for* the environment (traditional environmental education) (Lucas, 1979). My study does not consider education *in* the environment because there is no outdoor component explicitly recommended by the curriculum. However, EDM seems to overlap the goals of traditional **environmental science education**—whereby students are taught the scientific processes at work in the natural world (e.g., *about* the environment) —and traditional **environmental education**—whereby students are taught to respect and care about the environment (e.g., *for* the environment). In this case, it would seem that Satisfying Results could also be measured by looking at the results as they affect the environment. This bypasses the teacher as a “specified individual” and brings the focus directly on the area of concern introduced in the first chapter: the environment. Although not an “individual” in the normal sense of the word, the environment is certainly a stakeholder of great importance in EDM. To be clear, affecting students’ choices in a particular way relative to the environment was not a goal of CASES.

**Coherence.** The second perspective that Yates and Tschirart (2006) discuss is that of “Coherence.” “Procedures are ‘logically coherent’ if they do not contradict themselves” (Yates & Tschirhart, 2006, p. 424). I interpret this perspective in the context of EDM to mean that students’ personal environmental values and their choices are coherent or in alignment with one another. For example, to be coherent, a student who describes him or herself to be environmentally minded would choose an option that would be least damaging to the environment (assuming they have all the available

information). Likewise, a student who isn't environmentally minded would choose an option that may be more damaging to the environment. Knapp (1983) looks at this as a demonstration of the highest level of value development, whereby, "...a person's values are consistent with one another, internalized, and determine individual behaviors" (p. 25). This coherence was an implicit goal of CASES (Edelson, 2008, personal communication).

**Process Decomposition.** The third perspective, which is the authors' proposed alternative given their perceived shortcomings of the other two, is called Process Decomposition. Process Decomposition supposes that if a decision-making process can be partitioned into steps, and if each step is performed well, then the overall decision should be of higher quality. In other words, any step performed well may indicate a greater likelihood of a good decision. The authors propose that this perspective may in fact be the most practical. This is because any decision process can be decomposed into its components or steps in a number of different ways. Further, if an individual does not perform a given step well, that would direct the way in terms of working to improve their skill. I used this Process Decomposition perspective to make my work more focused and efficient. Specifically, I chose to focus my attention on one key step of the SCDM process from CASES.

Specifically, I chose to focus on the students' discussion of consequences (step III out of the five outlined on page 26 of this chapter). Per the discussion on the very first page of this dissertation, consequences are one of the most important aspects of making germane decisions in today's world. Kollmus & Agyeman (2002) citing Ajzen & Fishbein (1980, p. 239) state that "the beliefs concerning its consequences" are one of the

ultimate determinants of any behavior. Further, having the ability to take into account the long-term or indirect consequences of our decisions is one aspect of decision-making that can be used to separate novices from experts (Yates, personal communication).

I used these three perspectives—Satisfying Results, Coherence, and Process Decomposition—to develop three independent analytical methods for assessing high-school students’ environmental decision-making. The specific scoring and analytical methods are elaborated on in the upcoming Methods chapter.

## **Chapter Summary**

This chapter summarizes existing research and curricular developments related to high school students’ environment related decision-making skills. We know that most people make decisions intuitively rather than analytically, and that this may be one cause of many environmental issues. We also know that explicit practice with EDM is likely required if students are to improve their skills. It has also been shown that the assessment of EDM has not been grounded in common language or techniques. This is likely due to the fact that teaching decision-making in schools is a relatively new phenomenon. If this teaching is going to continue, then we ought to better understand what it is that we seek to accomplish. The curricula that I analyzed vary in the recommendations they make regarding assessment. In order to move the teaching and learning of EDM forward, we need to also move the assessment of it forward. This was the main focus in this research, and I outlined three perspectives which were to be transformed into analytical methods for doing so. These methods were developed in tandem with the study of CASES and SCDM, but the intention is that they would be flexible so as to be useful by others.

## **Chapter 3**

### **Research Design**

In this chapter, I accomplish two things. In the first half, I outline the decisions that were made in designing the study so as to best answer the research questions. In the second half, I outline the research methods in detail, including specific analytical techniques for interpretation of the data. Where appropriate, I report “raw” data or preliminary results in so far as they informed further analytical techniques.

#### **Design Rationale**

To achieve the goals I had set out in the last chapter, there were several specific needs that I had relative to processes, data collection instruments, and data collection opportunities. The following are listed in no certain procedural order: First, I needed to transform the three decision-making perspectives into three corresponding analytical techniques. Second, I needed a case study curriculum with which to operationalize these methods. Third, I needed a group of students whom I would have the opportunity to test relative to that case study curriculum. Fourth, I needed tests which I could administer before and after the curriculum intervention and which would yield information on the choices students were making and the process they were using to make their choices. This latter need stems from the idea that the sensitivity of the assessment methods could

be established by their ability to detect *changes* in students' decision-making abilities. Lastly, given that one of the techniques also involves values, I also needed information about students' personal environmental values at both pre- and post-testing times.

Most of these needs were met through my involvement with the developers of the high-school Environmental Science curriculum which has been mentioned, CASES. The developers of CASES were just becoming involved with a project to study the effectiveness of online teacher professional development, called the Impact of Online Professional Development (IOPD). This study became my "ship of opportunity"—as they say in Oceanography—to access students and teachers using the CASES curriculum. I mention this here, because with this opportunity there also came a few constraints which appear throughout the rest of the dissertation. The important piece of information at this point is that through IOPD, I had access to students who were experiencing a science curriculum that explicitly taught environmental decision-making.

IOPD was designed to last three years and to look at the relative costs and benefits of three conditions of professional development. The three conditions included traditional face-to-face professional development lasting one week, facilitated online professional development, and un-facilitated online professional development. The online conditions were designed to be preceded by a sixteen-hour, face-to-face component as well and then the online workshops and chat-rooms were made available throughout the school year. During the 2006-2007 school year, the IOPD project was in its pilot year and thus offered only the facilitated online condition. There were no selection criteria for teachers to participate in the study other than their willingness. At this point, I will describe the process of devising the decision-making tasks I used for

pre- and post-testing the students in my study. Following that, I will describe the process I used to find a suitable instrument for measuring the students' environmental values. The last section I describe, before moving on to the specific methodology, is my thinking relative to answering the third research question about the impact of teachers' values.

### **Devising Decision-making Tasks for Pre- and Post-testing**

To evaluate the decision-making skills of students, and the changes in those skills, I needed an instrument that I could use for testing before and after the CASES instruction. According to Parker and Fischhoff (2005), assessing skill in decision-making is best accomplished with open-ended tasks. Thus, the CASES research group and I designed tasks that would require each student to not only make a decision, but express why and how they made it. Further, the decisions we created and utilized for this purpose were seemingly common decisions, which are important to study, as according to Gardner & Stern (1996) "in order for people to express their pro-environmental attitudes in actual behavior, they must pay attention to environmental issues in their everyday lives" (ibid, p. 85). The research group had already devised two decision-making "scenarios" for the general purpose of assessing students' decision-making skills, but it had not been piloted or used prior to my joining the group.

These two scenarios were focused on the recommendation to a friend regarding buying a new car, and the recommendation to a city planner regarding new housing development. One of my first projects upon joining the research group was to examine the student pilot-test results of these decision-making scenarios. Neither scenario was directly related to a decision, or to content, encountered in the curriculum. This is consistent with Stiggins, Arter, Chappuis, and Chappuis (2006) statement that "...to

assess reasoning, the question has to be novel. If students worked on the answer to the question during instruction, then the answer is a piece of remembered knowledge, which does not require reasoning” (p. 103). In other words, as Laskey and Campbell (Laskey & Campbell, 1991) state, this measures “transfer of skills to new situations” (p. 131). Furthermore, students were not given hints or instructions to use any particular process while they did the task. These design decisions were purposeful, in order for me to determine if students would spontaneously use the SCDM process.

In both tasks, the students were asked to make a recommendation involving others rather than having the scenario represent an entirely personal issue. We thought this might encourage students to be more conscious in analyzing the scenarios (e.g., not relying on intuitive decision-making). In the car-buying task, the field of choices consists of three types of cars: a sports car, a hybrid, and a sport-utility vehicle (SUV). Students were given information about a “friend” to whom they will make the car recommendation as well as information about the cars, such as performance characteristics and environmental impacts. In the house-building task, students were asked to make recommendations to a town council considering several options for increased demand. Options included new townhomes, re-using warehouse spaces, and an eco-village outside of town. These two tasks were piloted during the 2005-2006 school year.

The pilot study was completed with one class at a public high school in a large Midwestern city. Racial demographics of this school in the 2002-2003 school year (most recent data available at that time) included 21% Black, 74% Hispanic, 5% White, and less than 1% Native American. Data from the pilot included 12 females, 5 of whom were Hispanic, 6 were Black, and 1 was White. The students had not had any specific

decision-making training as part of the class before being given the pre-test. The pre-/post-tests were given as bookends to the first of the three units that comprise the curriculum (Land Use—the same unit of CASES that comprised the instruction in the present study). Half of the students were administered the car scenario at pre- and post-testing, while the other half were administered the house scenario at both times.

Two results of the pilot-testing indicated that I should consider changing the research design of further studies. First, a number of students, for the post-test, wrote something to the effect of “I already did this...,” or “I would put the same as before.” These students seemed to be expressing that they remembered the scenario from having taken it before and felt that spending time on it again would be boring or a waste of time. And even the students who did write meaningful answers on the post-test tended to write only about half as much on the post-test as compared to the pre-test. Thus, students may not have shown improvement from pre- to post-testing because they were not writing as much as they were thinking, rather than because their thinking had not changed. This indicated that a balanced design, whereby students use one scenario at pre-test and a different (in content) but equivalent (in design) task at post-test, might work better. Thus, for the present study I had students switch scenarios from pre-testing to post-testing – what I will call “balanced” test design. This strategy was also used by Laskey & Campbell (1991) in their study of the GOOP decision-making process.

Second, the results we obtained for the car scenario seemed much more robust and authentic than for the housing scenario. Students wrote more and their writing indicated more engagement when talking about cars than housing options. I decided that this likely stemmed from the fact that a car-related decision would be a more realistic,

exciting, and imminent decision for this age group as compared to a house-related decision. Most American high school students are dreaming about their first car, whereas housing decisions are too remote for their concerns.

So, I decided that I needed to use two scenarios that were equally as imminent and engaging in order to maximize how much students wrote and therefore how much data I would have. This led me to design a new scenario. It involved the purchase of shoes for an entire student body at a school moving to school-wide uniforms. In this shoe-buying task, the students were presented with a situation in which their school is going to adopt a school uniform. They were asked to make a choice between three types of shoes that could be purchased at a reduced price if bought through the school—a leather tennis shoe, a styled synthetic shoe, and a canvas cross-trainer. In the scenario, all students would have to wear this same shoe to school and school-related events. The thinking was that shoes and cars are both items with a lot of “emotional charge” for high school students, there are many different options for both, and these different options include a wide variety of ecological impacts based on materials, production, re-use possibilities, etc. The car and shoe scenarios are included in their entirety in Appendices E1 and E2, respectively. For the scenarios, the students answer the following questions:

1. Which car (shoe) would you choose?
2. How would you convince your friend (or the school administration) that this is the best choice?
3. What steps did you take in making your decision?

Half of the students were given the car scenario at pre-testing, and half the shoe scenario. At post-testing, the groups were switched. Thus, the research design for looking at decision-making skills included giving students two common and real-life scenarios with a balanced design approach (alternating scenarios from pre- to post-test). And, even though the tasks had been designed to mirror one another and I did some of the analysis with the combined results, I also completed some parts of the analysis separately for the two tasks. This provided information on whether the students treated the tasks equivalently, by looking at whether students' choices actually mirrored each other for the two tasks. In other words, it provided information on whether students decided the same re: environmental friendliness for cars and for shoes.

### **Finding Personal Environmental Values Instrument for Pre- and Post-testing**

As stated earlier, for the Coherence perspective, I needed to be able to evaluate students' personal environmental values at two different time points (i.e., before and after instruction of CASES), and then look for changes. Thus, I searched for instruments that have been used to study individual's environment-related values. There are vast amounts of research into the acquisition and characterization of individual's environmental values. A number of instruments are available that allow the study of this important mental construct (see for example, R. E. Dunlap, van Liere, Mertig, & Jones, 2000; Gagnon Thompson & Barton, 1994; Meyers, 2002). I considered several instruments, and chose the New Ecological Paradigm (NEP) by Dunlap, van Liere, Mertig, & Jones (2000).

This instrument is a revised version of the New Environmental Paradigm (also NEP) developed in the 1970's (Dunlap and VanLiere, 1978). The 1978 version had been

found to have high internal consistency (Cronbach's alpha) of 0.81 (R. Dunlap & Van Liere, 1978), and had subsequently been used in many research efforts. It focuses on assessing three main areas: "beliefs about humanity's ability to upset the balance of nature, the existence of limits to growth for human societies, and humanity's right to rule over the rest of nature" (R. Dunlap & Van Liere, 1978). Revisions included in the later version include tapping a wider range of ecological worldview aspects, balancing the ratio of pro- and anti-NEP items, and avoiding outmoded terminology (R. E. Dunlap et al., 2000).

I found several features to be useful about this particular scale. First, I found the wording of the measures to be straightforward, which would make it more feasible for high school students; this was not true of all the instruments I considered. Second, its length was not cumbersome or too intrusive for use in school class periods, as compared to one instrument that included several hundred items. Third, because the survey had been widely used, many others had given the authors feedback on it (see Rideout, Hushen, McGinty, Perkins, & Tate, 2005 for a thorough review). This feedback directly impacted the changes made to create the 2000 version. In short, the NEP scale is user-friendly and thus frequently used for the purpose of measuring environmental values.

Some more background includes that the paradigm represented by the NEP is set in comparison to what the authors term the Dominant Social Paradigm (DSP). The DSP is the worldview inherent to our American culture. It under-girds everything in our culture, and as such is rarely questioned. The DSP in America has been handed down from generation to generation since the inception of the country and includes a strong focus on individuality, frontierism, and conquering nature (Lynch, 2000). And,

according to Gardner and Stern (1996), in recent years the DSP has evolved to include “belief in ample resource reserves, high technological progress and solutions, consumerism, and national/centralized community (ibid, p. 53). (See Dunlap and van Liere (1984) for more of their original discussion of the DSP.) With increasing attention to environmental problems, some people have questioned the DSP, looking for an alternative way of thinking. Dunlap & van Liere called this alternative the New Environmental Paradigm (NEP). Their survey was designed to place people’s values on a continuum between the DSP and the NEP.

The 19 items found in Appendix F include the 15 NEP items (R. E. Dunlap et al., 2000) plus four additional items recommended by Cordano, Welcomer, & Scherer (2003). With its focus, user-friendly design, and history, this survey showed promise for measuring the personal environmental values of the students in my study. However, all of the studies I read that utilized the NEP scale used it as a "snapshot" of individual's values; thus my use of it to detect *changes* in PEV may be a first.

### **Looking at Impact of Values Exemplified by the Teachers**

Relative to teachers’ values, although the evaluation of the teachers’ PEV could be interesting, I decided it was actually not the most important variable to measure. What was important was how those values might influence the instruction itself (e.g., the implemented curriculum). I decided to measure the values reflected in the instruction by looking at decision-related examples given by the teacher during instruction. The values implicitly or explicitly demonstrated to the students are the ones that matter most in influencing the curriculum attained by them, not the values that the teacher says that they hold by filling out a survey.

As was mentioned earlier, relative to instruction, I also felt it was important to determine and include some information about the teachers' classroom management. This is not an aspect of SCDM in particular, but it has been shown to have significant and positive influence on student achievement gains (Kempler et al., 2008). While a teacher may be very good at representing and using SCDM, if the classroom is noisy and only a handful of students in the front of the room are able to hear her, this may influence the results we obtain on student work.

To remain as unobtrusive as possible, these two sources of data regarding instruction were both based on five videotaped class sessions. The teachers were asked to videotape these sessions themselves as part of their participation in the IOPD study. Fellow members of the IOPD project team and I selected the set of lessons to be videotaped based on our various research needs, and each teacher videotaped the same set. The specific lessons we requested are outlined in Table 2, next page. The first video was a practice video—not focused on any SCDM-related material—after which an IOPD team member gave the teacher feedback to improve the quality of video capture. The other four videos were analyzed in more detail for this study, as will be outlined in the Methods section. Although not the ideal set for my study, I gleaned what I could from them.

Lesson <sup>4</sup>	Essential Question/	SCDM-related Focus
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<sup>4</sup> These include the **Chapter**, Lesson Number, and *Lesson Title*

	<b>Big Idea</b>	
<b>New School 1a:</b> <i>Overcrowded?</i> and New School 1b: <i>Using Land Well</i>	What does the problem at Central High have to do with the environment?	Introduction: Students become aware of their role as decision makers in this case.
<b>Resources 3b:</b> <i>Rainfall distribution</i>	Do most people on the Earth live in areas with lots of rain? Why might this be important?	None – computer and data-based activity
<b>Resources 4b:</b> <i>Protein Dilemma Constraints and Considerations</i>	What are three acceptable options for combinations of food that will provide you with enough dietary protein?	The first two steps of SCDM: -Constraints and Considerations -Options
<b>Resources 4d:</b> <i>Stakeholders</i>	For each option in my decision, do the positive effects outweigh the negative?	-Consequences -Stakeholders
<b>Ecosystems 2a:</b> <i>Food Chains</i>	How many food chains can exist in one Florida Upland community?	Ecological Community, habitat, trophic niche.

**Table 2: Lessons Teachers Videotaped**

Although not directly related to answering this research question at first glance, I was also privy to another piece of data related to these two teachers. In the early winter of 2007, an IOPD team member conducted interviews of the two teachers in the study. I was present for both interviews, but was not the interviewer. Questions focused on dealing with students’ values in the classroom, understanding the decision-making process, and the teachers’ role in this type of curriculum. In the Results chapter, I reveal a few particularly relevant excerpts from the interviews that help frame some of the differences found between the two teachers.

### **Summary of Design Rationale**

To aid in summarizing this section, it is important to note that some of the decisions I made were proactive decisions, directly in service of answering the research questions and part of the plan from the beginning. However, other decisions described were of a more reactive nature, in that I was trying to do the best I could under less-than-ideal circumstances that arose from teacher attrition in the study and other unforeseen

circumstances. Some of the latter, while unfortunate, were important enough to mention here and also in the Limitations section, which is found at the end of this chapter. At this point, I can't help but invoke the words of N.L. Gage (1978), "so far as I know, the invulnerable piece of research in any field of the behavioural sciences is non-existent...And the problems of doing research in the schools may in any case undo [the research worker's] sophistication" (p. 233).

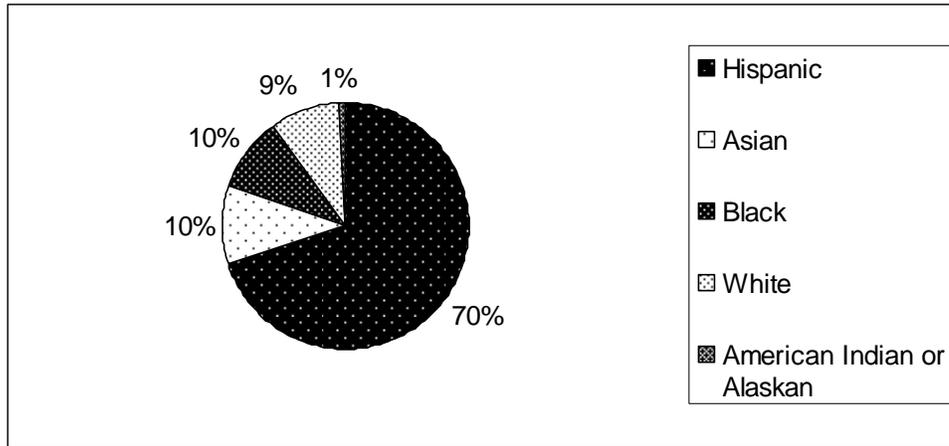
## **Methods**

At this point, the process I describe for answering the three research questions merges. What I mean is that the work I completed to develop the three assessment methods based on the Yates and Tschirhart (2006) expertise perspectives was entirely dependent on having a curriculum to study (e.g. CASES) and student pre- and post-test data to analyze which came from real-life classrooms with real-life teachers. Thus, in this section, I will first describe the school, teachers, and students I accessed for this work and then I will describe the analytical processes developed using that data for each decision-making perspective in turn.

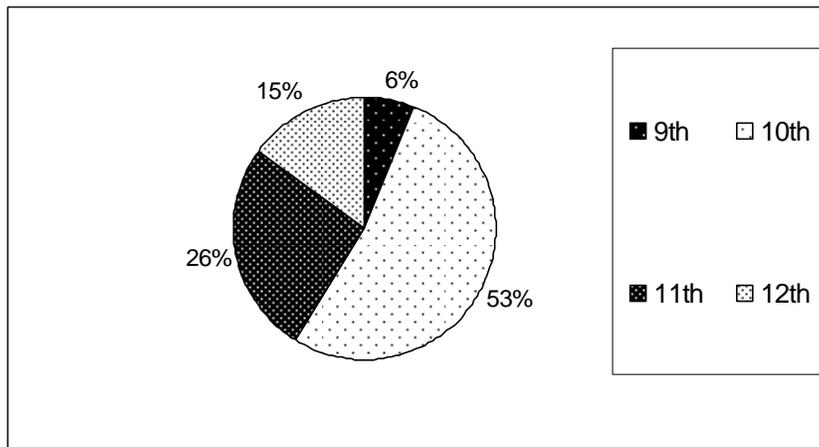
### **Subjects and Context**

This study was accomplished with approximately 170 students, distributed among 6 classes of two teachers in a large, urban high school in the Midwest. The school population consisted of approximately 1660 students total; 91% of the students were

economically disadvantaged, and 22% were English Language Learners<sup>5</sup>. The study sample was 60% female, with additional racial and grade-level demographics shown in Figures 1.a. and 1.b., below.



**Figure 1.a. Racial Demographics of Student Sample**



**Figure 1.b. Grade Levels of Student Sample**

Both of the participating teachers were new to this CASES curriculum in the 2006-2007 year and were part of the IOPD project, as mentioned earlier in this chapter. “Mara” and “Kristin.” Mara, an East Indian, had been teaching for six years prior to this study, and Kristin, an African American, for one and a half years. Neither of them had

<sup>5</sup> School data reported for most recent year available, 2006, and were found at: <http://research.cps.k12.il.us/cps/accountweb/>.

previous experience with the CASES curriculum nor with teaching decision-making. Participation in the IOPD online workshops was low for Mara and Kristin; however, both expressed enthusiasm for the curriculum throughout the year.

