

AN ABSTRACT OF THE THESIS OF

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The purpose of this study was to analyze the individual reasoning of 24 adults as they made decisions for two communities regarding municipal wastewater treatment. The two western Oregon communities were both responding to notices from governmental agencies of higher environmental standards for the purification of wastewater before it could be returned to local streams. Both cities considered the possibility of integrating this relatively unproven method into their existing conventional treatment systems.

There were differing opinions within both groups about the use of "green treatment" technology. For the group decisions City B rejected the idea and City A opted to try a small pilot project. The focus of this study was not on the outcome of the group decisions, but on the individual reasoning of each subject. Each of these people was asked to rate 20 statements about constructed wetlands using a 4 point scale to measure his/her initial core beliefs (ICB) in the context of this study. The range of possible scores was from -40 to +40, but the scores of the 24 subjects in this study ranged from

+2 to +39. It was assumed that a person with a low ICB score had a lower interest in using constructed wetlands for water purification than a person with a higher ICB score. Each subject was asked to verbally describe his/her reasoning in regard to his/her respective group decision in a face to face interview.

The interviews were designed to allow each subject to respond to questions about his/her personal content knowledge, decision commitment and alternative epistemology regarding the "green treatment" concept of water purification. The rhetorical arguments of each subject were audio-taped and transcribed. The data were qualitatively analyzed for critical thinking operations (CTO) and fallacious thinking patterns (FTP). A regression analysis showed a correlation coefficient for these features of -0.70. Nine of the subjects exhibited zero FTP in their reasoning. Those nine subjects scored within the interquartile range of the group distribution of ICB scores. Of the 15 subjects with FTPs identified in their reasoning, only two had ICB scores within the interquartiles, and the remaining 13 had ICB scores in either the upper or lower quartiles of the group distribution. This pattern suggests that a person with strong bias for or against the constructed wetland concept is more apt to make errors in reasoning than is a person with a moderate view of the issue.

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The Role of Scientific Thinking in Environmental Policy Decisions

by

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I understand that my thesis will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my thesis to any reader upon request.

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The Role of Scientific Thinking in Environmental Policy Decisions

CHAPTER I

THE PROBLEM

Introduction

Education is a major factor in preparing our citizens to participate in the formation of public policy. Educators in the past have stressed the importance of reasoning ability in the application of acquired knowledge to real life situations. Piaget (1972) and Izzi (1976) both theorized that individuals tend to reason at more sophisticated levels in areas in which they have more knowledge. Bolan & Nuttall (1975), found that differences in the personal skills and the roles of the participants in community decisions affected the outcome. The ability of government leaders and private citizens to make accurate decisions is connected to an understanding of the decision context.

This viewpoint has been reaffirmed by (Zeidler et al., 1992) and Zeidler (1997) who recognize the importance of scientific literacy and the commitment to cultivate scientific habits of mind in our students. These goals are expressed by Project 2061 as follows: "Scientific habits of mind can help people in every walk of life to deal sensibly with problems that often involve evidence, quantitative considerations, logical arguments, and uncertainty; without the ability to think critically and independently, citizens are easy prey

to dogmatists, flimflam artists, and purveyors of simple solutions to complex problems." (AAAS, 1989, p. 13).

Gregory et al. (1993) found evidence that risk perception regarding public policy decisions was influenced by the structure and content of each alternative. The way technical information is framed and presented can change the reference position of some people. MacGregor (1994) identified risk perception as a major factor in the formation of environmental policy. Gregory & Lichtenstein (1994) found that some college students rejected proposed new technologies even when there was a financial cost tradeoff, if they perceived some risk to public safety or to the environment.

Satterfield & Gregory (1996) found that a majority of people are deeply concerned about the environment, even if they do not agree with specific policies. They found that deeply cherished environmental values of individuals, created very complex opinions regarding public environmental policy. It was concluded that there was often a lack of complete understanding by many individuals, but when complete and clear information about natural ecosystems was provided, some strong opinions were changed.

A person's level of science understanding defined by Zeidler (1984a), as "scientific literacy" was identified as a factor that influenced moral judgments about environmental dilemmas. Zeidler (1982), Zeidler & Schafer (1984), and Zeidler (1985) have suggested that scientific comprehension, in addition to a positive attitude and strong commitment toward ecology, can

influence the level of reasoning used by some individuals when making social judgements about the environment.