### **Data Collection and Analysis for Each Decision-making Perspective**

\*\*An important note on procedure: To maximize the amount of students' exposure to CASES and thus their practice with SCDM and the potential for growth/change in their decision-making skills, it would have been ideal to administer the post-tests at the end of the entire year, rather than after just the first unit of CASES. However, as first time users of this curriculum it was predicted based on previous experience (Edelson, 2006, personal communication) that the teachers would likely not finish more than Unit 1 and part of Unit 2 during the year. The culminating decision-making project in Unit 2 does not come until its end, and even if teachers got that far by the end of the school year, testing at the end of the school year does not usually produce reliable results given the myriad of other conflicting activities and distractions at that time (Edelson, personal communication). Thus, covering only Unit 1 for the study seemed the optimal choice in that it served to equate as much as possible student exposure to the curriculum across different classes. Thus, all students experienced exactly the same amount of CASES (Unit 1: Land Use) at the time of post-testing. Furthermore, all student-related data collection instruments to be described in this section were given to students by their teachers over a two-day period at both time points. At pre-test time, the decision-making scenarios were distributed among the students (car vs. shoe) randomly by the teachers. Then, at post-test time those who took the car scenario

at pre-test, took the shoe scenario and vice-versa. The values instrument was identical at both testing points.

### Satisfying Results

For this perspective, I simply recorded the choice (car or shoe) that each student made. This is the answer to Question 1 on the decision-making task as described on page 52 in this chapter, so I looked in the space on the test given for this question, and recorded the answer. There were six possible choices; SUV, sports car, hybrid car; and leather tennis shoe, styled synthetic shoe, or organic canvas cross trainer. I then tallied the number of students making each choice at each of the two testing points. This “raw” data, *for only the 79 students who completed this task at both pre- and post-testing times*, can be found in Table 4, below.

Choice (n = 79)	Number of Students Selecting Choice at Pre- test	Number of Students Selecting Choice at Post- test
SUV	8	15
Sports Car	5	3
Hybrid Car	26	24
Leather Tennis Shoe	30	17
Styled Synthetic Shoe	4	9
Organic Canvas Cross Trainer	6	11

**Table 3: Raw Data for Choices on Car and Shoe Tasks**

I analyzed this data in several different ways. First, I looked at the changes from pre- to post-testing with the two tasks treated equally. This “equality” means that because the two different tasks (i.e., car and shoe) had been designed to mirror one another, I combined the choices from the tasks that represented the least environmentally-friendly

options with each other (e.g., LOW = leather tennis shoes and SUV), the most environmentally-friendly options with each other (HIGH = canvas cross-trainer and hybrid car), and the medium options with each other (MEDIUM = synthetic styled shoe and sports car). At this point, I calculated a change in the percentage of students selecting the LOW, MEDIUM, and HIGH options. Following this analysis, I determined the percentage changes from pre- to post-testing for the car scenario and the shoe scenario independently. I then also repeated the separate car and shoe scenario analysis for the student subgroups representing Mara's students and for Kristin's students. Thus, in the Results chapter for this section, there are seven tables to compare and contrast.

### **Coherence**

In order to analyze the students' coherence, or the match between their choices they made on the decision-making tasks and their values, I utilized the Satisfying Results or choices data as just described above. To this I added the personal environmental values information gleaned from the NEP survey instrument described in the first half of this chapter. It was completed by the students at both pre- and post-testing times, so that any changes in value could be determined. And, given the previous explanation of coherence, at each time point I looked for a match between students' values (Closer to DSP, Middle, or Closer to NEP) and the choice that they made in terms of its relative degree of environmental "friendliness." At this point, I describe my use of the NEP survey in detail.

On the NEP, each of the 19 NEP survey items invited a response on a Likert-type scale with options of Strongly Agree, Mildly Agree, Unsure, Mildly Disagree, and Strongly Disagree. Some of the 19 items were reversed in directionality (e.g., odd

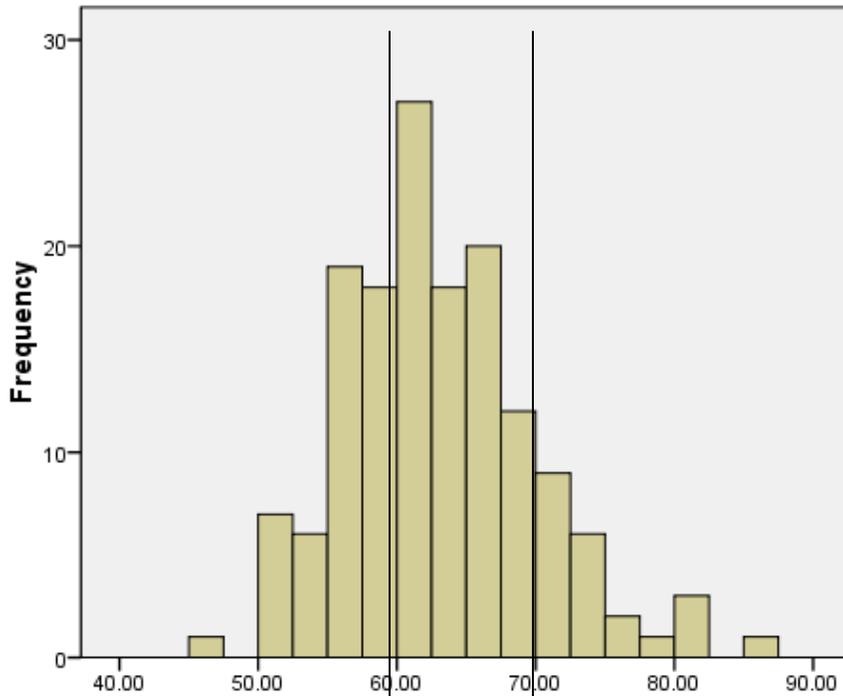
numbered items answered with Strongly Agree would indicate someone aligned with the NEP and even numbered items answered with Strongly Agree would indicate someone aligned with the DSP) by the instrument's authors, so that people need to pay attention while answering each item rather than falling into a pattern. When this is taken into account and a total score created by assigning scores of 1-5 (5 being assigned to Strongly Agree for the odd numbered items, 4 for Mildly Agree, etc.) to the responses listed above and summing them, low scores on the NEP represent people who are more closely aligned with the DSP and are less pro-environmental. People with higher scores on the NEP represent people who more closely aligned with the NEP and are more pro-environmental.

The NEP surveys were scored mechanically. Only students with 80% of the items (15) or more were used for analysis. Items that these students failed to answer were given a score of 3 (unsure). This assignment did not influence the scores of students based on the reversal above, because 3 or "Unsure" does not get reversed given the odd number of Likert options. Purposefully, this assignment ensured that these students did not appear to score closer to the low end of the scale than they would have had these unanswered items been left as 0's.

Given the survey set-up, the possible range of values scores is 19-95. The low end of this range would be attained by a student who answers 1 for all of the odd numbered items and 5 for all of the even numbered items (which then get reversed to 1's), and would represent someone with values very much aligned to the DSP. The high end of this range would be attained by a student who answers 5 for all of the odd numbered items and 1 for all of the even numbered items (which then get reversed to

5's), and would represent someone with values very much aligned to the NEP. The middle of the range, namely 57, would represent a person who answered all 3's (unsure), although this score could also be attained in a multitude of other ways.

Besides looking at the overall sample, I also devised three subgroups of students to “track” through the Coherence analysis. I also wanted to observe whether difference subgroups had a different pattern of change in values. These three groups were theoretical only, and I assigned individuals into groups based on the total NEP values score at the beginning of the study. Looking at the distribution of values in the entire group (see Figure 2, next page), I broke the students into a “Closer to DSP” group consisting of students with the lowest total scores on the NEP survey, a “Closer to NEP” group consisting of students with the highest total scores on the NEP survey, and a “Middle” group consisting of students in between these two more extreme groups. The vertical lines in the Figure represent the approximate division of the three groups. The pre-test NEP score summary is shown in Table 4, also on the next page.



**Figure 2: Histogram of NEP Scores at Pre-test**

	Sample Size (overall n=142)	Minimum	Maximum	Mean
Personal Environmental Values (pre-test)	142	47	85	62.71
Closer to DSP Group	48	47	59	55.98
Middle Group	72	60	69	64.03
Closer to NEP Group	22	70	85	74.32

**Table 4: NEP Scores at Pre-test Time**

I pursued exploratory factor analysis on the scores for the whole sample, as suggested by the authors of the NEP survey, to determine if the survey can be treated as a uni-dimensional scale or whether there might be multiple dimensions to people's values. However, this process yielded no identifiable factors, which is confirmed by the fact that I found no bi-variate inter-item correlations larger than 0.4. In addition, the reliability of

the results as measured by Cronbach's alpha is low, at 0.47. These results are quite different from what had been reported for previous use of the NEP instrument. Although prior results have found that the items load onto varying number of factors or "dimensions"—from one to four such dimensions (R. E. Dunlap et al., 2000, p. 430)—the authors note that this is likely a sample-specific issue. Further, they state that, "[i]f substantively meaningful dimensions do not emerge, however, and the entire set of items (or at least a majority of them) are found to produce an internally consistent measure, then we recommend treating the NEP Scale as a single variable" (ibid, p. 431).

This is the advice that I heeded, considering that as I continued with my analysis, there were results based on the NEP scores that seemed to be worthy of further pursuit. However, the failure of the results to load onto any number of factors was unexpected. This may indicate that there was a great deal of measurement error on the part of these high school respondents (e.g., not really paying attention to what the question was asking or just wanting to get through the task by responding without much thought). Another possibility is that it could be explained by cultural differences. My student sample had a large percentage of Hispanics, which may introduce unknown bias into the result. And, the NEP studies that I read all used adult samples, not youth. I discuss these issues further in the "Limitations" section later in this chapter.

Treating the NEP Scale as a single variable, as just discussed, once each students' score was tallied for both the pre-test and post-test, I calculated the change in their personal environmental values. I determined the average change in PEV for the entire group and for the three subgroups listed above. At a different stage of analysis, I also divided the students into subgroups based on whether they had Mara or Kristin as their

teacher. I did not do any analysis by class, as this would have yielded sub-sample sizes that would be too small to obtain any statistical powerful results. I determined all of the numerical results mentioned above (mean start value score, mean end value score, and mean change in values) for these various subgroups of students.

Getting back to Coherence, I calculated the percentage of students selecting each choice, but did this independently for each of the three beginning values subgroups. I thus created a 3x3 matrix where the cells represent the percentage of students of a given value subgroup selecting a given outcome. I created such 3x3 matrices for the pre-test time period and the post-test time period so I could determine if, overall, the coherence of the students changed. In addition, I created these same types of matrices separately for the students of the two different teachers. On the next page is a theoretical version of this matrix (see Figure 3, below). It provides a point of comparison for the actual results reported in Chapter 4.

<b>Values Group</b>	<b>Choice</b>		
	<b>1 (SUV or Leather Tennis Shoes)</b>	<b>2 (Sports Car or Styled Synthetic Shoe)</b>	<b>3 (Hybrid Car or Organic Canvas Cross Trainers)</b>
Closer to DSP	High %	Medium %	Low %
Middle	Medium %	Medium %	Medium %
Closer to NEP	Low %	Medium %	High %

**Figure 3: Theoretical Coherence Values**

The salient points from this figure include the following:

- The Closer to DSP group’s selections should lean toward the least environmentally friendly option (e.g., the SUV and the Leather Tennis Shoe). In other words, a high percentage of students with these values should select Choice 1.

- The Closer to NEP group’s selections should lean heavily toward the most environmentally friendly option (e.g., the Hybrid and the Organic Canvas Cross Trainers). In other words, a high percentage of students with these values should select Choice 3.
- The Middle group’s selections should be fairly balanced between the most and the least environmentally friendly options.
- With strict adherence to SCDM, no one should select Choice 2. Given the **constraints** in the tasks (specifically, in the car scenario, the “friend’s” family—a total of five people—plan to use the car for road trips; and in the shoe scenario the shoe needs to be general purpose, including being used during gym class), this choice should really be eliminated as a viable option. However, these statements might have been interpreted as **considerations** (conditions that would ideally be met) by some students, and as constraints by others (conditions that must be met). Students who interpreted the statements as considerations would be justified in selecting Choice 2. Students who interpreted them as constraints would not.
- Given that the values results do not span the entire 19-95 range of the NEP as described above (e.g., the “Closer to DSP” group actually contains 57, the exact middle value of the possible values of the NEP, with the “Middle” and “Closer to NEP” groups both squarely in the top half of the possible range), the theoretical coherence values do not read 100-0-0; 50-0-50; 0-0-100. This would be the ideal picture of coherence if the value results did actually span the entire possible NEP range, and if all students adhered to the definition of constraints and considerations per the previous bullet point.

To calculate statistical significance for the changes from pre- to post-test for coherence, I assumed that the *pre-test* percentages (e.g., the 3X3 matrix) represented the “expected” distribution and that the *post-test* percentages represented the “observed” distribution. This decision essentially treated the pre-test percentages as those that we would expect without any instruction, and the post-test percentages as those we observe with instruction. The Chi-square statistic was then calculated by using the summation of  $(\text{Observed}-\text{Expected})^2/\text{Expected}$ , and the p-values obtained from a Chi-Square table with two degrees of freedom.

## Process Decomposition

This perspective, as discussed earlier, considers that if a person performs the individual steps of a decision-making process well, each of those performances contributes to the likelihood of a higher quality decision. I used this perspective and for the sake of efficiency chose to focus on one key step within the SCDM process. As mentioned on page 45 of Chapter 2, I chose to focus on students' consequential thinking (e.g. the third step of SCDM: Consequences). In addition to the "theoretical" reasons I gave at that point, I also took into account some "practical" reasons based on my experience with SCDM itself. These include:

1. It did not make sense to choose the Options step (or any step before it) because in the testing scenarios, students were already provided the choices of three different shoes or three different vehicles, rather than having to develop the options themselves. Thus, the Consequences step was the first step where students would actually be able to demonstrate their own thinking.
2. I eliminated the "Tradeoffs" step as a focus for analysis because it would place me in a position whereby I was making judgments about students' values, which I wanted to avoid doing.
3. Lastly, the "Stakeholders" step and the "Consequences" step are deeply intertwined (looking at the impacts on certain stakeholders is essentially looking at consequences in a more specified manner; with the "consequences for who" identified clearly in the Stakeholder step). Between the two, I chose the "Consequences" step, as it seemed to more cleanly allow me to analyze student writing. Essentially, I could look for statements that exemplified "if X... then Y" thinking.

I acquired the data for this perspective from the students' answers to Questions 2 and 3: "How would you convince your friend (or the school administration) that this is the best choice?" and "What steps did you take in making your decision?" I began the analysis of consequential thinking by breaking students' answers into separate thoughts called "idea units" (Jacobs & Morita, 2002). An idea unit expresses a singular idea, but

may or may not coincide with normal sentence structure. Although Question 2 asked students the reasoning behind their final decision and Question 3 asked them to explain how they arrived at their decision, there was a great deal of variation in where students gave what information. Many students muddled discussion of those two requests into Questions 2 and 3. Thus, I ignored this question division in the scoring. Instead, I used whatever they wrote, regardless of where they wrote it. In each idea unit, I looked for student writing that demonstrated consequential thinking—the kind of thinking that would finish a sentence that starts, “**If** I were to buy this car (or these shoes), **then** \_\_\_\_\_.” An example from the student work is, “I would convince her that the Hybrid is the good car because it is a good car because it was [has] room for her and her friends.” (Words in [ ] are corrections to students’ writing/spelling to aid in understanding.)

In analyzing all students’ writing that was interpreted as this kind of statement, I looked for two things: (1) which option the consequences statement dealt with, and (2) whether they demonstrated thought about “cascading”<sup>6</sup> consequences. Then, by looking at the students’ answer in total, I considered whether the sum total of statements considered one option only, or more than one option. The consideration of more than one option is an important distinction between the analytic decision-making that is SCDM as compared to intuitive decision-making, where the decider almost without thinking determines their choice and then can usually only articulate support of this choice. I also looked for the type of consequences based on the “cascading” idea that is taught in CASES. This refers to the idea that there are direct consequences of choosing an option,

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<sup>6</sup> This is the language of the curriculum. “Cascading” gets at the idea of direct consequences followed by indirect consequences.

and that those consequences can have consequences, etc. Thus, I searched for indirect or “cascading” consequences in the student writing. Specifically, I looked for consequences that were written in ways that indicated that students were describing consequences given in the scenario in this way (and were logical) and/or mentioning consequences not given in the scenario that would actually be indirect consequences of those in the scenario.

Putting these two ideas together, I created a coding scheme that assigned students a score from 1-4, depending on how they discussed consequences in their answers to Questions 2 and 3. Figure 4, on the next page, shows on the horizontal axis that I considered the discussion of more than one option to indicate higher decision-making skill than the discussion of only one option. It also shows on the vertical axis that I considered the discussion of indirect consequences to indicate higher decision-making skill than the discussion of direct consequences. Thus, the weakest decision-makers (Level 1 in coding scheme) would discuss only *direct* consequences for *one* option. The strongest (Level 4) would discuss *more than one* option and would include *indirect* consequences. To order the scores for the two middle possibilities, I took into consideration the fact that three options were given in the scenario and as such required little independent thinking on the part of the student. However, identifying indirect consequences (even if they were given in the scenario, but would need to be articulated as indirect) required more independent thinking. Thus, a Level 2 would include consequence-related thinking characterized by discussing *more than one* option with only *direct* consequences and a Level 3 would include *one* option but with *indirect* consequences.

		SCORE	
		One	More than One
CONSEQUENCES	Indirect	2	4
	Direct	1	3
		# OPTIONS DISCUSSED	

Figure 4. Coding Scheme for Consequential Thinking

Table 5, on the next page, includes four examples of students' writing, and their scores based on this rubric. The choice made is indicated in parentheses at the beginning of the example. The "/" indicates the break between "idea units." I scored all students answers, with the help of someone whom I trained<sup>7</sup>, using this same coding scheme. We coded independently and achieved an initial inter-rater reliability (IRR) of approximately 86%. We discussed all answers on which we disagreed until agreement was reached or until we agreed to disagree. Thus, final IRR was 97%.

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<sup>7</sup> I thank Marcia McDade for her Herculean efforts.

Student Writing	Score	Score Justification based on Rubric
(Styled Synthetic Shoes) I would tell them its cheap / and the foot specialist thinks its excellent / 1. I would recommend that the school will by [buy] styled synthetic shoes. 2. It costs less / the ergonomic rating by foot specialist is excellent / comfort is good also. / 3. I just look at the chart and made my decision.	1	-All of the students' statements that indicate "consequence" type thinking are direct consequences. There are no "consequences of consequences" demonstrated here. -The student only discusses the option that they chose.
(Hybrid) She pays less, / it weights less, / rating safety is 10, / and its pretty comfortable./ The car looks pretty nice / <b>and is rated a 10 for safety for her family's safety when their [they're] taking road trips.</b> / I just decided on what seemed more reliable / and had better option not just for her but for her family too. / <b>And the Hybrid can run longer without needed gas all the time.</b> / <b>So, it will get you further without having to go by a gas station having to get gas.</b>	2	-There is at least one statement that indicates indirect consequences. See bolded sections: first, the hybrid has a safety rating of 10 (direct consequence of buying the hybrid) and thus the family will be safer when they are on road trips (consequence of having a higher safety rating); second, the hybrid can run longer on a tank of gas (direct consequence of buying hybrid) and thus you don't have to buy gas as often (consequence of running longer on a tank of gas). -The student only discusses the option that they chose.
(Hybrid) I would convince her that he Hybrid is the good car because it is a good car because it was [has] room for her and her friends / and it would good for her family trips, / and because she has little brothers the safety rating is high. / and this is how I would convince my friend to buy this car. / The steps I took to reach my decision was 1 <sup>st</sup> I look at how many people could fit in the car / and the sports car only holds two people. / So she could [couldn't] got that one / Then I looked at the miles per gallon, and hybrid had 60 in the city / and she does a lot of driving / and the hybrid do not cost that much and that is how I made my decision.	3	-All of the students' statements that indicate "consequence" type thinking are direct consequences. There are no "consequences of consequences" demonstrated here. -The student discusses more than one option: the hybrid and the sports car.
(Leather Tennis Shoes) I think they should purchase leather tennis shoes because everyone would like the style. / Even doe [though] they would cost \$35.00. / it a 9 comfort rating from 1-10. / so it would fit them comfortable. / It will last them two years / and the Ergonomic rating by foot specialist is good. / It's athletic performance is 7.0 and that's pretty high. <b>I also like the fact that they are white so they can go with any uniform.</b> / other shoe's such as the styled synthetic and Canvas Cross Trainer, are not as comfortable / and don't last that long. / students might not like that style / that's why I think we should get the Leather Tennis. / I went over the information on the shoe's / and set aside the goods from the bads. / I also read about each colum and decided the leather tennis would be good for everyone. / I thought about how they would perform in gym and to me it all pointed out good.	4	-There is at least one statement that indicates indirect consequences. See bolded section: shoes are white (direct consequence of being leather tennis shoes) and thus will match any uniform (consequence of being white).  -The student discusses more than one option: the leather tennis shoe, the styled synthetic, and the canvas cross trainer.

**Table 5: Examples of Students' Responses on the Decision-making Tasks**

To analyze this data, I look for students' movement from lower levels to higher levels based on their scores. I do this by looking at percentage changes from pre to post-testing at each score level. To complete the analysis, I also combine the lower two levels and the higher two levels. Thus I add the percentage of students who score at level 1 and

level 2 as well as add the percentage of students who score at level 3 and level 4 and then compare percentages from pre- to post-testing.

### **Looking at Impact of Values Exemplified by the Teachers**

As part of the study, another member of the IOPD research team and I transcribed the videos that the teachers recorded. The transcription was then broken into “instances” of teaching. Each instance represented a distinct and coherent part of the instruction, discussion, or activity in the classroom. This video analysis was not done solely for the purposes of my study. The other IOPD team member planned to use the results in his analysis of the teachers’ growth over time, based on the professional development efforts. Thus, he and I have worked together on this aspect of the study<sup>8</sup>. For this work, my colleague and I created a quantitative summary of “Instruction” (of SCDM) based on several aspects. Two of the aspects will be discussed here—values expressed by the teacher and classroom management—while the others can be found in Appendix G<sup>9</sup>.

**Values expressed.** For this analysis, we recorded which of three main value orientations were exemplified by the teacher in the definitions or examples given to the class. These value orientations are from Stern, Dietz, & Kalof (1993) and include concern for the self, concern for others, and concern for the environment. For example, if in an example the teacher talks about the impacts of choosing a certain diet on a students’ own health, the code would be “self.” If an example refers to the impacts on other people, it would be coded as “others,” and if it refers to the impacts on animals, water, land, etc., it would be coded as “environment.” We tallied examples of each value orientation and

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<sup>8</sup> I thank Richard Vath for his time and efforts. See Vath & Switzer (2008) for complete details and results.

<sup>9</sup> The other aspects of instruction that we analyzed were definition quality, example congruence, part-whole relationship (e.g. how the steps related to one another), and task congruence. They are not included in this paper because they are less relevant to its purpose, and because IRR was low.

created a “relative frequency” score, so that we could characterize the values-related atmosphere in which students were immersed while learning SCDM. In addition, if students gave examples, then what we scored was the teachers’ reaction to the example (e.g., if the students’ example demonstrated “self” values and was somehow agreed with or approved by the teacher, then this is what we coded given that the example implicitly became part of the instruction). Table 6, below, gives a few examples of instruction from the two classrooms and the values coding that resulted. (Student names have been removed, and replaced by S1, S2, etc.)

Context of Lesson	Transcript of Instance	Value Code
Deciding what food combinations to eat.	<i>Teacher:</i> Ok, lets take the first one. <i>S2:</i> what is your first combination? Give me a consequence. <i>S2:</i> Ok, if I decide to eat at home instead of at school, then it will affect my friends. I won't get to see them as much. <i>Teacher:</i> Ok, you can use that. Good.	Others
Introducing the concept of “Stakeholders”	<i>Teacher:</i> Let’s go and read the overview (reads from book). [writing on board] So, people, people that are around you. The next one is organizations. <i>S1:</i> Plants. <i>Teacher:</i> [repeats] plants <i>S1:</i> animals [Teacher writes this on board] <i>S1:</i> Physical environment. <i>Teacher:</i> So, now stakeholders are either people or the things that are around you. If you take one example, you can take the people around you. I have these two charts [on board]. So, stakeholders are those things that will be affected by your decision. You may be surprised how many people are involved in your decision.	Environment Others
Deciding what food combinations to eat.	<i>Teacher:</i> Okay, so who is the first person who is affected by what you eat for breakfast? <i>S2:</i> We are. <i>Teacher:</i> Okay let me write that down. Okay, so how will you be affected? What way is your breakfast affecting you? <i>S4:</i> Time <i>Teacher:</i> Okay you will lose sleep.	Self

**Table 6: Coding Instructional Instances for Values Exemplified**

After each interview was coded in this way, we tallied the number of each value code (self, others, environment) for each teacher over all four class periods. We then divided that number by the total number of teaching instances that had a value code. I also trained two additional scorers to score these video transcripts and used their results as a check on our original values. The two sets of results are well aligned (with the only differences of note for Mara in the Self and Others categories), as is shown in Table 7

below. V&S denotes Vath and Switzer (2008) as referred to earlier, while M&P refers to the other scorers' initials. In the Results chapter, I present and discuss the average of these two sets of results.

Values Expressed in Examples	Kristin (V&S)	Mara (V&S)	Kristin (M&P)	Mara (M&P)
Self	57%	37%	58	47
Others	17%	27%	17	17
Environment	26%	36%	25	35

**Table 7: Values Exemplified in the CASES Classrooms over 4 Class Periods**

**Classroom management.** This score refers to basic classroom management by the teacher. To measure classroom management, we looked at the “on task” behavior of the students. Being “on task” means that students were doing what they were supposed to be doing during the class period, as opposed to talking with others socially, taking naps, or otherwise distracting themselves from what the teacher was asking them to do. Phyllis Blumenfeld (personal communication, April 2007), one of the authors of the paper referenced earlier regarding the importance of classroom management, suggested the use of a scale from 1-3 to score this variable, as listed in the rubric (for reference, see the bottom of the second page of Appendix G).

Following the lead of Kempler, et al.'s (2008) work mentioned earlier, which includes classroom management, I used the mode for this score rather than the average. On a scale of 1-3, Kristin scored a 3 for all four class periods, thus a mode of 3. Mara's scores were 2,2,2,3 and thus a mode of 2; her classroom management was much more relaxed than Kristin's. To be specific, Mara's students were much more often off-task or unengaged in the main activity of the class. Many of her students were engaged in social

conversations, even having their back to the teacher for much of the class period. These results were consistent for the two sets of scorers.

**Teacher interviews.** The teacher interviews that I referred to earlier were not “scored” by a rubric in any way similar to all of the data explored thus far. The interviews simply provided insight into the teachers’ view of the curriculum, their role as teachers of this type of curriculum, and their opinion on how to address varying student values. There were a few key excerpts from these interviews that shed light on the results of the values coding just discussed, which I share in the Results chapter to help frame the student results.

### **Possible Limitations/ Methodological Flaws**

This research provides several new methods and insights relative to high school students’ environmental decision-making. A few design-related concerns need to be discussed at this point, however. They influenced the results of my study in ways that I could not predict or control.

First, as previously mentioned, the attrition of my case-study sample was reduced to that from a single school. This school has a high percentage of Hispanic students; specifically first and second-generation immigrants from rural Mexico. Thus, the results attained in the study may not be generalized to the adolescent population in the U.S. as I had hoped. There is some indication that Hispanics are similar to Whites in their environmental values, although this result is from a sample of Biscayne Bay National Park users in Florida (e.g., people who were out enjoying the natural environment) (Noe & Snow, 1990) and thus may not be representative of the general population on either

account. In another related study, foreign-born Hispanics differ more from Whites than U.S.-born Hispanics in their environmental beliefs as measured by the NEP (Johnson, Bowker, & Cordell, 2004). However, this evidence is about adults, not youth. Furthermore, I am unaware of studies that look at specific cultural biases in the NEP survey.

Second, the two decision-making scenarios were not tested for equivalency, as was mentioned at the beginning of this chapter. The car scenario had been pilot-tested, along with the discarded house scenario. However, because of time constraints, the shoe scenario was never pilot-tested before being used for data collection with this student sample. Up to this point, I had assumed that the design of the shoe scenario was comparable enough to the car scenario to consider them equivalent. Specifically, the choices for each were located along a spectrum of environmental “friendliness” and had similar constraints that should have eliminated one of the options. The specific details of this design have been discussed earlier in this chapter. This effort was made so as to support the “balanced” research design (e.g., students completing different scenarios at post-test than at pre-test). I still believe that this was a worthwhile approach given the results from the pilot work. However, my necessary assumptions about equivalency proved false as will be shown in Chapter 4. And, in fact, this issue may have a link to the first one mentioned, in that the “emotional charge”<sup>10</sup> of shoe and car decisions may be different for Hispanics as for people of other ethnic descent in our population.

A third area of limitation in this study is related to the characterization of the instruction by the teachers. In this study, I narrowed my scope of teacher-level variables

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<sup>10</sup> More discussion about emotional charge exists in Chapter 5.

to (a) the values that were exemplified by the teachers during classroom instruction, and (b) their classroom management style. These are only two facets of the classroom environment in which students were immersed. There are many more facets that could potentially influence the curriculum that students attained. And, these facets likely interact with one another in complex ways.

An additional concern in this study is having had the teachers (rather than researchers) administer the values survey and decision-making tasks. There are pros and cons to each approach. By having the teachers administer the tests, thus implying some level of accountability to the teachers, the students may have attempted to perform at their best. However, they may also try to predict which choice or outcome would please the teacher. In some cases, having the researchers (with whom there is no academic accountability) administer the survey might yield more authentic results. I am unaware of studies to this effect.

Lastly, given the likely complexity of the attainment and change of values and of decision-making skills, it would be beneficial to look at students' growth after they have experienced the entire 3-unit CASES curriculum as opposed to just the first unit as I have done here. As Ross (1981) states, "it has been suggested that it is unreasonable to expect improvements [in adolescent decision-making skills] in less than a full year" (p. 294).

Some of these limitations can be overcome by adjusting the methods, and by recruiting more teachers and students. Such adjustments, in addition to several future research recommendations made in the final chapter, will add greatly to this line of research.

## **Chapter 4**

### **Results**

In Chapter 1, I discussed the importance of teaching and being able to assess high school students' Environmental Decision-making (EDM) skills. Given that this is a new area of science education and that there is not one common reason for teaching decision-making nor one right answer for decision scenarios by definition, assessment is a complex task. Using three perspectives on decision-making expertise as well as a particular curriculum which includes EDM, I attempted to move the field of assessment forward in this area. I also acknowledged that values may play a role in the teaching and learning of this type of curriculum, given that they play a distinct role in decision-making. The specific research questions I posed were the following:

1. Given that organizations and educators have various goals for teaching environmental decision-making, by what methods can it be assessed?
2. How well do these methods work in assessing the environmental decision-making resulting from high-school students' experience with a specific curriculum with specific goals?
3. Are the decision-making outcomes impacted by the values exemplified by the teachers (keeping in mind differences in classroom management)?

This chapter presents the findings of my study. Presentation of the results is not in the same order as the questions, however, so I preface that now. The bulk of the results are organized by the three main decision-making expertise perspectives: Satisfying Results, Coherence, and Process Decomposition. However, I do contextualize all of these results by first looking at the two aspects of instruction by Mara and Kristin as I think the differences seen there provide an appropriate framing for what follows. Essentially, I look at the results for the entire student sample<sup>11</sup> first, followed by a look at two subgroups determined by teacher. The results for each teacher are thus framed by the whole group results, which situates them and tells the most interesting story regarding how differences in values (and classroom management) might influence the student results. In addition, the three subgroups of students based on personal environmental values are used to organize results for the Coherence perspective. Thus, there is no distinct section for the results of Research Question 3 as these results are presented throughout the other sections.

### **Differences in Instruction**

At the start of the 2006-07 school year Kristin had been teaching for one and one-half years and had previous work experience working in the engineering industry. Mara had been teaching for six years in the United States, and had been a teacher in India prior

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<sup>11</sup> Although the entire student sample included 172 students, there was a great deal of flux from the beginning of the research period to the end. Students moved from one class period to another, dropped the class or school altogether, or added the class. Thus, the actual number of students with “matching” pre- and post-test was much smaller than 172. I will report this relevant “matching” number as the “n” in each table of results presented in this chapter; it varies depending on which set of results are being discussed. From now on, “entire sample” means those with matching pre-and post-tests.

to that. Neither teacher had previous experience with the CASES curriculum, or with teaching decision-making in any context prior to this school year and this study.

As mentioned in Chapter 3, a fellow member of the IOPD research group and I interviewed the two teachers during January of 2007. Tables 8 and 9 (below and on the next page) contain some key portions of the interviews regarding each teachers' views on values in EDM, and their own role as teachers of the Stakeholders-Consequences Decision-Making process (SCDM). The specific interview questions that brought out their views on these topics varied for Kristin and Mara, so the questions asked of them are included for reference. The entire transcript of both interviews can also be found in Appendices H1 and H2.

Interview Question	Kristin
What is your definition of decision-making? What does it mean to make a decision?	...I think that when you make some kind of decision you have to weigh your options and figure out if this is the best for me. And I think that deep down we're all looking [pause] <b>every decision we make is based off of what is best for me.</b> It's not really altruistic about what is best for the world or for my neighbor, it is: how am I going to get the most out of this?
Do you think they'll [the students] have a hard time weighing their personal values versus the more objective, so-called constraints?	I can see them having a hard time with their own personal constraints and considerations and I think it's because <b>they're so used to not having that voice.</b> Of saying, its okay for you to say, "I want this and this and this."...I also think that they might be thinking that they have to think in terms of environmental science, you know "we have to all be tree-hugging hippies and drive hybrid cars and want to save the whales", and that's not what the curriculum is based on. And, that's what I really like about it. But, I think they're still having a hard time with it. Okay, "it's environmental science, we need to save the whales, and I have to do everything for the greater good..." [No], <b>it's okay to be selfish.</b>

**Table 8: Kristin's Interview Excerpts**

[portions in brackets added by me for clarity; bold-faced print added to draw attention to phrases that I considered particularly important]

Interview Question	Mara
What would you do as a teacher to help them negotiate their different values?	...I'm teaching environmental science based on the values that we have as science teachers and <b>we want to pass on to students how to save the environment</b> . That is the main thing. And then conservation. Conservation is like anything can conserve in your life is best for the generations to come. So, those are the values that...even a simple example like saving water. How can you save water. How can you save plants. How can you save animals. <b>So we wanted to put those ideas in their brains so that they always think in terms of protecting the environment.</b>
Do you think that the students are going to have a hard time weighing the importance of their personal values versus the more objective considerations?	It's not a challenge, but maybe if you think that it is a challenge...you know, American kids are spoiled. They wanted to have so many things. If it is a school [referencing the case in Unit 1 that students work on], we should have all these things. So, but <b>as a teacher we have to direct them to the right decision-making</b> . Think in terms of the land you're going to use, it is not possible to have all those things. You want to coexist with the gopher tortoise, then there won't be a possibility of having all those things.

**Table 9: Mara's Interview Excerpts**

[bold-faced print added to draw attention to phrases that I considered particularly important]

The excerpts shown here are fairly representative of responses in other parts of each interview. What I gleaned from the interviews in general, and from these excerpts specifically, was that Mara seemed to believe that her role as a teacher of SCDM and environmental science is to ensure that students value the environment, whereas Kristin appeared to believe that she could help students voice their own values, whatever those were.

In addition to these interviews, this same IOPD researcher and I analyzed the videotapes of the two teachers as they taught SCDM. The full set of these data and results can be found in Vath & Switzer (2008), while only the results related to values are shown in Table 10, next page. Once again the values shown here are the mean of the results of Vath & Switzer and those of M&P who scored all of the teacher data for the sake of inter-rater reliability. These results show that Kristin used more examples with

“self”-oriented values in her teaching than Mara did<sup>12</sup>. Statistical differences in the other categories did not exist. One way to summarize these results is that overall, Mara’s examples show more balance among “self,”- “others,”- and the “environment”-related values while Kristin’s examples were skewed toward “self”-related values.

<b>Values Expressed in Examples</b>	<b>Kristin (n=48 instances)</b>	<b>Mara (n=99 instances)</b>	<b>z-test for differences in proportions</b>
Self	57.5%	42%	Sig. at .90 level
Others	17%	22%	n.s.
Environment	25.5%	35.5%	n.s.

**Table 10: Values Expressed in the Examples Used by Kristin and Mara**

A point of comparison for these percentages is the CASES curriculum itself. In looking at the curriculum for the four lessons that were videotaped, I found that “self”-valuing is mentioned twice (29%), “others”-valuing is mentioned three times (43%), and “environment”-valuing is mentioned twice (29%) for seven total examples<sup>13</sup>. See Appendix I for an example of each type. While a rough measure, this shows the intended curriculum to be fairly balanced between the three value orientations for the lessons used to calculate the teachers’ percentages in Table 10, above. Comparing these curricular percentages to the teachers’ instructional percentages, I concluded that the teachers do imprint their own agenda onto the enacted curriculum (even if unconsciously). Kristin exemplified “self” more than the intended curriculum, and others and environment less. Mara stressed “self” and “environment” more than the intended curriculum, and “others”

<sup>12</sup> Pearson’s Chi-squared testing showed no statistical differences between the two teachers, but the z-test shown above did show differences for the “self” category.

<sup>13</sup> The first lesson, Resources 3b: Rainfall Distribution is actually completely science content focused, and does not deal with values or decision-making at all. So, the percentages given derive from the other three lessons, Resources 4b: Protein Dilemma; Resources 4d: Stakeholders; and Ecosystems 2a: Food Chains.

less. Thus, it appears that the implemented curriculum of Mara was closer to the intended curriculum than was Kristin's in this regard<sup>14</sup>.

My colleague and I also scored the teachers on their overall classroom management. Kristin had a higher mode score, 3 on a scale of 1-3, in classroom management than Mara, whose mode score was 2. To give life to these scores, Kristin often used a timer in class to budget time on various activities. Students were pressed to diligently work on the task at hand so that they would be ready for the next task. Students were respectful to Kristin and were on task virtually all of the time that was captured on tape. Mara's classroom environment was much more relaxed. Students came late, talked back to Mara, and those in the back rows would often face away from the front of the room to talk with peers for extended periods of time rather than engage in the activities that Mara and the front rows of the class were doing.

To summarize all of these results, I would describe Kristin's classroom to be one in which classroom management was high, activities were highly structured time-wise, and examples used in the teaching of SCDM were mostly "self"-valuing. Mara's classroom was one in which classroom management was less apparent, activities were engaged in by those in the front rows more frequently than the back rows, and the teaching examples were more evenly distributed among "self," "others," and "environment." These differences between the two teachers provide the context for the student results presented in the rest of this chapter.

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<sup>14</sup> Using the curriculum distribution of values as the "expected" values, and Kirsten and Mara's values independently as the "observed", I was able to calculate Chi-squared "goodness of fit" statistics for both teachers. Both were significantly different than the curriculum values distribution ( $p < .005$ ), though Mara's Chi-squared statistic (28.4) was smaller than Kristen's (38.5).

## Satisfying Results

First, I looked at the students’ decision-making skill through the lens of the “Satisfying Results” perspective. This perspective in the context of environmental science courses generally might espouse that environmental science education could be in the business of changing behavior (decisions) to be more sustainable (though not a specific goal of CASES). In other words, a satisfying result of environmental science education is more environmentally friendly decision outcomes. This might be the stance taken by traditional “Environmental Education” programs, and was echoed in Mara’s motivations as revealed in her interview cited at the beginning of this chapter. Thus, in using this perspective, I looked solely at the choices that students made to see if CASES had this effect despite this not being one of its goals. Table 11, below, summarizes the students’ choices based on the scenarios that they were given before and after their experience with Unit 1 of CASES. This table represents the 79 students with matching pre- and post-tests, regardless teacher or decision scenario.

<b>Choice</b> (Only Students with Pre- Post Matching)  n-79	<b>% of students selecting choice (pre)</b>	<b>% of students selecting choice (post)</b>	<b>% Change</b>
SUV	10	19	+9
Sports Car	6.3	3.8	-2.5
Hybrid Car	33	30	-3.0
Leather Tennis Shoe	38	22	-16
Styled Synthetic Shoe	5.0	11	+6.0
Organic Canvas Cross Trainer	7.6	14	+6.4

**Table 11: Choices Made by Students with Both Pre- and Post-tests; Both Scenarios**

I did not compute statistical significance for these changes because presented in this way, these numbers don't mean much. What is more important is to look at the changes within each decision-making task (e.g., shoe or car)—to check for task equivalency—, and for each teacher—to check for potential instructional influences. The next six tables accomplish that. This first set of two tables breaks the above table into two by scenario only. Table 12 (on the next page) represents those students who responded to the car task, and Table 13 (also on the next page) represents those students who responded to the shoe task.

In each of the three following sets of tables, I looked at several key items. First, I looked at the percentage change for students who selected Option 2 for both scenarios. This particular option, for both scenarios, could have been eliminated as a viable option based on the constraints/considerations listed in the scenario (as mentioned in Chapter 3). So, as students gained experience with SCDM, they should have been less likely to choose Option 2. Thus, I looked for a decreasing percentage of students selecting it from pre-test to post-test. Second, I looked at the percentage changes for the SUV and the Hybrid. Taking the Satisfying Results perspective to specifically include the environment would suggest that more students should have selected the hybrid at the end as compared to the SUV. Thus, a positive percentage change for the hybrid would be “satisfying” for the environment, as would a negative percentage change for the SUV.

Choice	Pretest % (n=39)	Post-test % (n=42)	% Change
(1) SUV	21	36	+15
(2) Sports Car	13	7	-6
(3) Hybrid	67	57	-10

**Table 12: Choices made by all students with both pre- and post-tests; Car Scenario Only<sup>15</sup>**

In this table, I find that there was a decrease in the number of students who selected Option 2 (the sports car). I also find that there was actually an increase in the percentage of students who chose the SUV (least environmentally friendly) and a decrease in those who chose the Hybrid (most environmentally friendly). These results are contrary to the expectations discussed above.

Further, these results are completely opposite of those presented by the shoe scenario, in Table 13, on the next page. Students who responded to the shoe task increased the selection of Option 2 (here, the styled synthetic shoe). This is an unexpected result given the constraints and considerations in the scenario. They also increased their selection of the canvas cross trainers (most environmentally friendly) and decreased their selection of the leather tennis shoe (least environmentally friendly). Given the environmental information taught in CASES, I would have expected both scenarios to reveal movement from the least environmentally friendly option to the most environmentally friendly option.

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<sup>15</sup> Testing for statistical significance for this and all similar tables cannot be completed, because the same students were not writing the same decision scenario from pre- to post-testing. This is one side-effect of the “balanced” research design.

Choice	Pretest % (n=40)	Post-test % (n=37)	% Change
(1) Leather tennis shoes	75	46	-29
(2) Synthetic styled shoes	10	24	+14
(3) Canvas Cross Trainer	15	30	+15

**Table 13: Choices made by all students with both pre- and post-tests; Shoe Scenario Only**

With the exception some differences in the percentages for Option 2, these same overall patterns hold for both Kristin’s and Mara’s students. Tables 14-17, below and on the next page, are provided for comparison.

Choice	Pretest %	Post-test %	% Change
SUV	18	32	+14
Sports Car	6	5	-1
Hybrid	76	63	-13

**Table 14: Choices made by Kristin’s students with both pre- and post-tests; Car Scenario Only**

Choice	Pretest %	Post-test %	% Change
Leather tennis shoes	67	31	-36
Synthetic styled shoes	0	31	+31
Canvas Cross Trainer	33	38	+5

**Table 15: Choices made by Kristin’s students with both pre- and post-tests; Shoe Scenario Only**

Of note in the results for Kristin is the large gain in the number of students who selected Option 2 (especially for the shoe scenario). This may be partly due

to her classroom instruction, namely that her classroom was more “self”-oriented in the values exemplified while teaching SCDM. Thus, students may have learned that what they want is more important than other considerations or constraints. Their selection of the styled synthetic shoe may reflect that their desire to be stylish outweighed others (e.g., being environmentally friendly).

Choice	Pretest % N=22	Post-test % N=23	% Change
SUV	23	39	+16
Sports Car	18	9	-9
Hybrid	59	52	-7

**Table 16: Choices made by Mara’s students with both pre- and post-tests; Car Scenario Only**

Choice	Pretest % N=22	Post-test % N=21	% Change
Leather tennis shoes	82	57	-25
Synthetic styled shoes	18	19	+1
Canvas Cross Trainer	0	24	+24

**Table 17: Choices made by Mara’s students with both pre- and post-tests; Shoe Scenario Only**

Of additional note is that when looking at the difference between the two scenarios (for all students, regardless of the teacher) there is a pattern, which suggests that the two scenarios were not equivalent. Although they were structured to be parallel, students appear to be more willing to move toward being environmentally friendly when faced with the shoe task, but not so for the car task. Whether this is a flaw in the scenarios themselves, or purely due to the content differences and students’ attachment to

shoes vs. cars, I do not know. One other question did come to mind, however, that I needed to test.

Because the car and shoe scenarios were not actually given to the same students pre- vs. post-test, I decided that it was also important to compare the subgroup of students who started with the car scenario and compare it to the subgroup of students who started with the shoe scenario. I will call these “task groups.” Group A started with the car task and ended with the shoe task. Group B started with the shoe task and ended with the car task. The results are shown in Table 18 and Table 19, below.

Choice	Pretest % Car N=39	Post-test % Shoe (n=37)	% Change
1	21	46	+25
2	13	24	+11
3	67	30	-37

**Table 18: Group A results**

Choice	Pretest % Shoe N=40	Post-test % Car N=42	% Change
1	75	36	-39
2	10	7	-3
3	15	57	+42

**Table 19: Group B results**

From these two tables, it appears that the two groups changed in completely opposite ways. Group A shifts toward the less environmentally friendly choice while Group B shifts toward the more environmentally friendly choice. Given that the instructions to the teachers were to distribute the test randomly, I have a difficult time explaining these results. In recording the data, I saw no pattern based on gender, grade-

level, or any other variable to which I had access. So, faced with two options to explain these last two sets of results, namely that either the tasks were not equivalent in some important respect or that the task groups were “stacked” in some way, it is easier to believe and to explain that the tasks were non-equivalent rather than the two groups of test takers.

To summarize the Satisfying Results section, I conclude that this might be a simple and direct method for looking at students’ choices assuming that two tasks which were equivalent in terms of how students’ responded to them. However, the specific results based on this perspective are inconclusive with regard to cars and shoes, given that students seemed to react so differently to the two scenarios. Another interpretation of this data is discussed in Chapter 5.

### **Coherence**

In order to determine students’ coherence relative to environmental decision-making, I utilized the choices that students made as discussed in the previous section of Satisfying Results and the results of the NEP environmental values survey. To begin, I first present the results of the NEP survey. Table 20, on the next page, reports the pre-test and post-test NEP scores for the whole sample as well as for the three subgroups already mentioned. For reference, in the Methods chapter I discussed the possible range of scores on the NEP as being from 19-95, with a mid-point of 57. Given this as reference, both the “Middle” group and the “Closer to the New Ecological Paradigm (NEP)” groups in my sample at pre-testing time fully lie above the mid-point of the available range, or in the more environmentally friendly range of values. The “Closer to Dominant Social Paradigm (DSP)” group in my sample actually contains the midpoint of

the entire possible range of the NEP scale. Thus, my sample is skewed toward the NEP end of the range provided by the scale.

When looking at the entire group of students in the study, there were no changes in environmental values (see the first row of Table 20, below). However, in breaking the students into subgroups by their values at the beginning of the year, a more interesting story unfolds. For each group, I report the range of values in addition to the standard deviation so that these values can be compared to the NEP scale itself.

<b>Group</b>	<b>n Pre- (Post)</b>	<b>Range of NEP Scores</b>	<b>Mean Start Value (std. dev)</b>	<b>Mean End Value (std. dev)</b>	<b>Change in Mean Values</b>	<b>Effect Size</b>	<b>Paired t-test Significance</b>
Whole Sample	86	50-85 (55-82)	62.78 (6.83)	63.61 (5.91)	0.83	Not significant	.140
Closer to DSP	30 (27)	50-59 (55-59)	56.2 (2.72)	57.59 (1.15)	+1.39	0.67	.000
Middle	45 (44)	60-69 (same)	64.0 (2.70)	63.95 (2.74)	-.05	Not significant	.292
Closer to NEP	11 (15)	70-85 (70-82)	75.7 (4.69)	73.47 (3.46)	-2.23	0.54	.011

**Table 20: Students' New Ecological Paradigm Scores**

Looking at changes in values from pre-testing to post-testing, the “Closer to DSP” group at the beginning moves in a direction toward the NEP (i.e., their average score increases), the “Middle” group stays the same, and the “Closer to NEP” group moves in a direction toward the DSP (i.e., their average score decreases). The changes for both the “Closer to DSP” group and the “Closer to NEP” group are statistically significant with moderate effect sizes. While these changes could exemplify “regression to the mean,” there is another possible explanation. In this case, it may be that the students’ values

have become less extreme due to exposure to other viewpoints. The students at the extremes may have gained a more balanced perspective through thinking about the case studies in the curriculum, and by learning the environmental science content.

Next, I present the same PEV information separated by teacher. In fact, a deeper story unfolds by looking at the change in values for the students of each teacher (see Table 21, on the next page). It becomes clear that there was an interaction between the beginning student value group and the teacher. Specifically, it is not all of the original “Closer to DSP” students whose values move closer to the NEP. Only Mara’s students show this statistically significant score increase on the values scale. In addition, it is not all of the students of the original “Closer to NEP” group whose values move closer to the DSP. Only Kristin’s students show this statistically significant NEP score decrease. One item of note in this table is that although the sample sizes (n’s) are given for both pre- and post-testing time, the Paired t-test by definition only looks at the students originally in that group. Thus, for significance testing, the n’s for both pre- and post-testing are the pre-test number.

Group (at beginning)	Teacher	n pre (post)	Mean Start Value (std. dev)	Mean End Value (std. dev)	Change in Values	Effect Size	Paired t-test Sign.
Closer to DSP	Kristin	15 (11)	57.07 (2.25)	57.36 (1.43)	-	n.s.	0.074
	Mara	15 (16)	55.33 (2.94)	57.75 (0.93)	2.42	1.11	.000
Middle	Kristin	16 (18)	64.25 (2.44)	64.56 (3.05)	-	n.s.	0.257
	Mara	29 (26)	63.86 (2.86)	63.53 (2.47)	-	n.s.	0.599
Closer to NEP	Kristin	5 (7)	77.00 (5.61)	72.71 (2.75)	-4.29	0.97	.008
	Mara	6 (8)	74.67 (3.98)	74.13 (4.05)	-0.54	n.s.	0.127

**Table 21: Students' New Ecological Paradigm Scores, by Teacher**

Given the findings regarding the differences between the two teachers at the beginning of this chapter, these results make some sense. Mara's students were in a classroom environment where more of the examples given were *environment*-valuing than Kristin's students were. Mara's students who started with "Closer to DSP" values were affected by being in a more environment-valuing classroom. Mara's students who were already closer to the NEP point of view weren't affected by this environment-valuing atmosphere as much, perhaps because it simply supported the views they already held. Thus, there is no significant change in their values. A similar pattern, but in the opposite direction, appears for Kristin's students. Her students were in a classroom environment where more of the examples given were *self*-valuing than Mara's. Kristin's

students who started with “Closer to NEP” values were affected by being in a more self-valuing classroom. Kristin’s students who were already closer to the DSP point of view weren’t affected by this self-valuing atmosphere as much, perhaps because this supported the views they already held. Again, this might explain why there was no significant value change for them. This result points to the existence of an interaction between the student “value group” and “values expressed by teacher”.<sup>16</sup>

The implication of all of the above is that some students’ Personal Environmental Values do respond to instruction. Although there is negligible movement toward the NEP end of the range of values scores for the sample overall, this change was not significant. Thus, many students’ values do not change to a statistically significant degree, but those that do appear to respond in ways that vary with the type of instruction. The results here suggest that students whose teachers’ examples stress “self”-oriented values more than the other two values (“others” and “environment”) moved away from the NEP and toward the DSP end of the spectrum. Students whose teachers’ examples are more balanced (including “self”-, “others”-, and “environment”-oriented values) moved away from the DSP and toward the NEP end of the spectrum. Furthermore, insofar as there is an interaction between the students’ values at the beginning and the instruction, students whose teachers’ examples don’t align with the students’ own values are more apt to change their values. In other words, the instruction seems to have more of an effect on the thinking of students with values different than those represented in the teachers’ examples. A caveat is that these findings rest heavily on the behavior of an

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<sup>16</sup> Considering that the NEP Scale does not specifically measure values related to “others”-orientation, I have to attribute these results to the differences in “self”- and “environment”-oriented examples given in class by the two teachers.

extremely small number of students<sup>17</sup> so I do not consider them reliable. The methods utilized here do offer some direction for future work in this area, however. More discussion on this is presented in Chapter 5.

With both pieces of the Coherence data in place (choices and values), I discuss how I developed the methods of analysis for this perspective. To review, how I interpreted coherence in this study is the consistency or match between a student's stated values and their choices. Not only was this an important perspective on decision-making expertise considered by Yates and Tschirhart (2006), this type of coherence is an implicit goal of the CASES curriculum: "Our assumption is that initially students will not be aware of how their values might be relevant to these decisions. Improved coherence would result from being more explicit about their values and applying them systematically in decision-making" (Edelson, 2009, personal communication). To examine at this coherence, I created tables with the values survey data as rows and the choices from the decision-making task as columns, as demonstrated in Chapter 3, page 67. In Table 22, on the next page, I present the percentage of students in each value-group (same subgroups defined for Research Question 1) that chose each option on the decision-making task. The shoe selections and car selections are initially combined in this analysis, but I did separate them later.

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<sup>17</sup> The detailed analysis which reveals the specific numbers can be found in Appendix J.

N=77 Values Group	*Choice on Pre-test (% of EV Group)			*Choice on Post-test (% of EV Group)			Pearson's Chi- Squared Test
	1	2	3	1	2	3	
Closer to DSP	61	8.7	30	50	18	32	p < .005
Middle	46	16	38	39	18	43	Not significant
Closer to NEP	30	0	70	36	7	57	Not significant

**Table 22: Coherence for all students**

As I describe some of the findings of note in this table, it is important to remember that there was a significant increase in environmental values for the Closer to DSP group, no change for the Middle group, and a significant decrease for the Closer to NEP group. Next, I describe some specific observations from the table to support an interpretation that the students seemed to make decisions that were coherent with their environmental values, but that this coherence changes in different ways dependent on the teacher.

First, taking a wide vantage point, this table shows that the Closer to DSP values group most heavily selected the least environmentally friendly choice (61% at pre-test and 50% at post-test). The Closer to NEP group most heavily selected the most environmentally friendly choice (70% at pre-test and 57% at post-test). Further, the Middle group was the most evenly spread among the three choices, both at pre- and post-testing<sup>18</sup>. These findings support my statement above that there is good overall coherence between students' values and their choices.

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<sup>18</sup> It is important to note that in the case of Option 2, coherence as I've defined it conflicts with the decision-making process/scenarios. Because Option 2 is the "middle" case relative to being environmentally friendly, I would expect there to be a fairly even spread among the students in all value

Second, narrowing in on changes from pre- to post-, there is only one value group that shows a statistically significant shift. The “Closer to DSP” group results show movement away from the least environmentally friendly option and toward the other two options. Thus, in general, I would say that the fairly good coherence seen at the beginning of the CASES unit actually decreases from pre- to post.

Third, within the Closer to NEP group, more students selected Choice 2 at post-test than at pre-test; selection of Choice 2 increased from 0 to 7% for this group. This change might reflect the fact that the environmental values for this group had decreased overall. However, it may be an artifact of the sample size. The movement of just one or two individuals can have a large apparent effect. Regardless, this finding does beg the question about the differences between the two teachers because the decrease in values for the Closer to NEP group only occurred for Kristin’s students. For this purpose, Tables 23 and 24 (below, and on page 101) show the same coherence-related information as above in Table 22, but separately for each teachers’ students.

N=33 Values Group	*Choice on Pre-test (% of EV Group)				*Choice on Post-test (% of EV Group)			Pearson's Chi- Squared Test
	1	2	3		1	2	3	
<b>Closer to DSP</b>	47	5	47		42	8	50	Not significant
<b>Middle</b>	36	4	60		29	24	48	p < .005
<b>Closer to NEP</b>	45	0	55		22	11	67	p < .005

**Table 23: Coherence for Kristin's students**

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groups who select it. However, because Option 2 is also discouraged as a viable choice given the constraints in the scenarios, this option should be chosen the least.

Looking first at the pre-test columns, Kristin's students showed only marginal coherence. For example, the "Closer to DSP" group was evenly split between the Hybrid and the SUV, where they should have been leaning toward the SUV to be coherent. The "Middle" group leaned heavily towards the Hybrid. The "Closer to NEP" group was the most coherent with more students selecting the Hybrid. Looking at the changes from pre- to post-testing, only the "Middle" and "Closer to NEP" groups changed their choices significantly. Specifically, the "Middle" group became more spread across the three choices, which I would consider more coherent, and the "Closer to NEP" group leaned more heavily toward the Hybrid, which I would also consider more coherent. Thus, overall, Kristin's students became more coherent in their choices from pre-testing to post-testing.

Mara's student results suggested good coherence at pre-test time (see Table 24, next page). The Closer to DSP group very heavily chose Choice 1, the Closer to NEP group very heavily chose Choice 3, and the Middle group was most evenly spread among the three choices. However, this coherence was reduced by the time of post-testing. What I noticed is that there was a shift away from Choice 1 for the "Closer to DSP" group and a shift toward Choice 1 for the "Closer to NEP group," and both of these group's changes were statistically significant. The Middle group showed statistically significant changes as well, although it became less spread across the three groups. Thus, overall, Mara's students became less coherent in their choices from pre-testing to post-testing.

N=44 Values Group	*Choice on Pre-test (% of EV Group)			*Choice on Post-test (% of EV Group)			Pearson's Chi- Squared Test
	1	2	3	1	2	3	
Closer to DSP	78	9	13	53	33	13	p< .005
Middle	44	22	33	42	12	46	.005 < p < .01
Closer to NEP	25	0	75	55	0	45	p<.005

**Table 24: Coherence for Mara's students**

In summary, what this analysis revealed was that many of the students showed consistency between their values and their choices at pre-testing. Overall, Kristin's students' consistency increased over time whereas Mara's students decreased. One possible explanation for these different results for the two teachers is their styles of classroom management. My impression is that due to Mara's more relaxed classroom management many students missed a lot of the main points of the lessons, and thus would not have had the practice with SCDM that Kristin's students did. Missing out on that practice might mean that coherent decision-making skills did not develop beyond what they had at the start of the year.

The last look at coherence that seems of importance was to again compare the two tasks to one another (i.e., shoe vs. car). This will give yet another look at the equivalency between the two scenarios. See Tables 25 and 26, on the next page.

All Students CAR N=39	*Choice on Pre-test (% of EV Group)			*Choice on Post-test (% of EV Group)			Pearson's Chi- Squared Test
	1	2	3	1	2	3	
Values Group							
Closer to DSP	31	15	54	50	8	42	p < .005
Middle	20	15	65	29	9.5	62	.025 < p < .05
Closer to NEP	0	0	100	33	0	67	Can't calculate

Table 25: Coherence for Car scenario only

All Students SHOE N=36	*Choice on Pre-test (% of EV Group)			*Choice on Post-test (% of EV Group)			Pearson's Chi- Squared Test
	1	2	3	1	2	3	
Values Group							
Closer to DSP	100	0	0	50	30	20	Can't calculate
Middle	67	17	17	50	28	22	p < .005
Closer to NEP	75	0	25	38	13	50	.025 < p < .05

Table 26: Coherence for Shoe scenario only

Examining these two tables, I noticed first that the coherence of the students at pre-testing time was mixed for the two scenarios. The “Closer to DSP” group showed unimpressive coherence for the car scenario (more students selected the Hybrid than the SUV), but high coherence for the shoe scenario (all of the students selected the leather tennis shoes). The “Closer to NEP” group showed high coherence for the car scenario (all of the students selected the Hybrid) and low coherence for the shoe scenario (the majority selected the leather tennis shoe). The “Middle” group was spread between the three choices, but with somewhat heavy and opposite leanings when comparing the car and the shoe (65% selected the Hybrid, and 67% selected the styled synthetic shoe).

Looking at changes in coherence for the two scenarios between pre- and post-testing time, I concluded that the “Closer to DSP” group increased its coherence for the car scenario (increasing students selecting the least environmentally friendly choice) and decreased its coherence for the shoe scenario (more students selected the most environmentally friendly choice). The “Middle” group showed mixed changes relative to coherence for the car scenario, but definitely became more evenly distributed among the three choices for the shoe scenario. The “Closer to NEP” group showed decreased coherence for the car scenario (a third of them selected the least environmentally friendly option at post-test time as compared to 0 at pre-test time) and increased coherence for the shoe scenario (a shift away from the least environmentally friendly option to the most environmentally friendly option pre- to post-testing).

Results from the coherence perspective were clearly mixed. Although there was still evidence of overall increases in coherence from pre- to post-testing, the comparison between the shoe and the car scenarios indicates once again that the two scenarios were not equivalent in some respect. Students did seem to “behave” differently with the two decisions. Given that the scenarios were constructed in a parallel fashion, it seems likely that the “emotional charge” of shoes and cars was very different for these students. I discuss this idea more thoroughly in the final chapter.

### **Process Decomposition**

Finally I used the process decomposition perspective, which asserts that if each step in a given process of decision-making is performed well, this will contribute to an overall better decision. Thus, one can examine progress toward

good decision-making by looking at individual steps or by “decomposing” the process. Using this perspective, I focused on the “Consequences” step of SCDM for efficiency (although, ideally, one would look at all steps in a process to be complete). Table 27, below, shows the changes in students' consequential thinking score from pre- to post-testing. (As a reminder, this score is based on the number of options discussed and whether direct or indirect consequences were discussed. Refer back to Figure 4, page 71). This table shows that from pre-test to post-test the percentage of students' shifts from lower to higher consequential reasoning. However, there were no significant changes within the individual score levels nor with the combined score levels (i.e. 1 combined with 2 or 3 combined with 4.)

Consequence Score (n=80)	Pre	Post	Change	Significance (McNemar test)	Combined Change	Signif. (McNemar test)
1	62.5	55.0	-7.5	0.458	-11.2	0.122
2	16.2	12.5	-3.7			
3	13.8	21.2	+7.4		+11.1	
4	7.5	11.2	+3.7			

**Table 27: Percentage Change in Consequential Thinking from pre- to post-testing for all 80 students**

The following two tables (28 and 29, on the next page) show the same information, but the first table represents Kristin’s students, while the second represents Mara’s students. Kristin’s students show the desired growth pattern; students moved toward more complex thinking regarding consequences, as was also seen overall (in Table 27, above). A statistically significant change occurred in that twenty-two percent

of the students moved from the lower two levels to the higher two levels. Results in Table 29, below, show that Mara’s students did not demonstrate the desired pattern.

Consequence Score (n=36)	Pre (valid %)	Post (valid %)	Change	Significance (McNemar Test)	Change2	Signif. (McNemar Test)
1	58.3	44.4	-13.9	0.253	-22.2	0.039
2	22.2	13.9	-8.3			
3	8.3	22.2	+13.9		+22.2	
4	11.1	19.4	+8.3			

**Table 28: Percentage Change in Consequential Thinking from pre- to post-testing for Kristin’s students (n=36)**

Consequence Score (n=44)	Pre (valid %)	Post (valid %)	Change	Significance (McNemar Test)	Change2	Signif. (McNemar Test)
1	65.9	63.6	-2.3	0.664	-2.3	1.00
2	11.4	11.4	0			
3	18.2	20.5	+2.3		+2.3	
4	4.5	4.5	0			

**Table 29: Percentage Change in Consequential Thinking from pre- to post-testing for Mara's students (n=44)**

It is clear that Kristin’s and Mara’s results are quite different from one another when looking through the lens of Process Decomposition, and that the overall results were driven by the larger and statistically significant results from Kristin’s classroom. Kristin’s students showed gains in their ability to express Consequences as defined in SCDM, whereas Mara’s did not. This difference between the results of the two teachers may derive from the difference in their classroom management style. In Kristin’s classroom all students were engaged in the practice of using SCDM. In Mara’s

classroom many students were disengaged in this practice and “off-task” much of the time.

One note that must be made regarding the combining of 1 with 2 and 3 with 4 in this consequential thinking analysis is that by doing so, I have effectively collapsed the 2-dimensional coding rubric shown in Chapter 3 (Figure 4 on page 72) into a one-dimensional coding rubric measuring only whether students discussed one option vs. more than one option. The differences between students discussing direct vs. indirect consequences are no longer captured.

## Summary of Results

The major findings of this research include:

- Each of the three decision-making perspectives and the methods I devised based on them provide a unique opportunity to assess students’ decision-making skill.
- Looking at students’ SCDM skills through the lens of the **Satisfying Results** perspective revealed no statistically significant changes in the options that students chose from pre-testing to post-testing. Students were not more or less likely to choose options based on the nature of their environmental characteristics.
- Looking at students’ SCDM skills through the lens of the **Coherence** perspective revealed mixed results with regard to gain in the consistency between students’ Personal Environmental Values and their choices. More specifically, the results varied by teacher, with Mara’s students showing less gain in coherence than Kristin’s students. This difference may be attributable to the more relaxed classroom management style of Mara as compared to Kristin, whereby fewer students were engaged in learning SCDM.
- Looking at students’ SCDM skills through the lens of the **Process Decomposition** perspective shows that Kristin’s students made significant gains in their consequential thinking. Mara’s did not, which again may be due to her more relaxed classroom management style, whereby fewer students were engaged in learning SCDM.

Additional findings of this research include:

- High-school students' Personal Environmental Values were malleable with instruction of CASES and SCDM. Changes were small, but an interesting pattern was revealed. Students whose values at the beginning of the study period were most different from those of their teacher changed their values the most, and in the direction of those exemplified by the teacher.
- Differences in instruction seemed to influence students' results. Both the values exemplified by the teachers and their classroom management styles appeared to influence students' environmental values and their decisions. Students' values changed more when their teachers' examples were contrary to the students' original values. Students whose teachers had firmer classroom management styles learned and utilized more of the SCDM skills, when assessing them through the "Coherence" and "Process Decomposition" perspectives.
- Furthermore, the two scenarios (car and shoe) were likely not equivalent in some critical way. This difference was apparent from both the Coherence and Satisfying Results perspectives. Given that this was true for two out of the three perspectives, I did not test for task differences with the Process Decomposition perspective.

## Chapter 5

### Conclusions/Implications

In this chapter, I discuss the results that I have obtained in this study. I first discuss the Satisfying Results, Coherence, and Process Decomposition results given the case-study application of them with CASES, and then look at these approaches in general. I then discuss the “teacher effects” which appear in the results, followed by the values-specific results that surfaced through looking at the student data via the Coherence perspective. General implications are discussed, especially as they relate to the need for assessment in this area, as was discussed in the first two chapters. I end this chapter with recommendations for further studies in this area.

#### Three Methods for Assessing Decision-making

**Satisfying Results.** While changing students’ choices or behaviors was not a goal of the CASES curriculum, it was worth checking to see if it had this effect. The results showed students moving toward being more environmentally friendly for the shoe scenario but not for the car scenario. This unexpected result was seen for students of both teachers. The current research in this general area is scarce, as the studies that I found relative to environmental decision-making with high school students either only addressed in-class discussions (see Ratcliffe, 1998)—e.g., not assessment of

individuals—or only involved decisions about the same type of large-scale conservation/environmental issues such as pollution and conservation scenarios that were the focus of the curricula (see Fortner, Arvai, Froschauer, & Malinowski, 2003; Hungerford, Volk, Ramsey, Litherland, & Peyton, 2003; NSTA, 1997; Snyder, Dockterman, & Lewbel, 1991) –not everyday, personal, consumer-type decisions. Mine is the only recent educational study of which I am aware that attempted to assess students’ decision-making using individual consumer-type decisions.

One interpretation of the results obtained here is that, while the two scenarios were intended to be parallel—including presenting equally compelling decisions for adolescents—this may not have been the case. Although unforeseen, this possible non-equivalency of the decision-making scenarios could be considered an interesting and worthwhile finding itself. There are a number of compelling and possible reasons why these two scenarios were not treated equivalently by the students. Although not very current, Moschis and Moore (1979) provide a number of reasons why students may have reacted differently to the cars and shoes by looking through the lens of socialization. These reasons include brand name of products, social class of students, the sources of information that adolescents tend to prefer for certain “everyday” purchasing decisions, and the criteria they use for purchasing certain items. For example, for purchasing a pair of dress shoes (the closest item in their study to those in my study), adolescents used the criteria of “well-known brand name” slightly more than they used “on sale” or “parents like” (p. 107). In my study of the three cars and three shoes, only the pictures of one car (Mustang GT) and one shoe (Adidas “tennis” shoe) were obvious. It may be that students with these as brand name preferences were selecting them, regardless of the other

information available. Confounded with this, Moschis and Moore argue that socioeconomic background may affect decision-making patterns of adolescents because there are differences in experience with money. Adolescents from low-income homes, like those in my study, may have less experience with the consumer environment, which means less experience with various products in the marketplace. This might mean that they have less brand preference going into a particular consumer-related decision.

More recently, work done by Bechara, Damasio, & Damasio (2000) in the field of brain chemistry provides the possibility that emotions play a strong role in decision-making. Essentially, they describe a process by which the “set of immediate and long-term outcomes for each response option is processed in sensory imagetic and motor terms and is then recorded in dispositional and categorized form” (p. 296). In laymen’s terms, there is a chemical trace left in the brain by interactions people have with various objects in the world. When faced with a decision about those objects, various associated emotional states get triggered. If there is a strong (either positive or negative) emotion associated with an object, “somatic states may indeed serve as the decision maker” (p. 305). Thus, cars and shoes may evoke very different “emotional charge” for various students and for totally different reasons based perhaps on gender, age, experiences in life, etc. The work of Pooley & O’Connor (2000) adds that “[i]t would seem that attitudes formed through direct experience with an attitude object tend to be affectively based, whereas attitudes that are formed on indirect experience seem to be cognitively based” (p. 718). The scenarios the students were given had a mixture of information about objects they would be familiar with (e.g. cars, shoes, school, friends)—which may have led them directly into the affective domain—and objects they would not be as familiar with given

their urban location (e.g., biodiversity, the grassland and water it takes to raise cattle, etc.)—which would have led them into the cognitive domain. In other words, it would be hard to know whether students’ choices were made based mostly on their SCDM-related decision-making skills or on their emotions. More research will be needed in this area to determine whether my results were an artifact of this particular student sample or whether this highly different response for cars and shoes would be true for others as well. Furthermore, based on the work of Moschis and Moore (1979), Bechara, et al. (2000) and Pooley & O’Connor, (2000) it is obvious that the design of two “equivalent” tasks is not a simple matter.

Another entirely different interpretation of these results is possible, however. As has been previously discussed it was not a goal of CASES to change students’ choices or behavior per se, and it did not do so overall. The mixed results whereby no net change toward (or away from) more environmentally friendly choices was seen could be construed to mean that CASES did not exert influence in this way. Thus, with this perspective and the goals of CASES in mind, Satisfying Results might be considered a successful method. Additional tests of this perspective with curricula that do have actual behavior change as a goal will need to be accomplished in order to verify its accuracy as an assessment method.

In addition to looking at the particular results obtained by this case study, looking at the Satisfying Results perspective itself is worthwhile. It is unique as compared to the other two perspectives used here in that it requires a declaration of one’s point of view or one’s values. Specifically, one’s (or one’s organization/curriculum) determine what “satisfying” means. I chose in this dissertation to look at the results from the perspective

of the environment as opposed to some other stakeholder. This perspective would be consistent with at least one of the educational organizations mentioned in the first chapter, namely the National Association of Environmental Education (NAAEE), as well as with one of the teachers in the study (Mara). NAAEE has a clear stance regarding education **for** the environment. This professional environmental education association advocates for educating future citizens to care for the environment by engaging in sustainable behaviors. My results, then, would be mixed from the point of view of organizations such as the NAAEE that would have young citizens making increasingly environmentally friendly choices on all consumer-related decisions. In other words, they would prefer to see the number of students selecting the most environmentally friendly options to increase, regardless of whether the decision involves cars, shoes, or any other good.

**Coherence.** This perspective was used to describe the match between students' personal environmental values and their choices on the two tasks. Coherence was an implicit goal of the CASES curriculum. Results obtained by looking at the students' responses from this perspective were also mixed. For the whole sample, coherence significantly decreased for the "Closer to DSP" group, while the other two groups did not change significantly. Looking only at Kristin's students, there was a statistically significant increase in coherence for both the "Middle" and "Closer to NEP" groups, while the "Closer to DSP" group showed no significant change. Looking only at Mara's students, there were statistically significant decreases in coherence for all three groups. Thus, the results for the whole sample were dominated by Mara's results for the "Closer to DSP" group. The results for the other two groups were in opposite directions for the

students of Mara and Kristin and so “cancelled each other” and no significant change was seen overall.

One possible explanation of these differing results by teacher is that Mara’s students did not experience the curriculum as intended, mainly due to Mara’s less effective classroom management. This would have weakened the implemented, and thus the attained, versions of CASES and SCDM. Kristin’s students, on the other hand, had greater exposure to the intended curriculum, due to her more effective classroom management. For this reason, I will focus the rest of this discussion on Kristin’s results. More discussion about this issue of instructional differences between Kristin and Mara follows in a later section so I do not elaborate here.

As mentioned above, Kristin’s students show an increase in coherence for both the Middle and Closer to NEP groups. The Closer to DSP group shows no change. Given that I found no other studies analyzing subgroups of students based on their values, I can only surmise why the Closer to DSP group behaved differently than the other two groups. To begin, I wonder whether this group is generally less conscious of what their values are—the Dominant Social Paradigm by definition is the value system or worldview that permeates the culture and as such is unquestioned or unexamined. The New Ecological Paradigm is an alternative to this paradigm and developed in reaction to it. Thus, it may be that students who have values closer to the NEP end of the spectrum (which includes both the Middle and the Closer to NEP subgroups in my study) are more conscious of their values because they have developed them specifically rather than blindly adopting the DSP. Being more conscious of their values, they may be more able to make choices which are consistent with those values. And, the CASES curriculum

appears to have increased this ability, perhaps due to its focus on conscious use of values in making decisions. The Closer to DSP group may be less conscious of their values, and by extension less able to make choices coherent with their values. And, the CASES curriculum did not appear to help this particular group move forward in this way.

Regardless of the reasons for the changes (or not) for the different groups of Kristin, the overall results for her students imply that CASES and SCDM had a positive effect on the match between students' PEV and their choices. This was an implicit goal of CASES, as discussed earlier. This is encouraging for two reasons. First, it shows that the analytical method developed here was sensitive enough to capture those changes. Second, as Knapp (1983) states, "at the highest level of value development, a person's values...determine individual behaviors" (ibid., p. 25). What we see here, then, is that CASES is helping some students to more closely align their values with their decisions, and that this is a step forward developmentally—for values development as well as for decision-making development. I know of no other studies that have looked at the actual coherence of students' values and their decisions, so this may be a novel and important approach to studies in this area. In fact, Mann, Harmoni, & Power (1989) reported that there were no research results on "consistency" (p. 271), which is closely related to what I have called "coherence."

**Process Decomposition.** The improvement of students' use of a decision-making process was an explicit goal of the CASES curriculum. The results obtained by looking at students' responses with this perspective were also mixed, again based on teacher. Kristin's students showed positive movement along the scale of 1-4 relative to consequential thinking. Mara's students did not. Once again, I speculate that this

difference in students' results is due to the difference in the teachers' classroom management. I believe that Kristin's students attained more of the intended curriculum than did Mara's, because Kristin created a better foundation for learning, as discussed in the last section (Kempler et al., 2008). Specifically, the results suggest that Kristin's students improved in their ability to consider the consequences of more than one option before making a choice. In so far as the consequences step can be used as a representative measure for the entire SCDM process, these results (of Kristin's students) are positive. They would indicate that the decision-making skills of high school students may be improved with direct and contextualized instruction. In addition, the use of this perspective to analyze SCDM skill changes seems successful. Changes were able to be detected, thus some level of sensitivity is present in the way that consequential thinking was analyzed.

Additionally, this finding is consistent with the study of the GOFER decision-making process by Mann, Harmoni, Power, Beswick, & Ormond (1988), which found that the self-reported decision habits among students of average age 15.3 years increased over the course of study (16 total contact hours). I believe that my study is in fact a better representation of actual student learning than Mann, et al.'s in that the assessment is from an external source rather than self-evaluation. However, mine is equally imperfect in that, "[a] more rigorous evaluation is the extent to which students subsequently and correctly apply the skills they have learned in their personal decision-making" (ibid., p. 161). Ideally, such evaluation or assessment would be attained by looking at students' decisions in their actual lives, not on a piece of paper. However, this approach would also invite a suite of methodological challenges.

Looking more generally at this perspective, it may be the least controversial of the three used in this study as it is the most “value-free.” It gives information about the skills students have acquired, potentially without having to consider the specific decision being made, or the related values held. One could look at the number of options and the type of consequences, and measure the combination of those things with a rubric similar to mine, regardless of the specific content. I must acknowledge, however, that I have only looked at one step of the SCDM process, namely “Consequences”. The intent of the Process Decomposition perspective is that all steps would be important in discerning someone’s skill or expertise. Thus, future work in this area could and should develop assessment for entire decision-making processes—and again, many contain similar components—to make this technique complete.

### **Summary of Decision-making Assessment Results**

The decision-making results obtained here affirm that in some ways, decision-making expertise provides more complexity relative to assessment as compared to the fact-based knowledge taught in traditional science classrooms. There are many ways to look at decision-making. In this study, I chose to attempt to make sense of students’ skills in this area by using open-ended tasks. These in turn require thoughtful creation and administration, as well as various rubrics for scoring them. Further, the goal that one has in mind for teaching these skills in the first place determines which technique(s) might be “right” for assessing students’ skills. Although there were modest changes in students’ decision-making expertise in this study, the main contribution provided by this work is the application of decision-making expertise theories to the task of assessing student decision-making work. The three perspectives on decision-making that I

rendered into specific analytical methods each shed light on different aspects of students' EDM.

The work I have done here provides specific avenues for matching the assessment of decision-making with the goals for teaching it. Thus, the merit of the research I have done here lies mainly in its methodology. In one sense, with the methods I developed, I was able to “uncover” the goals that the developers of CASES had for the inclusion of the explicit teaching of SCDM. What I found is that (given good classroom management), the assessment techniques essentially detected positive attainment of those goals. Behavior change was not a goal of CASES, and the Satisfying Results findings show no overall behavior change. Coherence was an implicit goal of CASES, and the results show some positive changes here. Students' use of a process was a goal of CASES, and the Process Decomposition method detected positive gains relative to one key step of SCDM. The methods demonstrated three viable options for evaluating student growth in decision-making skills.

Lastly, although my results were modest in their significance, and mainly for one teacher, I speculate that some of this modesty may be due to the small sample size resulting from extreme attrition. More significant results might be acquired with a larger sample. Starting a study with much larger numbers of teachers and students would be my recommendation, given that attrition seems somewhat common in educational research.

### **Instruction-related Results**

The findings of this research suggest that two aspects of instruction made a difference in students' EDM and values changes. The two aspects I looked at were the

values exemplified by the teacher and their classroom management. As was discovered in the results, values exemplified by the teacher seem to play a role in which students' values change and in what direction. This influence has been suggested for years, as stated by Carbone (1987), teachers "cannot avoid imparting values in one way or another in the normal course of their activities qua teachers...What we consider 'good', 'right', or 'important' constantly guides our practice, whether consciously or not" (ibid., p. 10). My results lend empirical evidence to Carbone and other's (see Gudmundsdottir, 1990) statements to this effect.

My results also confirm the finding of Kempler (2008) whereby teachers' classroom management differentiated student achievement in project-based classrooms. Essentially, classroom management (among other things) provides a "foundation for learning" (ibid, p. 3). My assessment of the two classrooms and the results of the students in those classrooms is that Kristin provided more of that foundation for learning than Mara did. While this is likely not a new finding, nor specific to classrooms where CASES is being taught, it continues to be relevant. Teachers with more effective classroom management practices seem to be able to reach more of their students. Students in the classroom where time and behavior were monitored and managed showed greater gains in consequential thinking and coherence between values and choices. Students in the less carefully managed classroom showed fewer such gains. This finding is consistent with the "process-product" research as reported by J. Brophy (1986) from over 30 years ago which links teacher behavior to student achievement. One aspect of what Brophy reviews in the research available at the time is Fisher et al.'s (1980) "academic learning time" (Brophy, 1986, p. 1070). Academic learning time is defined as

the time students are engaged in academic tasks that they can complete successfully. I would suggest that Kristin's students had more of this academic learning time than did Mara's. And, taking a broad view, these findings may also support Brophy's discussion that low-SES students need "more structuring from their teachers, more active instruction and feedback, more redundancy, and smaller steps with higher success rates" (ibid., p. 1073). Kristin's instructional style provided structure through the use of breaking tasks down into smaller segments, and using a timer to keep them moving through those segments at a brisk pace with time to check-in between the segments. These techniques seemed to translate to higher levels of student attainment of the CASES curriculum with this population of low-SES students.

To conclude this section, I refer back to my research question in this area which dealt with the values exemplified by the teacher, but I felt it important to recognize the important role of classroom management as well. In the analysis, I dealt with these two aspects of instruction completely independently of one another. Values-exemplified by the teacher affected the values results of the students. Classroom management styles affected the foundation of learning for decision-making skills. Confounding them or looking for interaction effects of the two was impossible to do statistically given the small sample size, so I treated them separately. In real life and in real classrooms this is not the case, and does present a methodological challenge. However, given that teacher effects would be expected given human nature and given the nature of the curriculum (i.e. explicit inclusion of values), the methods used here are given credence by having found such differences between teachers. In summary of this discussion about instruction, I embrace a conclusion drawn by Schneider et al. (2005): "Only by understanding

teachers' initial attempts at reform and the range of enactments that are reasonable to expect can we begin to develop materials that support a variety of teachers in making changes" (p. 307). Given that the CASES curriculum is a newly published, reform-oriented curriculum requiring teachers to step out of traditional science teaching roles, my findings may help developers of similar types of curricular materials, as well as professional development experiences, to support teachers. Teachers may need support in understanding the intent of the curriculum developers as well as the potential influence that their own "take" on things might have on student outcomes. Additionally, it is critical that teachers develop good classroom management skills in order to best achieve the educational goals toward which they strive.

### **Values-related Results**

*\*\*Note: This section does not reflect an explicit research question. Through the exploration of values for the Coherence perspective, however, there were interesting results that seemed worth exploring.* This study's results show that some high school students' Personal Environmental Values were malleable. This in itself is not necessarily a noteworthy finding. However, getting more specific, what I found was that students at the more extreme NEP and DSP ends of the scale became less extreme over the course of one unit of CASES. The most interesting part of the story is that this malleability was dependent on the values expressed by their teachers during instruction. Students whose values changed significantly were those whose values at the beginning of the study were most different from the values exemplified by their classroom teacher. Students with more environment-oriented values moved away from the New Ecological Paradigm end of the NEP spectrum when the teacher stressed more "self"-oriented values. Students

with more self-oriented values moved away from the Dominant Social Paradigm end of the NEP spectrum when the teacher stressed more “environment”-oriented values. Students who had teachers who expressed values similar to the students’ original ones, or who had values in the middle of the spectrum did not change their values. I know of no other studies which have attempted to document changes in students’ environmental or other values based on values expressed by their teachers. This evidence is important as it lends specificity to the inherent differences between the intended, implemented, and attained curricula.

This finding—in concert with Manoli et al.’s (2007) finding<sup>19</sup>—implies that the education vs. indoctrination debate is not moot. I first borrow the words of Halstead and Taylor (2000) to describe the two-fold role of school: “to build on and supplement the values children have begun to develop by offering further exposure to a range of values that are currently in society...; and to help children to reflect on, make sense of and apply their own developing values” (p. 169). The first part of this statement seems closer to what indoctrination might be (e.g. moving students toward a certain set of values) although with a positive spin, while the second seems closer to education (e.g. helping students find their own values). These descriptions may be points on a spectrum between extreme indoctrination and agenda-free education, but it is interesting that Halstead & Taylor express both roles as important in school. Given that Guber (2003) found that Americans value the environment, it would seem that moving students toward more pro-

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<sup>19</sup> The one other study I have found which used the NEP with students, found small but significant results; Manoli, Johnson, & Dunlap (2007) found that 10-12 year-old students changed their environmental values as measured by a modified version of the NEP after a 5-day program. Interestingly, their sample included Hispanic students (in Arizona) and Caucasian students (in Arizona and Pennsylvania), but no results are reported by race.

environmental values is appropriate given that this is a current societal trend. What to teach in science is often connected with the cultural, social, and environmental issues of the day. In other words, “[o]ne way by which a particular society might espouse its value system is through its educational system” (Rennie, 2007, p. 199). The post-Sputnik flurry and resulting push for engineering as a major focus of science education (Novak, 2005) is one good and fairly recent example. In the present day, one could argue that the degradation of the environment and its implications for our collective future requires that we advocate for students to more highly value the quality of the environment. Yet, even saying this does not mean that the answers to the complex and global environmental issues are obvious or that there is one “right” solution.

In teaching science that includes a discussion of values, we are directly addressing the National Science Education Standard cited in Chapter 1: “Science and technology are essential social enterprises, but alone they can only indicate what can happen, not what should happen. The latter involves decisions about the use of knowledge” (NRC, 1996, p. 199). Furthermore, as Jorde & Morke (2007) wrote, “[b]y introducing multiple values into the controversy, including biological, economic, social and political arguments, students will hopefully understand the complexity of how decisions are made in a society and how values influence opinions and actions” (ibid, p. 180). Another way to look at the issue of dealing with values in the school science context is that we are helping students see that even given the same scientific (or other) information, people make different decisions because they value different things. This is an important life lesson itself.

If causing change in environmental values should be a specific goal, however, what are other ways that have been found to make a difference? Chawla (1998) interviewed numerous environmental professionals in the US and in Norway to find out what shaped their decision to do work in that field. She found that during adolescence and early adulthood, education and friends were most frequently mentioned. At other stages of life, other experiences were more important. For example, during childhood the experiences with most influence were direct contact with nature and familial role models. And, during adulthood, the most important influence was pro-environmental organizations. Thus, while there are many ways by which people find entry into environmental awareness and thinking, at the time of adolescence education may be one of the two most effective. My results provide some evidence that education may make a difference in real time, and not just in retrospect.

To summarize the values-related results, I highlight two things. First, there were changes in PEV for some subgroups of students and these were related to the values exemplified by the teacher. However, with the small sample size, these results are not very reliable. Thus, this is not a strong contribution to the literature, but could be a useful avenue for further work. Another potential contribution stems from the methodology. Looking for changes in values by disaggregating the sample to look at them in subgroups is not an approach I have seen in any values-related education research. In his study, Leming (1981) compiles the results of 33 different values clarification studies and finds that little or no confidence is warranted for that approach. Although my study would at first glance support this statement, for example by looking at students in the aggregate, the story changes when looking at subgroups of students. This makes me wonder

whether some of the studies about which Leming reports would also find changes if they looked more closely at the range of students present and possible different effects within that range. Thus, my effort may move this area of research forward by creating some common ground toward Halstead and Taylor's (2000) statement that "[t]he evaluation of school effectiveness in values education requires agreement over...how to measure the value that schools add to pupil's development" (p. 189). Given that changes in values were seen with these methods could mean that adolescents are still at a point in life where their values are malleable. It is well worth the effort to understand how this value change occurs in classrooms.

### **Broad Implications**

In this section, I will mainly discuss the broad implications of the assessment-related research completed here, as opposed to the values- or instruction-related research. This portion of my work may be the most novel relative to the existing literature. In order to focus on this portion, I will remind the reader that I began this dissertation by highlighting the fact that several organizations have explicit goals for teaching Environmental Decision-Making (EDM). However, these goals do not necessarily imply the same outcomes for students. This statement is exemplified by looking at some of the specific phrases in the standards mentioned in the first chapter. For example, the American Association for the Advancement of Science promotes "fostering intelligent respect for nature" (Rutherford & Ahlgren, 1989, p. vi), the National Research Council aims to improve students' "rather simple and naïve ideas about the interactions between science and society" (NRC, 1996, p. 197), and the North American Association of

Environmental Education wants students to be able to “evaluate the consequences of specific...changes, conditions, and issues” and to “articulate a position on an environmental issue” (NAAEE, 2004). While not entirely inconsistent with one another, the student outcomes they suggest are not the same.

The AAAS goal suggests that they want to target students’ values, and perhaps their behaviors. “Intelligent respect” for nature could be interpreted as either the values a person holds or his or her behaviors—it is not entirely clear. Given that behaviors require decisions before they become behaviors, I suggest that the AAAS might be well served by using either the Satisfying Results and/or the Coherence perspective to evaluate the effectiveness of their approach to environmental science and decision-making education.

The NRC goal suggests they want to replace students’ naïve ideas about interactions of science with society with more realistic ones. This is at least one way to interpret the verb they use, “improve.” To me, in the context of environmental science this could translate into having students better understand the consequences that humans have on the natural world. Thus, I suggest that the NRC would be well served by using the Consequential Thinking scoring rubric I have devised here. They wouldn’t necessarily need to use it as part of a whole decision-making Process Decomposition approach, but as a stand-alone way to see if students’ ideas about the interactions of the natural world and society are becoming less naïve.

Lastly, the NAAEE wants students to be able to take an informed stand on issues, which is assumed to lead to beneficial environmental choices. As mentioned previously in the Results chapter, the NAAEE would likely be best served by using the Satisfying Results approach to looking at student decision-making about the environment. Although

my interpretations of these organizations goals could be argued, I believe that it is important to attempt to determine what it is they are actually calling for. It is also important to try to get these organizations to be more specific and clear about their goals. It should no longer be acceptable to be vague. If curriculum writers and teachers look to these organizations for guidance about what to teach, then that guidance should be straightforward.

These three examples demonstrate, though on a scale larger than the classroom, what is referred to by Stiggins, Arter, Chappuis, & Chappuis (2006) as “target-method” match: “The heart of accuracy in classroom assessment revolves around matching different kinds of achievement targets...to the appropriate assessment method” (p. 95). In other words, it is important to have an assessment method which corresponds with the goals that are the target of instruction. This match is part of what ensures accurate interpretations of what students know and are able to do. And, as the number of education benchmarks and standards related to decision-making are taken seriously, and as the number of decision-making curricula rises, my work can be used to ground other’s efforts by providing useful techniques for assessing change in students’ decision-making skills, based on the goals for doing so. My impression of most EDM-focused curricula is that this grounding has been lacking, and that assessment techniques have been non-existent and/or not informed by the idea of “target-method” match. This study provides a foundation for both educators and/or curriculum developers and several choices of technique to create the right combination which matches their goals.

One other “big-picture” implication or application of this work relates to some other work by Stiggins et al. (2006). They differentiate between “assessment *of* learning”

and “assessment *for* learning”. Assessment of learning can be thought of as being for the purpose of accountability, while assessment for learning can be thought of as being for the purpose of promoting learning. Assessment of learning is for audiences outside of the student and assessment for learning is for the student (p. 89). It is my impression that the Satisfying Results and Coherence methods described in this work could be classified as assessments of learning. I say this because with both perspectives, one either has a “satisfying result” or “coherence”, or one does not. In this way, these perspectives are outcome oriented. They give information about the end of the learning process, not the process itself. On the other hand, the Process Decomposition method could be used as an assessment for learning. By breaking down a decision-making process into components and analyzing a students’ performance on each one, that student could learn an immense amount about their own progress. In the words of Yates and Tschirhart (2006), “...if a decider is poor at some particular decision process element, this is itself a partial explanation of that individual’s lack of overall decision-making proficiency. It also points to very specific things one can do to improve expertise...” (p. 427).

Thus, there are two assessment frameworks to which these three decision-making assessment approaches might contribute. One is the target-method match framework. Flexible approaches allow for various users to fit their assessment techniques to their goals for teaching decision-making in the first place. Second is the framework of assessment for learning and assessment of learning. With different purposes for assessment (e.g. furthering the learning versus reporting the learning) these approaches allow various users to glean the appropriate information about a students’ decision-making.

## Next Steps

To move our understanding forward relative to the assessment of Environmental Decision-Making, there are several areas of research that I would recommend. First, it would be informative to apply these approaches to additional case-studies, such as 1) CASES and SCDM again, but with a much larger sample size; 2) other curricula with a focus on EDM, but with different stated goals; 3) other curricula with decision-making processes included, but without the environmental focus. These additional case studies would help define the boundaries within which the three assessment approaches developed here are effective.

Given that recommendation, there are some preliminaries which stem from the limitations of my work discussed in Chapter 3. These are methodological issues that if improved, would increase the reliability and validity of the work done here. The first of these is the development of open-ended decision-making tasks that students would actually treat as equivalent. Teasing out the differences in students' answers that derive from the content of the scenarios as opposed to some other aspects (e.g., "emotional charge") would be worthwhile to try to accomplish—especially if their reactions are also somehow strongly tied to their cultural or racial background. If we are to understand changes in decision-making of students with a balanced test design (students responding to a different task at post-test than at pre-test), then more work is needed in this area. Researching different types of scenarios that students might react to equivalently would be a useful next step.

The second area I would recommend for future work has to do with looking more closely at the complexity of the implemented curriculum. I used only two variables to explain teacher effects: classroom management and values teachers used in their examples. While these two measures did provide some degree of explanation for the differences in student results, there are likely many more variables at which to look. One example of a potential variable is the teachers' intentions. I came close to being able to triangulate the teachers' intentions in this study, but they were not directly measured or applied in the analysis. It would be important to understand the goals that teachers have for teaching curricula such as CASES so that we can understand the alignment (or not) of the curricular goals and teachers' goals. The design of professional development efforts and curricular supports could be quite different based on the degree of this alignment. Specifically, using case studies such as those provided here that "represent alternative ways of teaching the same content could be particularly valuable in fostering prospective teachers' examination of the influence of values on instruction" (Gudmundsdottir, 1990, p. 51). If "prospective" is broadened from meaning "pre-service" to being new to a particular curriculum, looking at alternative approaches to the same curriculum (and the subsequent effects on students) would be invaluable professional development.

One place to look for guidance on this issue comes from a study of science teachers' intentions by Zint (2002). In this study, several prediction models were tested to see which best explained teacher incorporation of environmental risk education (defined as the probability that harm will occur to the environment). The three models included the Theory of Reasoned Action, the Theory of Planned Behavior, and the Theory of Trying. The results suggest that attitude toward the behavior (i.e., teaching

environmental risk education) is the strongest predictor of science teachers' intention to act. An extension of this study that might be useful is to conduct the surveys with teachers who are familiar with the intentions of a certain curriculum that involves the behavior in question (e.g., CASES). Both Mara and Kristin clearly had an intention to act, meaning to teach this material, and both likely believed that they were "acting" accordingly and teaching their students how to "do" SCDM. However, there were major differences in what that actually looked like in their classrooms, and what the students walked away with. Furthermore, it might be useful to parse out results for different types of teachers. For example, rather than looking at science teachers in general, it might be useful to differentiate the results by type of science teacher. Physics teachers may have less material to cover that is related to environmental risk. The results for Environmental Science teachers, on the other hand, may be much more interesting and pertinent to study.

These next three suggestions for future work are more general and do not necessarily pertain to shortcomings in my own methods, and would add to my work in ways beyond the methodology. They relate more to the teaching of environmental decision-making rather than to the assessment of it. First, given that my results were quite modest and add to other studies with modest to meager results (e.g. see Laskey & Campbell, 1991), I wonder whether we are laying the right type of foundation for this work with adolescents and environmental decision-making. Through this dissertation process, I have come to more fully appreciate that decision-making involves knowledge, skill, and *affect* (Ross, 1981). It may be too much to expect that focusing on knowledge and skill in the middle- and high-school grade levels is going to have a large effect without having created the affective or emotive connections to the natural world first.

Looking at Sobel’s (1998, adapted from Sobel, 1995) prescriptions, a good progression is described by “[i]n early childhood, activities should center on enhancing the developmental tendency toward empathy with the natural world. In middle childhood, exploration should take precedence. And, in early adolescence, social action should assume a more central role” (no page number available). It may be that curricula such as CASES and the teaching of environmental decision-making processes is absolutely appropriate, but that they would have a larger chance of creating change if the youth learning it had developed empathy with the natural world prior to beginning the curriculum. Given this, it may be that we need to look more closely at the teaching of decision-making as the capstone learning—*for* the environment—that is added to many other years’ worth of developmentally appropriate learning *about* and *in* the environment. So, the question that arises is how can all three areas be developed effectively, especially for those students who live in large, urban settings? One course in high school seems less than we could and should be doing with those students.

Second, it would be useful to follow the research track of Kastens and Turrin (2006), who were mentioned in the introductory chapter. These authors gave some insight into the values we espouse for any geoscience education course: “As they grow up to be voters and consumers or decision-makers or policy-makers, we hope that learners will make wiser decisions about individual and societal interactions with natural systems...” (ibid, p. 422). However, what these same researchers found is that there is minimal to no support in the state standards (49 states that have standards) for how individuals impact the environment. As mentioned in the first chapter, this seems like a disconnect between what we hope and what we have actually created via the standards-

based system of educational accountability. So, another area for future work might be to look at the match between our cultural values and the values that are implied by our state and national science education standards. If we truly value the environment, as Kempton et al. (1995) found, that should be actively reflected in our culture, our organizations, and in what the standards and benchmarks outline for educating future citizens. Granted, we (like any culture) hold multiple sets of values and so we must make tradeoffs. Are the tradeoffs we are making, as represented in our standards and benchmarks, the ones that we truly believe are the most beneficial for future generations and the planet they will inhabit? Do they accurately reflect who we are and who we want to be?

Lastly, assuming that we do want to achieve an education that is good for students as well as good for the environment, another issue that deserves further research is one that relates to the Ten Cardinal Issues of decision-making introduced by Yates and Tschirhart (2006). The first cardinal issue is that of “Need.” This need issue “is about whether and how decision problems are recognized at the outset” (p. 429). Recognizing everyday decisions such as which car or shoe to buy, what transportation to utilize, at what temperature to set one’s thermostat, etc., as environmental decisions rather than just consumer or budgetary decisions may be one way in which ground can be gained for the environment. Thus, another area for future research would be to look at how to encourage people to see everyday decisions as worthy of systematic or analytic processes such as SCDM, as opposed to intuitive or heuristic-based decisions. Considering that every student will grow up to make decisions that affect the environment, how do we get them to slow down in this fast-paced world and consider the consequences of their actions? Given that such deliberation goes against our fast-paced cultural norms, it seems

that such deliberation would cause major dysfunction. However, I assert that we would only need to use such deliberation until our new heuristics are aligned to the current reality (e.g., there isn't always more where that comes from, more is not always better, etc.). Once these new and updated heuristics are more functionally in place via deliberate practice (Kollmus & Agyeman, 2002), our decisions will be better informed by the current reality that scientific evidence supports, and we can return to being rapidly intuitive about our daily choices.

### **Final Thoughts**

Environmental decision-making is a complex and important area of study, and our approach of study needs to be matched with our goals for doing so. The links between our cultural values, our educational organizations, our teachers' motives, and students' learning are highlighted by looking closely in this area. This study moves us toward being able to align our assessment of decision-making skills with various goals for teaching it. More work is necessary, and this study has the potential to provide a common language and methodological foundation for future efforts.

## Appendices

## Appendix A: Ten Cardinal Issues

Decision-Making Focus	Author	Decision Moniker	Preliminaries			ADDITION	Core						Aftermath				
			Need	Mode	Investment		Options	Possibilities	Judgment	Value	Tradeoffs	Acceptability	Implementation				
General	Yates & Tschirhart (2006)	10 Cardinal Issues				Pre-Options											
	Beyth-Marom, Fischhoff, Quadrel and Eurbay (1991)	GOFER				Goals Clarification	Option Generation	Fact Finding	consideration of Effects						Review		Implementation
	Lasky and Campbell (1991)	GOOP				Goals	Options	Outcomes	Probabilities								
	Beyth-Marom, Novik, and Sloan (1987)					Define the Problem	List alternatives	list relevant dimensions for assessment			evaluation of dimensions and alternatives			Weighting and Deciding			
	Hammond, et al. (1998)	PROACT				Define the Problem, consider list of Objectives	Identifying Alternatives		Consequences				Tradeoffs				
	NSTA (1997)			Whose Decision is it?		Identify Goals	Identify Options	Outcomes	Decision Chart, Probability		Expected Value		Importance Bars		Are students happy?		
	Gregory, Clemmen, Satterfield, Stone (1996)			Habit vs. Active Decisions; Decision Ownership		Assessing Quality of Information	Creating Alternatives	Structuring Consequences	Understanding Uncertainty		Identifying Values		Making Tradeoffs		Negotiating		
	Edelson (2006)	SCDM				Considerations, Constraints	Options		Consequences					Stakeholders			
	Tom Snyder Productions (1991)					Set Priorities	Consider Options	Examine Analogies	Predict Consequences								Take Action
	Former, et al. (2003)	PROACT															

See above (Hammond, et. al. 1998)

## Appendix B1: Letter Explaining School District Decision

John Smiley  
School Board President

Dear Students,

As members of the Parent, Teacher, and Student Association of the Central School District in Florida, we need your input on the following decision. As I'm sure you are aware, Central High School has become overcrowded, with over 200 students currently being taught in temporary classrooms. This population pressure is only going to get worse, as the school board predicts that we will have an additional 1000 students in the district within the next two years. In order to handle this problem and prevent similar ones in the future, we would like to build a school that can handle 2000 students total.

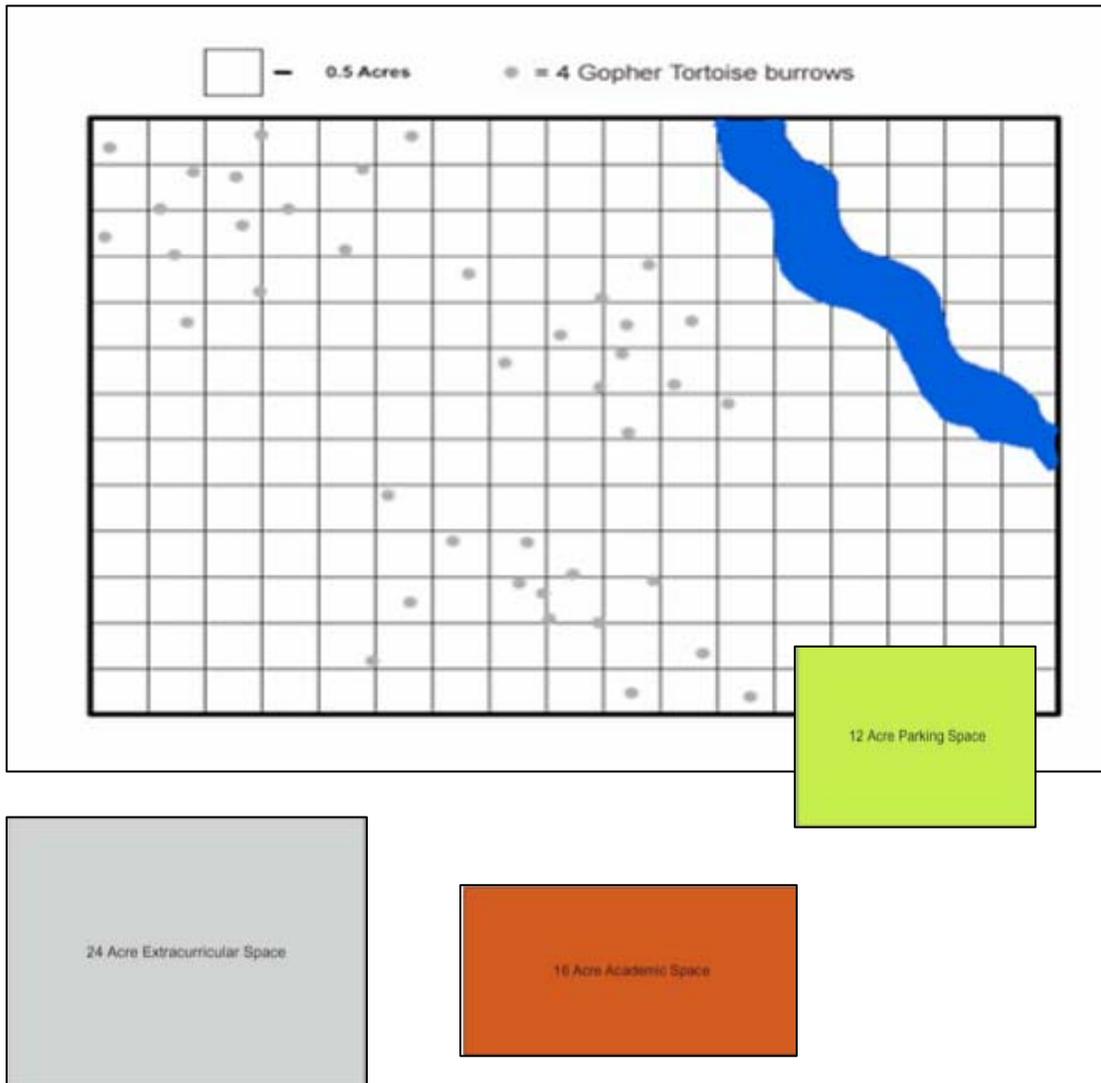
The piece of land that we have been given for the school site is home to 80 gopher tortoises, which are listed as a species of special concern in Florida. These tortoises are important to the upland ecosystem in Florida, and the school board does not want to wipe out this population of tortoises. Instead, we would like to create a plan that will allow the tortoises to co-exist on the site with the school. We think this will be an invaluable opportunity for science classes to observe the tortoises and we will be doing our part to preserve Florida's unique animals.

The total amount of land available is 100 acres. Approximately 4 acres are taken up by a river and 9 acres are on the far side of the river.

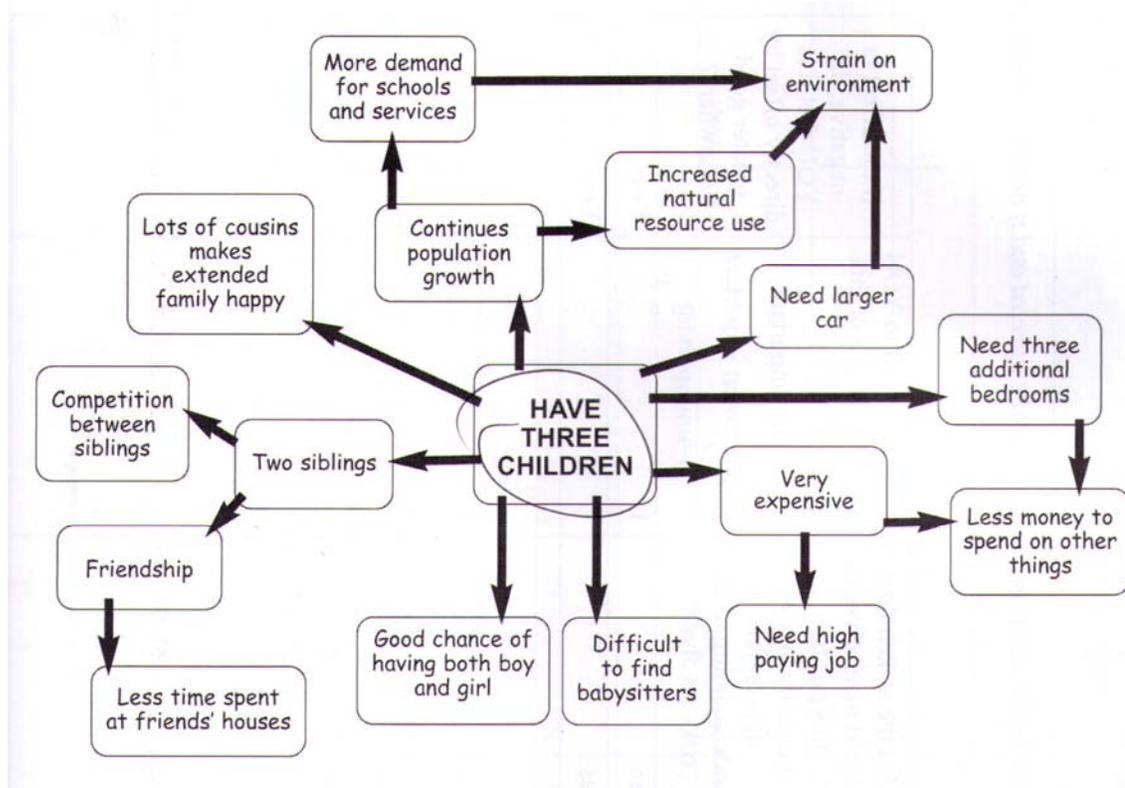
Your task is to determine where to place the school buildings to give us a good school, while still allowing the gopher tortoises to survive. Use the attached maps and building plans from the architect to help you make your decision.

Sincerely,  
John Smiley

## Appendix B2: New School Site Map and Building Cut-outs



### Appendix C: Cascading Consequences Chart



## Appendix D: Stakeholder Chart

### Three Children

Who are the stakeholders that will be affected by this action?	In what way(s) will they be affected?	+ or -	Is this effect the intended goal of the action or is it a side effect?	Has the stakeholder placed themselves in this position voluntarily and with appropriate understanding of the risks involved?	How important to YOU are the interests of this stakeholder? 1=very important 2= somewhat important 3=unimportant	If the effect is negative, do YOU feel it is directly offset by greater good elsewhere?
Me	Risks of 3 pregnancies	-	Side effect	Yes	1	Yes
Both me and my husband	\$\$	-	Side effect	Yes	1	Yes
	Happiness in having 3 children	+	Goal			
Children	Less attention from parents	-	Side effect	No	1	Yes
	Siblings to love or hate	+ or -	Goal			
Extended Family	Three children to care for in an emergency	-	Side effect	No	2	Yes
	Three grandchildren / cousins	+	Side effect			
World Community and Environment	Increase population growth	-	Side effect	No	2	No
	Increase resource use	-	Side effect			No

## Appendix E1: Car Decision-Making Scenario

### Which Car Should It Be?

Imagine that you have a friend who is planning on buying a car. She has narrowed her choice down to three different options: an SUV (Sports Utility Vehicle), a sports car, and a hybrid (Car that runs on both electricity and gas). However, she is having a hard time choosing between them (she likes them all!), and has asked for your help in making a final decision.

So ... you are to make a recommendation on which car your friend should buy. The following pages have some information (about your friend and about the cars) to help you make your recommendation. In addition, feel free to use any knowledge you have (about cars, people, etc.) that isn't already included here.

Please consider all of the possible effects of your friend's car-buying decision as you come up with your recommendation.

**Once you've made a decision, go to the TASK A page in your answer booklet and answer the following questions:**

- 1) **Which car would you recommend that your friend buy?**
- 2) **How would you convince your friend that this is the best option?**
- 3) **What steps did you take to reach your decision?\***

\*Your teacher will hand out additional pieces of paper for you to use in coming up with a decision; you can turn these in to help show how you made your decision.

### Information about Your Friend

- She lives in the city, about 5 miles from her school (too far to walk)
- Up to now, she's been taking the bus to school with her three best friends; if she gets a car, she wants to give these three friends a ride to school as well.
- She has a job delivering pizzas, which means she does a lot of city driving (she's been borrowing her aunt's car to do this up to now, but plans to use her own car for this once she gets it).
- Her family (two younger brothers, mom, and dad) enjoys taking road trips; they're looking forward to her getting the car because their old car is no longer reliable and they hope to use hers to drive to Colorado for their next family vacation.

## Information about the Cars

	Cost (\$)	Size <sup>1</sup>	Gas Mileage <sup>2</sup> (miles per gallon)	Annual Greenhouse Gas Emissions	Safety Rating (10 is best) <sup>3</sup>	Resale Value	Performance <sup>4</sup> (10 is best)	Comfort <sup>5</sup> (10 is best)
<b>SUV</b>	25,000	5 seats; 86 cubic feet	15 city/ 20 hwy	11.4 tons/year	6	High	4.5	8
<b>Sports Car</b>	18,000	2 seats; 15 cubic feet	19 city/ 27 hwy	8.50 tons/year	8	Low	7.5	3
<b>Hybrid</b>	21,000	5 seats; 10 cubic feet	60 city/ 51 hwy	3.5 tons/year	10	Medium	4	6

<sup>1</sup>One cubic foot = 7.5 gallons of milk, so the SUV could hold 645 gallons of milk; Sports Car could hold 112.5 gallons of milk; Hybrid could hold 75 gallons of milk

<sup>2</sup>City number is for driving on city roads, Hwy number is for driving on highways.

<sup>3</sup> Safety rating includes braking ability, head restraints, airbags, stability control, and crash testing.

<sup>4</sup>Performance rating includes acceleration, steering, handling, and braking.

<sup>5</sup>Comfort rating includes how much head and legroom there is, how comfortable the seats are (lumbar supports, amount seats can adjust, etc.), and how easy it is to get in and out of the vehicle.



**SUV**



**Sports Car**



**Hybrid**

## **Additional Information**

### **Gas**

- Automobile gas comes from fossil fuels, which are a limited natural resource; the more gas we use, the more quickly these fossil fuels run out. Currently, fueling passenger cars accounts for 25% of the world's oil consumption. Some experts predict that at the rate we are consuming gas, it will run out by at least 2040. When we run out, we will have to find sources elsewhere. Some suggestions have been to drill in Alaska or the South American rainforests, which would destroy the land and any animals or plants living there.
- Currently, gas prices hover around \$2.00 per gallon; prices are expected to remain high into the next year as tensions in the Middle East, a major supplier of gas, continue. In fact, prices may continue to rise as this resource becomes more difficult and costly to obtain.

### **Emissions**

- Emissions refer to the gases and particles that are produced by the engine of a car.
- These emissions include “greenhouse gases” (such as carbon dioxide, nitrous oxide, and methane) that contribute to global warming:
  - As more greenhouse gases enter the atmosphere, more of the sun's heat is trapped near the surface of the earth
  - This makes the earth and atmosphere hotter
  - Among other things, the resulting increase in temperature may affect biodiversity as it causes more and more plants and animals to die off
- In addition to potentially contributing to global warming, high emissions contribute to air pollution, which leads to health problems, including leukemia and anemia, and often breathing problems such as asthma.
- Household use of transportation is responsible for 27% of greenhouse gases and 24% of air pollution.

### **Safety**

- SUVs are considered less safe than other cars because they are more likely to roll over in an accident or sharp turn. In addition, they pose a greater risk to other non-SUV drivers, since an SUV's large size means that in an accident with another car, it is more likely to cause serious damage to the other car (and the other car's passengers).
- People tend to drive faster in sports cars, which increases the likelihood of accidents (this also means that car insurance for a sports car is more expensive than for an SUV or Hybrid).

### **Other Potential Considerations**

- Off-roading in an SUV can cause damage to soil and endanger plants and animals that live in the area. When the heavy SUV drives over land, the soil compacts, which damages the habitat of certain plants. It can also compress any sand or mud it drives over so that it cannot hold as much water. This makes it harder for animals and plants to live on or in that surface.
  - There is a one-time tax deduction of \$1500 for people who buy a Hybrid
  - There is a wait list for Hybrids – you have to wait at least a few months after ordering it before it arrives,
- 

**Please answer the following questions about your decision in your answer booklet:**

- 1) Which car would you recommend that your friend buy?
- 2) How would you convince your friend that this is the best option?
- 3) What steps did you take to reach your decision?

## **Appendix E2: Shoe Decision-Making Scenario**

### **Which shoes should we wear?**

Imagine that your school has a new principal and they are instituting a school uniform for all students. In order to save money, the school is going to purchase shoes in bulk from one company and then sell them to the students at a discount. The administration has narrowed the choice down to three different shoes: a leather tennis shoe, a styled synthetic shoe, and a canvas cross trainer. However, they are now interested in including the students in the final decision.

So...you are to make a recommendation on which shoe your school should buy for everyone. The following pages have some information (about the school's plan and about the shoes) to help you make your recommendation. In addition, feel free to use any knowledge you have (about shoes, people, etc.) that isn't included here.

Please consider all of the possible effects of the school's shoe-buying decision as you come up with your recommendation.

**Once you've made a decision, go to the TASK B page in your answer booklet and answer the following questions:**

- 1. Which shoe would you recommend that your school buy?**
- 2. How would you convince the administration that this is the best decision?**
- 3. What steps did you take to reach your decision?**

\*Your teacher will hand out additional pieces of paper for you to use in coming up with a decision; you can turn these in to help show how you made your decision.

### Information about the school

- There are 1000 students in the school...so this decision will have a large impact.
- The shoes will be worn every school day, and to all school-related functions in the community.
- In addition, the school hopes that these shoes will be used during gym class so that students do not have to buy a different pair in order to participate.

### Information about the shoes

Shoe	Bulk Price per pair of shoes	Average Weight (grams)	Comfort <sup>20</sup>	Athletic Performance <sup>21</sup>	Ergonomic Rating by Foot Specialist <sup>22</sup>	Ecological Footprint (acres)	Waste Stream	Lifetime (years of wearing)
Leather Tennis Shoe	\$35	145	9	7.0	Good	7.6	Medium	2
Styled Synthetic Shoe	\$25	190	6	3	Excellent	2.1	High	1
Organic Canvas Cross Trainer	\$29	120	7	7.5	Very good	3.3	Low	1.5

<sup>20</sup> Scale is 0-10. A small group of students wore the shoes every day for one week and were asked to rate them. For example, one student gave a '5' for a shoe that felt great at the beginning of the day but by the end of the day she couldn't wait to take them off; and a '10' for a shoe that she felt comfortable in all day long.

<sup>21</sup> Scale is 0-10. Another small group of students rated shoes after wearing them while doing a variety of sports activities. One student gave a 2 for a shoe that was so heavy he felt like he was running with bricks on; and he gave a 10 to a shoe that felt 'light as a feather'.

<sup>22</sup> Foot doctors have rated these shoes in a magazine article. For them, 'Excellent' means that there is good arch support and enough room in the toe box without the foot being able to slide around. A 'Good' means adequate arch support and enough lacing to create a snug fit.



**Leather tennis**



**Styled Synthetic**



**Canvas Cross Trainer**

### **Additional Information**

#### **Ecological Footprint**

- This measures how much land and water area is required to produce the shoes and get them to the consumer. More acres means that more resources are used to produce the shoes.
- For example, leather shoes have a larger ecological footprint because raising cattle for leather requires lots of grass and water.
- The organic cross trainer comes in a box that is made of recycled and unbleached cardboard, and its sole is made of recycled tire tread. So, it requires less land and water in its production.
- The components of most shoes are created in different parts of the world and then brought together by airplane to be assembled. The fuel usage creates a larger ecological footprint. So, the organic cross trainers have a smaller ecological footprint because they are fully assembled in one country.

#### **Waste Stream**

- This measures the amount of waste produced in the creation and disposal of the shoes. Things that contribute to the waste stream are: pollution resulting from the manufacturing process, ability of the shoe to be recycled, or ability of the shoe to breakdown naturally in landfills. A shoe with a high waste stream creates a lot of pollution and is not recyclable or biodegradable.
- For example, the upper part of the canvas shoe is made of fibers that will biodegrade after a period of time.
- Traditional leather is tanned with formaldehyde...while the tanning process makes the leather soft and helps it last longer, this formaldehyde can leak back out of the leather over time and is toxic to humans and other animals.
- Synthetic shoes are generally made of petroleum-based chemicals (plastic). One of the byproducts of making plastic is dioxin. If dioxin is released into the environment, it can pose a health hazard to animals and humans. Specifically, it has been linked to many health issues such as endocrine system disruption, cancer, neurological damage, birth defects, immune system damage, and reproductive system damage.

- Organic means that no pesticides are sprayed on while a product is being grown; often when pesticides are being used, some of it ends up in waterways which can harm aquatic life and mammals who live in or drink the water (including humans)

### **Other Potential Considerations**

- If the school buys shoes that are considered environmentally friendly, it will receive payment from the state under a program to encourage sustainable practices by public institutions. So, the school will be saving even more money if they buy the organic cross trainers.
- The canvas shoes come in a smaller range of colors because the company only uses soy-based dyes, which come in limited colors. Soy-based dye is considered a renewable resource, however, compared to petroleum-based dyes.
- Shoes, which have many petroleum-based components, are more hazardous to the health of the workers who assemble them.

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**Please answer the following questions about your decision in your answer booklet:**

- 1) Which shoes do you recommend that the school buys? \_\_\_\_\_
- 2) How would you convince the administration that this is the best option?
- 3) What steps did you take to reach your decision?

## Appendix F: New Ecological Paradigm Survey

**Directions:** Please turn to the Environmental Values page in your answer packet. Read each statement below and select the answer on the answer sheet that most expresses how much you agree or disagree with it. You can select *Strongly Agree*, *Mildly Agree*, *Unsure*, *Disagree*, or *Strongly Disagree*.

*Do you agree or disagree that:*

1. We are approaching the limit of the number of people the earth can support.
2. Humans have the right to modify the natural environment to suit their needs.
3. When humans interfere with nature it often produces disastrous consequences.
4. Human ingenuity will insure that we continue to make the earth livable.
5. Humans are severely abusing the environment.
6. The earth has plenty of natural resources if we just learn how to develop them.
7. Plants and animals have as much right as humans to exist.
8. The balance of nature is strong enough to cope with the impacts of modern industrial nations.
9. Despite our special abilities humans are still subject to the laws of nature.
10. The so-called "ecological crisis" facing humankind has been greatly exaggerated.
11. The earth is like a spaceship with very limited room and resources.
12. Humans were meant to rule over the rest of nature.
13. The balance of nature is very delicate and easily upset.
14. Humans will eventually learn enough about how nature works to be able to control it.
15. If things continue on their present course, we will soon experience a major ecological catastrophe.
16. Pollution laws have gotten too strict in recent years.
17. Anti-pollution laws should be enforced more strongly.
18. Environmental regulations have placed unfair burdens on industry.
19. We must take stronger measures to conserve our nations' resources.

## Appendix G: Scoring Rubric for Instructional Videos

Definition	Comments/Examples
1 No explicit definition offered	Accuracy - using the term, and using it correctly
2 Inaccurate definition	
3 Accurate definition but partially incomplete and/or terminology not adhered to	*NOTE: the first coded instance in a teaching episode is expected to be coded for definition; subsequent ones are not expected to (thus may have a 99 is appropriate)
4 Accurate definition and correct use of terminology	
<b>Example</b>	
1 No explicit mention	*note: only if there are no related examples in the entire lesson
2 Example not relevant, inaccurate, or unclear	*Relevancy: to a decision, not necessarily to curriculum content
3 Example relevant but not sufficiently described	
4 Example relevant, sufficiently described, and explicitly tied to the step	1-4 instead?
	what to do about all the 0s in the definition
<b>Part-Whole Relationship</b>	
1 Definitions/examples used confound 2 or more steps	
2 Connection implied but not fleshed out	
3 Explicit connection but not sufficiently described or inaccurate	
4 Explicit connection is relevant, sufficiently described, and explicitly tied to step(s)	
	Things that students are doing <b>primarily</b> by themselves or in groups
<b>Task</b>	
1 Task is irrelevant to learning SCDM	
2 Task is relevant but directions and task goal are insufficiently described	
3 Task is relevant, the directions are clear, but the goal is not made explicit	
4 Task is relevant, the directions are clear, and the goal is explicit	

<b>Values</b> (single or combination for given instance)	
Self	
Others: other people	
Environment: plants, animals, & non-living surroundings	
<b>CLASSROOM MANAGEMENT</b>	
1 Students consistently off-task (more than 50% of class)	
2 Students off-task about half the time	
3 Students consistently on-task	
****SCDM Steps****	
<b>Constraint</b>	
Definitions: absolute requirements, must not violates, needs	
<b>Considerations</b>	
Definitions: things that would be nice to have, things that are not absolutely necessary, wants	
<b>Options</b>	
*Not well-specified in the curriculum	
Definitions: three possible choices that adhere to constraints and address as many considerations as possible	
<b>Consequences</b>	
Definitions: the chain of events that will happen when you choose a specific option, something that follows as a result	
<b>Stakeholders</b>	
Definitions: people, organizations, plants, animals, the physical environment, etc. that are affected by a decision	
<b>Tradeoffs</b>	
*Special case: need not use the terminology "tradeoffs"	
Definitions: explaining how negative effects are or are not outweighed by positive effects when making a decision	

## Appendix H1: Kristin's Interview

**Kristin, January 2007**

*Brief prep conversation on purpose of interview...*

*INTERVIEWER: Before talking about the curriculum, I'd like to first talk about decision-making in general. So, what is your definition of decision-making? What does it mean to make a decision?*

KRISTIN: To me making a decision basically requires the person in question to weigh both the pros and the cons. And the thing is that when you're making a decision, you don't think about making those pro and cons categories – it just happens. So part of it is ingrained. But I think that when you make some kind of decision you have to weigh your options and figure out if this the best for me. And I think that deep down we're all looking... every decision we make is based off of what is best for me. It's not really altruistic about what is best for the world or for my neighbor, it is: how am I going to get the most out of this.

*INTERVIEWER: Okay. Have you ever taught decision-making in the high school context before?*

KRISTIN: No, I have not.

*INTERVIEWER: Okay, so in what ways do you think that the environmental decision-making as it is defined in the curriculum is different or the same as they way you defined decision-making?*

KRISTIN: I think it's pretty similar in that it makes the students look at both sides of the equation, look at the pro and the con. Instead of... and then looking at how that then goes into their entire decision-making process. Versus, just making a decision or a conclusion based off of instinct, they are forced to look at both sides before we make a decision. Let's look at the good and also possibly the bad.

*INTERVIEWER: Do you think that the way the curriculum defines environmental decision-making is appropriate for your students?*

KRISTIN: For my students, I find that the method is great. The methodology is perfect for my students. However, I'm finding that the language is a little too advanced for my students as it sits. So therefore I have been making modifications to the language to help them understand what is being asked of them at certain times. But as far as the steps go, it's fabulous.

*INTERVIEWER: When you say "method", could you say a bit more about what you mean?*

KRISTIN: About the methodology? Right, well looking at having the students first of all

decide what is best for them and then moving into, okay let's broaden it out a bit further to consider what's best for others, and then look at... okay, now that I have a couple of options let's look at the consequences. I think a lot of times adults and teenagers alike forget about the consequences of actions until it happens. So by having them sit down and look at the consequence chart and say, okay if I do this what's going to happen? Alright... it's almost like playing a game of chess or checkers. You need to think ahead to your opponents move before you make your move. So, then having them make the consequence charts, looking at all of the consequences that could come across, and in that same vein explaining that just because it has the word "consequences" that it is not necessarily a bad thing. A consequence is just something that happens as a result of something that you have done. I think a lot of times kids tie in the word consequences to be a negative. Not just something happens. But then going one step further with the stakeholders, bringing back in that idea that everyone somehow is affected by the decision that you make. So how are they all affected? Did you want them to be affected, or was it something that happened that you had no control over?

*INTERVIEWER: Okay, and you said that some of the language was difficult – could you say a little bit more about that?*

*KRISTIN: With what I found with my students, a lot of them are English as a second language. So when you're throwing in words like consequence or stakeholder, this is a brand new word for them. Whereas this is normal vocabulary for native speakers, if you throw in the word stakeholder to someone still learning English or only recently learned English (age 10 or 12) it can be confusing or befuddling.*

*INTERVIEWER: So what have you tried to do to overcome those language issues?*

*KRISTIN: Um, I tried to introduce them to the new vocabulary, and if I make a decision that it's not the meat and potatoes of the lesson than I'll actually change the wording. Either the category, or... I can think specifically of the stakeholders charts. The first time we did that, I altered some of the wording on the chart – took away some of the wording that I thought was unnecessary just to make it clear to my students, okay this is what this column is asking you to do and this is what this column is asking you to do. Therefore they wouldn't get trapped in the smaller words that make good sense contextually but can confuse the students.*

*INTERVIEWER: Great. So another aspect of decision-making that comes up in the curriculum is the issue of values. So first off, how important do you think considering values is in making environmental decisions?*

*KRISTIN: I think the values portion is really important. I think the decisions we end up making, if you think about green type values, we do based on our own personal values. You know if I personally was a vegetarian, was a vegan than I would not advocate for the killing of animals. That's my own personal value, however that's not going to be the same for somebody else. So I think that by having the kids look at their own personal values it gives them a voice and makes them feel like their decisions are actually going to*

be important because we're asking them "what do you think" and "what are your personal beliefs about this." And I think that teenagers are so often used to... and students in general... being told what to do and how to do it, that this whole idea of "wait a minute, I have an opinion and I have a voice in this?" It's kind of foreign to them.

*INTERVIEWER: Great, and that leads me to my next question directly. How do you go about helping students think about values or value systems that are different from their own when they are making environmental decisions? They've now been giving a voice, and they are now a variety of potential competing values in their groups... how do you help them make sense of that as they are trying to arrive at their environmental decisions?*

KRISTIN: That tends to be the most difficult part is, once you have them look at themselves than having them turn around and look at what somebody else feels is important. And the way I found that to work most effectively in my classes is to have them in their groups each talk about what they find to be important. It's helpful that in our school... thinking about the protein dilemma specifically... we have a high Muslim population. And there are quite a few students who are practicing Muslim and therefore they don't eat pork. And when that was first brought up, I think it was completely foreign to the non-Muslim kids: "what do you mean you don't eat pork? Why not?" You know, and it's that whole idea of having a religious idea not to do something kinda floored my non-Muslim students but it also opened up a dialogue as to: "well, what else can't you do?" So in addition to understanding that other people have different value systems and put different values into different categories, it also opens up a dialogue as to, you know we're not always the same but we need to figure out how to get to the same or similar endpoint.

*INTERVIEWER: So, how would you assess students who demonstrate good reasoning skills, going through the entire decision-making process... but they fail to show a real understanding of different values other than their own when they ultimately arrive at a decision. How would you assess their understanding?*

KRISTIN: Well, I guess it would depend on what the goal of the assignment was. Is the goal for them to understand other people's values, or is the goal for them to understand the steps of the decision-making process?

*INTERVIEWER: Good question. (NOTE: makes comment at this point about the next question being awkward, but going ahead with it anyway to try it out). So let's assume that this is in the context of their final presentation. So they've now had to arrive at an environmental decision and had to present it. And in doing so, they in fact demonstrate that they reasoned pretty well through the steps. But failed, either in group presentation or individually talking with their groups, failed to demonstrate an understanding of competing values... so does that suggest to you that they don't fully understand EDM, or... how does it relate?*

KRISTIN: I think that it suggests that they may not understand competing values more

than decision-making. Because they can go through the steps and understand the steps... and it's possible to do that without really understanding competing values. So as far as assessing... wow, that is a weird question... (*quick comment from INTERVIEWER: it is, and it shouldn't be this weird – but you're doing fine!*). Um, how would you assess that? I guess it would come down to some more probing questions from the instructor or from the students coming up with their own questions... I guess I would say that when going through the presentation if a red flag went off, okay they've got this part but they're totally missing this other part, that if by asking questions along those same vein to try to bring competing values. I would think that the competing values and understanding would be there, it just may not be brought up to the front.

*INTERVIEWER: Okay. So now I want to talk a little more specifically about chapter 6 in unit 1, which is the Florida School Project. So do you think your students are prepared to revisit the Florida School project decision given what they've learned thus far in the unit?*

KRISTIN: I think that they are prepared to revisit it, I don't think that they know that though. (smiles)

*INTERVIEWER: So which activities in the unit so far do you think were most helpful in their understanding of EDM to this point?*

KRISTIN: I think the most important activities, in terms of framing it, were the activities that have them to do either the steps all together or just parts of the steps. Um, I think that when you're learning something new, repetition is going to be your best friend. And so by having the students, and in fact I think it would be good if there was even more of it in the book... okay, now let's revisit constraints and considerations... and have it more often. Um, but by having the kids repeat and practice on the different steps of the decision-making process that will help them when they have to bring it back into context.

*INTERVIEWER: So, a related question. And I think you just answered it, but: are there some specific decision-making skills that your students need to work on before they are truly ready to revisit the Florida school project? You just talked about maybe needing to practice some of the steps... is there anything else content-wise or otherwise that they might need to work on?*

KRISTIN: I know for my students... and I think part of it was just how much time we've taken for this unit. I think ideally if we were able to stick with the 8 week if would've been more efficient. But I think with ours, because it was so long ago that we've talked about populations... it's kind of in their heads and they'll bring it up, well we know the population needs to stay at a certain level... but they'll forget what really goes into populations. And it was just, with us... all of our kids are so used to direct instruction. Just telling them, telling them, telling them. So I think for them it was a little overwhelming getting all this new stuff. And they're getting used to being in the driver seat. For my students looking at them, a refresher of the early work... on populations and even on resources... would've better prepared them for this project. Just to remind them,

you know don't forget: we've got this part and this part. Then understand ecosystems... they've got that down like clockwork. But it's the beginning stuff that they didn't think was very connected.

*INTERVIEWER: So do you anticipate or plan to bring some of those things up as you go through this last chapter?*

KRISTIN: That's something that I'd like to do and I know I need to do more of for next year... is emphasize the tie-ins. Okay, they're not all separate entities, separate chapters... okay look how they fit together. So next year I don't want it to be so piece meal.

*INTERVIEWER: Okay, so in lesson 1 students are asked to revisit the FSP and consider their constraints and considerations (which you're doing yesterday and today). Were there any particular challenges that you anticipated your students having coming back to that task? After a little while....*

KRISTIN: The only challenge that I thought would be the understanding or just knowing the difference between considerations and constraints. I know that I wanted to revisit the definitions of those and even give some examples because, again, those are words that are not used often as part of the normal vocabulary. And even if we've done it two weeks ago, they would still not have a good grasp on it. So since that was the first major part of this project, let's have a little refresher on what a constraint is and what a consideration is. And even then, using different vocal and terms...

*INTERVIEWER: Do you think students will have a hard time as they think about this issue of constraints and considerations? As they move forward in developing their options, do you think they'll have a hard time weighing their personal values versus the more objective so-called constraints? [note: this is a badly worded question – I was trying to get out the constraints that arise out of the letter...]*

KRISTIN: I can see them having a hard time with their own personal constraints and considerations and I think it's because they're so used to not having that voice. Of saying it's okay for you to say, I want this and this and this. It's okay, you're not going to be painted as a bad person for saying that. That I think is going to be the difficult idea. I also think that they might be thinking that they have to think in terms of environmental science, you know we have to all be treehugging hippies and drive hybrid cars and want to save the whales, and that's not what the curriculum is based on. And that's what I really like about it. But I think they're still having a hard time with it. Okay, it's environmental science, we need to save the whales, and I have to do everything for the greater good... it's okay to be selfish.

*INTERVIEWER: Great. So in lesson 2, students are asked to narrow their options using their constraints and considerations, and the curriculum provides a chart to help them work through these issues. Do you anticipate that your students will have any challenges with this activity given what you've seen so far in the unit?*

KRISTIN: My students have a hard time with math. So that's going to be... that's going to be our challenge. Is just the math part. And it seems like it would be such a trivial part of it, in that its not a big understanding, but if you have trouble understanding just spatially, you know, how big an acre is and what is 24 acres for 12 acres and what is that going to do for you in the long run. So I guess the math and proportions is what's going to hurt them, well not really hurt... challenge them in the narrowing process.

*INTERVIEWER: Do you think that the chart, the way it's constructed, is a useful way of helping them narrow their options?*

KRISTIN: Yes, um I'm a big believer in charts. And I'm not sure if that's just because of my science background and that I like things nice and neat, but I think the charts help the students organize their thoughts. So no, I like the chart.

*INTERVIEWER: Is there anything that you might want to change or alter about the way the charts are set up in the curriculum?*

KRISTIN: Uh, I've found them pretty useful so far except for, again, just tweaking a little bit of the language. And so we do a lot of modeling, so a lot of the charts that we do I'll make overhead copies of and walk the students through the beginnings of them. But as far, again, language is still, you know, the major crux with our kids.

*INTERVIEWER: So... how successful do you think students will be in this activity in justifying their options? So they have to arrive at 3 options as part of that lesson...*

KRISTIN: That is going to be difficult, the justification part. Um, it's easy to make or give an opinion or say, I think this option works. But when you're asked to back it up, I think that's where they might run into a bit of trouble and I think that's where, it's going to be on the instructor to say, go back to the chapters, what can you say to back this up. Right now this is just a hanging statement, what can you do to convince me? And just having them understand that they have to convince the audience. You know, back it up with facts not with fiction. Back it up with why you think it's true or false.

*INTERVIEWER: In lesson 3 students are asked to consider the impacts of their proposed options by considering the stakeholders in the FSP decision. And one of the analysis questions in this activity asks the students to explain how their list of stakeholders is related to their lists of constraints and considerations. Do you think that students will have any difficulty in that task?*

KRISTIN: I think they might have difficulty because their lists of constraints and considerations may not have specific stakeholders in them. So they'll be looking for a direct correlation. Instead of reading that question as, who might be affected by your actions, they might think it asks what stakeholders have you listed in your constraints and considerations. So, that is more of a context... so what do we mean by that question is what I have to try to get across to them. We're not asking you directly who is listed under

your constraints and considerations, but instead who under your constraints and considerations are affected?

*INTERVIEWER: Okay, so going off of that, is there anything that you might do to help them understand that it may not be direct but that there are some implications of their constraints and considerations that affect stakeholders...*

KRISTIN: Um, what I find that works really well with my students is that we'll read the questions in the book and then I'll try to rephrase it for them. And I'll usually put my rephrasing on the board that way they can look at both. Here is the question, here is [Kristin's] phrasing. And it does help them out because you know sometimes the connection can be lost. And for me, it's not so bad for them to get a little help in making those connections.

*INTERVIEWER: Great. So another analysis question in that same lesson asks students if they want to change their list of constraints and considerations as a result of what they've learned in the process of going through... first off, how important do you think it is for students to revise their constraints and considerations as they're finalizing their environmental decisions?*

KRISTIN: I think it's very important. I think that, you know, some of the best things that we do are the things we can go back and redo. You know some of the best things in school are those papers where you can go back and reword a draft and revise it. And I think that it shows the students that its okay to go back and change your mind. That something that you decide to do right at the beginning, and then you learn something along the way and want to change it, that that's okay. You're not going to be faulted for it. There's nothing wrong with going back and saying, I was wrong. Or my decision was not the best decision so let me change it for the future.

*INTERVIEWER: Is there anything in particular that you plan on doing to help your students make that revision process happen?*

KRISTIN: Uh, I like to play devil's advocate a lot in my classes when I have a chance to. So I think that I would, with the groups individually so as not to put the kids on the spot in front of the entire class, but you know take a look and then ask them those devil's advocate questions... well, what about this? What if I throw this in, you know, how does that change your decision – or does it change your decision? You know, remind that they also have the option of not changing their decisions at all.

*INTERVIEWER: So do you think that your students will have any difficulty in engaging in that revision process?*

KRISTIN: I think that they might because some of my students, um, have a fear of being wrong. I think that so often they're told that its good to please the teacher and to make the teacher happy and how's the teacher going to be happy if you're not right all the time and not confrontational. But I think that by opening up the dialogue and saying it's okay to

change it, or I want you to argue with me, I want you to stand up for this, I think it will help them understand that its okay to bring in new information or change whatever they need to do.

*INTERVIEWER: Great, that wraps up my questions... some additional closing comments about the curriculum, discussion of language levels, etc.*

## Appendix H2: Mara's Interview

**Mara, January 2007**

*Brief prep conversation on purpose of interview...*

*INTERVIEWER: First of all, what is your definition of decision-making? What does it mean to make a decision?*

MARA: In a simple way, I would say that decision-making should be thinking positive and negative aspects of the problem. Decide what you wanted to do. Uh, according to the textbook decision-making is thinking about constraints and considerations. Constraints are the limitations, and considerations are... if they are there, you would love to have them. And based on that, you would make a decision.

*MARA: So, should I go into the subject, or is it okay?...*

*INTERVIEWER: No, that's good. I wanted to hear your think about that a little bit...*

MARA: So for the students, it is totally... I can say that it is a totally new idea. Telling them, like you know, once you wanted to make a decision, think both about positive and negative aspects of the points you're going to do. And then make a decision based on that. And then before making a decision, think about the consequences that the people are going to face based on the decision.

*INTERVIEWER: Have you ever taught decision-making in any other context before?*

MARA: Of course, you know we always use positive and negative aspects... but I never went directly into this concept of saying that, you know, constraints and considerations... and then, decision-making based upon your constraints and considerations. We never used those vocabulary, and in my 5 years of teaching I've never used those words.

*INTERVIEWER: Okay. So by using those words, do you think it's expands on what decision-making means?*

MARA: Yeah, you are definitely giving them a clear-cut meaning about what do you mean by the decision-making process. So the student will... you know, according to how your brain takes it. The information. The brain always takes it, you know, all the positive things. When you ask a question to your student, all the positive things that go into your brain comes out, and differences like, it comes out both by positive and negative, uh, you can say it as ideas. So, for example, like you know. It is not always good for you to drive while speeding. Okay, I take it in a positive way, but when it comes out of my mouth as "why is it not good for speeding", the student will come out like you know, with "there is a possibility you will meet with an accident." Or else they will say that it is fun to drive fast. So your brain sends the message in both positive and negative aspects of a particular topic. I learned this recently when I studied one of the books saying that how your brain processes these messages and how it comes out of your brain when you take it out and

talk about the same information.

*INTERVIEWER: Okay, so I think you've touched on this, but do you think that the way the curriculum defines environmental decision-making is appropriate for your students? Do you think it is useful...*

MARA: Yes, it is really useful.

*INTERVIEWER: Okay. And I think you just talked about why.*

*INTERVIEWER: One of the aspects of environmental decision-making that comes up in the curriculum is the issue of values. And so I wanted to ask you a couple of quick questions on that. How important do you think considering values is for making environmental decisions?*

MARA: One thing is, based upon the type of students that we have. We do have students from, you can say it as, from all... a mix of students from different countries. And different religions. And then they have different individual values. When they come out with the personal values, it is a possibility that each student will understand and know those values from the other students. Like when you do something like this in groups. So that is about the personal values of the student. And then, it is always good to know the different values of other people compared to your own values.

*Brief interruption*

*MARA: So is that appropriate, my answer to your question?*

*INTERVIEWER: Yeah, it is. So you were talking about how the values played out with the diversity, and you seemed to think it was important... so how would you help students think about values and value systems that are different from their own? So as you said, you have students that may get together in groups... they may have different values. Their personal values that are going to weigh into how they are going to make their decision. What would you do as a teacher, or how do you think doing something as a teacher, to help them negotiate those different values? Those possible different values.*

MARA: Okay, well anyway, I'm teaching environmental science based on the values that we have as science teachers and we want to pass on to the students how to save the environment. That is the main thing. And then, conservation. Conservation is like anything you can conserve in your life is best for the generations to come. So those are the values that... even a simple example like saving water. How can you save water. How can you save plants. How can you save animals. So we wanted to put those ideas in their brains so that they always think in terms of protecting the environment.

*INTERVIEWER: Okay. So how would you assess students who seem to display good reasoning skills - that is, they seem to understand the different issues that go into making good decisions - but they fail to show an understanding of different competing values? So*

*basically, a student that shows good reasoning skills in understanding the nature of the problem (e.g., the Florida school project... they know how to weigh the issues). But they don't necessarily display an understanding of, my values might be different than yours, and how should I go about thinking about those different values when I...*

MARA: Okay, so as a teacher I can talk with them, but the best way they learn is through their peers. They can share it, this grouping is the thing that helps them learn things from the other students. And they know the facts of the values... are things true or not true, those things. Especially thinking about nutrition value, like when you talk about protein. You don't have to eat meat, but many students from India don't eat meat. And muslims don't eat pork. So these are the students that come out and say they are surviving without eating meat. From my birth. And my mom and dad, they don't eat meat. And we're surviving. We know how to get the protein we need from just eating plant material.

*INTERVIEWER: Okay, so if you have a student who, even though they've been in one of those groups. And they've been exposed to some different ideas. But they still seem to only be displaying one kind of value and not really understanding the role of those other kinds of values when they're presenting their decisions, how would you assess them?*

MARA: Okay, you mean if they can't buy those values?

*INTERVIEWER: Well, not necessarily if they don't buy them. But if they fail to see their importance in making their final decision... or, do you not believe that this happens? That by putting them in groups, that really does expose them to the values. And that that can really solve...*

MARA: Well, but not only in groups. In the general class discussion part of the... and then, just by displaying what they wrote to the whole of the classroom. And then ask them to comment on those groups, they might write on those papers what they think of their values and their decisions...

*INTERVIEWER: Okay. Now, I wanted to talk a little more specifically about the Chapter 6 in the unit. So... and this is just a question about your impression. Do you think that your students are prepared to revisit the Florida School Project given what they've done so far in the unit. So just yesterday you began the final chapter, do you think the students are prepared to work through those issues?*

MARA: The students always give an importance to how you present things to them. We are presenting this to them as the final project. They know that the final project is the one which will carry a lot of weight in the grades. So they will definitely show a lot of interest in this final project. And one more thing is, I told them that they are not going to be on their own – even though they're going to be in groups – I'm going to help them and give them guidance through the end of the project. And then we give them a rubric that they have to follow, and they're going to follow that rubric. And that's one more type of guidance we're giving them. And then they're those people who have computers at home, or they can use the computer to lab, to finish their project report. Even though this project

is 2 weeks, we're not totally letting them out.... These are the rubrics you have, go do it. It is not like that, we are going to guide them until the end of the project.

*INTERVIEWER: Okay. Which activities in the unit so far do you think were most helpful for the students in terms of their understanding of environmental decision-making? So up until now, the beginning of chapter 6.*

MARA: Okay, the first part I can definitely say is consequences based on your constraints and considerations. Because that is totally new for them. And they very well remember those things. And then they immediately came out with the flow charts we made for the nutrition value, and for Anna's decision about kids. Like one kid, two kids, and consequences. And they even remembered the stakeholders based upon your decision. Who are the people that are going to be affected by this. And then, of course, they know that Florida School Project... over and over, we come back to it. They know it is about how many school buildings we're going to construct, and immediately they come to the gopher tortoise. And they know that it is an endangered species and a keystone species. It is easy for a student to understand endangered species because it is already there, that they learned. But very few students know what a keystone species is. It is totally new for them.

*INTERVIEWER: Okay, so you mentioned that the final project is 2 weeks. And it's structured and you're trying to give them support as they work on the different aspects of the final decision. What kind of knowledge and skills do you think your students need to particularly focus on over these two weeks? What kinds of things do you think they could particularly benefit from reviewing or practicing more in order to help them with their final decision?*

MARA: One thing is, they can go to the previous chapters and then get info on what we did before. And the second thing is, when it comes to the project, are they better at understanding the project from the first day when we presented the project, and then these last days.

*INTERVIEWER: Right, and the question is: do you think that they are?*

MARA: They are. Definitely they are.

*INTERVIEWER: Is there anything that you think they still need to work on to help them make that final decision? Anything in particular?*

MARA: Maybe. When you come to the selection of those buildings and those things, mathematically they need to know how to calculate the amount of land. Even though it is 100 acres, and you can use your brain and say, okay so much of land is going to these buildings and total them, and then... when they come to class they'll say I need a calculator to calculate those.... So, their understanding when it comes to the numbers, they can't think on their own. And the combinations, like, how many combinations of 3 buildings can you do, they don't know... they don't know how to do it. So tomorrow,

we're going to face a little problem. Like 2 small buildings and 1 large buildings. And like, if I do two combinations like that along with them, there is a possibility that they will go with that.

*INTERVIEWER: Okay, let me now ask some questions about some specific lessons that you're already begun and will be doing shortly. In the first lesson, which you've been doing yesterday and today, students are asked to revisit the Florida School Project to develop their constraints and considerations to help them with their decisions. And I already started to ask you about the challenges they were going to have. Do you think that the students are going to have a hard time weighing the importance of their personal values versus the more objective considerations? So, they're personal values... in your class, for example, they were talking about the gym or a better track field. Versus the things that are characterized in the letter. Do you think that's a challenge for them?*

MARA: It's not a challenge, but maybe if you think that it is a challenge... you know, American kids are spoiled. They wanted to have so many things. If it is a school, we should have all these things. So, but as a teacher we have to direct them to the right decision-making. Think in terms of the land you're going to use, it is not possible to have all those things. You want to coexist with the gopher tortoise, then there won't be a possibility of having all those things.

*INTERVIEWER: Okay, so after they develop their different considerations, do you think that they will have a hard time ranking the importance of them?*

MARA: Uh, I don't think so. When we talk about all those things, especially we give them the details, like you cannot construct the building on top of the building, or you cannot construct the building on top of the river, you cannot construct an underground parking lot. So when they come out with those ideas, we – in a way – disregard those ideas saying that they are not possible, you are not supposed to do those things. So when they are sitting in their groups, they know that they are supposed to do those things. Construct those buildings.... So when are they are sitting in those groups, I think that they will definitely come out with one conclusion for the final project.

*INTERVIEWER: Okay. In the second lesson, students are asked to narrow their options using the constraints and considerations as a guide. And the curriculum provides a chart for them to work through and rule out options. Do you think that your students will have any difficulty...*

MARA: That's the one that I'm talking about. "How many options are we going to get? What combinations do you want..." Okay, so maybe if you show one or two examples then it is easy for them to go for the different options.

*INTERVIEWER: Do you think that the chart is a useful way to help them narrow their options?*

MARA: Definitely. It is definitely going to be useful. One thing is, the textbook has

given one chart for everything. For the buildings as well as the gopher tortoise land. In our teachers' edition, they give two tables. One for the gopher tortoise land, one for the buildings.

*INTERVIEWER: And do you think that's a better way of doing it?*

MARA: That is a better way of understanding things when you separate both tables. Maybe if possible, I will ask them to do the second table too. Those students who have the constraint about the gopher tortoises.

*INTERVIEWER: Is there anything else you might do to customize or change the tables, compared to the way that they look right now?*

MARA: The tables look good, but I want to do it separately for the school and for the tortoises.

*INTERVIEWER: So if you do it separately, do you think it will be hard for the students to understand how to put those things back together and consider them...*

MARA: No, I don't think so.

*INTERVIEWER: Okay, in lesson three students are asked to consider the impacts of their proposed options. And one of the analysis questions asked students to explain how their list of stakeholders are related to their lists of constraints and considerations. Do you think that your students will have difficulty with this task?*

MARA: Uh, stakeholders... I don't think so.

*INTERVIEWER: It asks them to explain how their list of stakeholders are related to their lists of constraints and considerations.*

MARA: I don't think so. They know who are the stakeholders. When you make a decision, these are the people that are going to be affected. Stakeholders may not only be living organisms like plants, animals, human beings... there is a possibility that nature may get hurt. Nonliving things like water, soil... so they know the stakeholders. Maybe we'll repeat again what they are and try to connect them to their constraints and considerations.

*INTERVIEWER: Okay, so you think that as long as they are aware of the stakeholders that they'll be able to connect them to the...*

MARA: Yes, I think so.

*INTERVIEWER: Okay, another analysis question in that lesson asks the students if they would like to change their initial constraints and considerations as a result of what they've learned throughout the unit...*

MARA: There is a possibility that it will change...

*INTERVIEWER: Do you think that they will have difficulty with that?*

MARA: It will definitely change after... they're saying that I'm going to give 50 acres of land to the gopher tortoise. So 50 acres of land, plus 4 acres for river, then 14 or 16 acres of land on the other side of the river... so when you add this all together it is going to be more than you have, so they realize that they have less space to put the school buildings. So definitely they are going to change... maybe not all, but one or two of them will. So maybe I will not go for 50 GT but I will go for 40 GT...

*INTERVIEWER: So how important do you think it is for them to revise their constraints and considerations at that point? At the point when they've moved through...*

MARA: Definitely in the final project, it is a must for them to do. It may not be considerations, but it must be constraints because they are the only limitations that they have to do for this project. I will definitely let them know that if they are making a constraint, that they have to follow that constraint all the way through.

*INTERVIEWER: Okay. Is there anything that would do to help them through that process of revising their constraints and considerations? Is there anything that you anticipate them having trouble with? You know, "we've already done this before, why are we doing it again?" How would you answer that question?*

MARA: Depending on the size of the building that they chose, definitely they will have a problem locating those buildings. Those burrows are everywhere, so if you want me to protect those burrows then slowly they will come up with – I'm sorry but I have to cover up some burrows. And if I'm covering up some burrows, then I'm killing some GTs. And then, you know, they definitely place a problem. It is not that easy to place those buildings in that vacant land.

*INTERVIEWER: Okay, so let me paraphrase and see if I understand what you're saying. When they approach the end of the project and they are making their decisions, if they make a mistake... are having an error than that will help them understand that they are going to have to change something about their constraints and considerations.*

MARA: When they face the difficulties of doing these things, definitely they will know that they will go back. What they are doing, where they made those mistakes... and when they come back definitely they will know what they are doing.

*INTERVIEWER: Okay, so do you think there is something that you could do to help them as they go back and make those changes? Or do you think that they will be able to make those changes given what they understand?*

MARA: I will give them the guidance, what are the things that they have to do to follow

their constraints. And everyday, we keep saying that if you make a constraint please make sure that you follow it. Considerations, then it is okay. But constraints part of it, you have to follow it for your final project.

*INTERVIEWER: Okay, very good. Thanks so much. Those were all the questions that I had.*

*Additional wrap-up comments: positive comments about the curriculum in terms of its construction and organization; difficult to finish in one semester, which was a shame because they had to move into the new year.*

**Appendix I: Examples of “Self,” “Others” And “Environment” Valuing Material from CASES Curriculum**

<b>Type of value exemplified</b>	<b>Lesson</b>	<b>Text and page number</b>
Self	Resources- Protein Dilemma: 4b Constraints and Considerations	"A consideration might be that you love to eat [a] particular kind of food..." (Edeson, 2005, p. 128, student edition)
Others	Resources-Protein Dilemma: 4d Stakeholders	"If you become vegetarian, you might not eat lunch in the school cafeteria, decreasing their business." (ibid, p. 130)
Environment	Ecosystems- Food Chains and Food Webs: 2a Food Chains.	"In this activity, you will explore both these relationships [predator-prey and producer-consumer] within communities on the Florida school building site....This should help you make your final decision about the land use of the new school." (ibid, p. 147)

## Appendix J: Analysis of Movement Between Values Sub-groups

Another way to look at the results of the NEP survey was to examine whether any students changed their values enough to move into another group. Looking at the sample sizes (n's) given in the table and comparing the pre-test and post-test numbers suggests that some students did in fact, change groups. By maintaining my cut-off points between value groups, I computed cross tabulations of numbers of students in each group from pre-test and post-test. Cross-tabulations of the number of students in these groups with pre-tests as rows, and post-tests as columns are shown for all 86 students with matching pre- and post-NEP survey results (Table J1), Kristin's 36 such students (Table J2), and Mara's 50 such students (Table J3) on the next pages.

**EV Group at Pre-test \* EV Group at Post-test Cross-tabulation**

Whole Sample		EV Group at Post-test			
		Closer to DSP	Middle	Closer to NEP	Total
EV Group at Pre-test	Closer to DSP	20	10	0	30
	Middle	7	30	8	45
	Closer to NEP	0	4	7	11
	Total	27	44	15	86

**Table J1: Value Group Cross-tabulations for Whole Sample**

The numbers in the diagonal of this table (20, 30, 7) represent the number of students who remained in the same value group from pre-testing to post-testing. The

numbers above that diagonal (10, 0, 8) represent students who crossed a threshold into a new group, moving closer to the NEP end of the scale. Specifically, ten students moved from the “Closer to DSP” group to the “Middle” Group and eight students moved from the “Middle” Group to the “Closer to NEP” group. No students moved all the way from the “Closer to DSP” group to the “Closer to NEP” group. The numbers below that diagonal (7, 0, 4) represent students who crossed a threshold into a new group, but moving in the other direction or toward the DSP end of the scale. Specifically, seven students moved from the “Middle” group to the “Closer to DSP” group and four students moved from the “Closer to NEP” group to the “Middle” group. No students moved all the way from the “Closer to NEP” group to the “Closer to DSP” group. Given the discussion about the values-group changes relative to the teacher differences, the next question is how these results break out per teacher.

**EV Group at Pre-test \* EV Group at Post-test Cross-tabulation**

		EV Group at Post-test			
		Closer to DSP	Middle	Closer to NEP	Total
EV Group at Pre-test	Closer to DSP	9	6	0	15
	Middle	2	11	3	16
	<b>Closer to NEP</b>	<b>0</b>	<b>1</b>	<b>4</b>	<b>5</b>
	Total	11	18	7	36

**Table J2: Value Group Cross-tabulations for Kristin’s Students**

The results for Kristin, above, show that nine students total (6+0+3 above the diagonal) changed their values enough to move one group toward the NEP end of the spectrum. Three students (2+0+1 below the diagonal) moved in the opposite direction—toward the DSP—enough to change groups. However, combining this information with that from Table 21 (page 95), I can only delve in to the Closer to NEP row, given that it was only these students of Kristin whose values changed significantly. From Table J2 I see that it was actually only one student of Kristin’s who moved from the Closer to NEP group to the Middle group, thus decreasing the mean NEP score by 4.29 points. This one student’s values changed enough to influence the results significantly.

Similarly, the results for Mara (next page) show that nine (4+0+5) of her students also moved one group toward the NEP end of the spectrum. Eight (5+0+3) students moved in the opposite direction—toward the DSP—enough to change groups. Combining this information with that from Table 20 once again, I can only pay heed to the “Closer to DSP” row, as that was where values changed significantly. In this case, there were four students who increased their values enough to change groups and enough to cause the 2.42 point rise in mean end value for that group from pre-testing to post-testing.

**EV Group at Pre-test \* EV Group at Post-test Cross-tabulation**

Mara					
		EV Group at Post-test			
		Closer to DSP	Middle	Closer to NEP	Total
EV Group at Pre-test	<b>Closer to DSP</b>	<b>11</b>	<b>4</b>	<b>0</b>	<b>15</b>
	Middle	5	19	5	29
	Closer to NEP	0	3	3	6
	Total	16	26	8	50

**Table J3: Value Group Cross-tabulations for Mara's Students**

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