Zeidler (1984b) asserted that the notion of attitude must be regarded as a framework of variables with interrelationships in the context of science education research. He indicated the need to include intentions and behaviors with respect to an experience or object, in addition to the more familiar focus on the individual's beliefs and knowledge about the specific area of interest. This is in agreement with the theory of reasoned action explained by Ajzen & Fishbein (1980). They referred to the beliefs that underlie the attitudes of an individual as behavioral beliefs. Personal beliefs can influence positive or negative intentions to perform a given behavior. A second factor of this theory is a person's perception of social pressure to perform or not perform a specific behavior. This factor is referred to as an individual's subjective norm.

Zeidler & Schafer (1984) explored the cognitive structures of individual students when making moral judgements about public environmental dilemmas within a social context. They examined the effects of science content knowledge, past experience, moral reasoning ability, and attitudes, on individual moral decisions. The subjects of the study were college age environmental science majors ($n=86$) and nonscience majors ($n=105$). In phase I a level of moral reasoning ability was established for each subject on social and nontechnical environmental issues.

In the second phase qualitative aspects of the discourse trends between pairs of subjects were examined. Eleven sets of two subjects with similar affect for the environment, but with different levels of moral reasoning about the ecological dilemmas were paired. It was concluded that the groups of science and nonscience majors had equal ability for general moral reasoning. However, in response to environmental dilemmas, the science majors exhibited higher levels of moral reasoning, and were able to sway the moral judgements of their peers who had lower levels of moral reasoning ability.

The dual importance of scientific and social insight is recognized by Zeidler (1984a), who stated, "in order to achieve the long acknowledged goal of science literacy, it is necessary to include moral and ethical issues in an interdisciplinary science curriculum." (p. 418). Clearly, if people are to make informed policy decisions in a world of technology and science, they must have an adequate understanding of both their social responsibility and of science. Ajzen & Fishbein (1980) "assume that human beings use or process this information in a reasonable fashion in their attempts to cope with their environment. Beliefs are thus viewed as underlying a persons attitudes and subjective norms, and they ultimately determine intentions and behavior." (p. 62)

Recent studies give additional support to the prior findings. Zeidler (1997) examined "social thinking" and social construction of scientific

knowledge. One important conclusion of his study was that the specific personal beliefs a person has on any topic can contribute to fallacious ways of thinking about that topic. Zeidler (1997) explained that, "an emphasis on the social construction of knowledge refers to (the) role of beliefs with respect to different social institutions" (p. 494). He listed examples of fallacious argumentation related to social thinking by students as: "validity concerns, naive conceptions of argument structure, effects of core beliefs on argumentation, an inadequate sampling of evidence, and altering the representation of argument and evidence" (p. 484). It is plausible to speculate that these or similar fallacies will be found in the thinking and reasoning of adults within the context of socio-scientific public policy development.

Zeidler's previous findings provide a basis for the present study. He concluded that, " individuals with high moral reasoning ability generally convinced others with lower moral reasoning ability to accept certain issues in resolving environmental moral dilemmas as being the most important or pertinent ones. The issues that were generally chosen were, in fact, those issues that reflected higher stage issues. Individuals with high moral reasoning ability also tended to convince those with less sophisticated moral reasoning ability to choose a particular course of action in resolving an environmental moral dilemma" (Zeidler & Schafer, 1984 p.11). These conclusions are consistent with the theories of Piaget (1972) and Izzi

(1976). They are also supported by the findings of Bolan & Nuttall (1975) and Satterfield & Gregory (1996).

Context of the Problem

In 1974 the state of California adopted new waste water standards that forced the city of Arcata to upgrade the local sewer system. In a community planning process, a constructed wetland was selected as an alternative treatment system in place of the conventional system recommended by state authorities. Key actors in the original planning were three professors from Humboldt State University and Frank Klopp, the public works director for Arcata. The professors were George Allen (fisheries), Bob Gearheart (engineering) and Stanley Harris (wildlife management). The city council gave approval in February 1977.

The innovative plan was initially rejected by the California Regional Water Quality Board. That decision was appealed and state approval was given in October 1977 for a three year pilot program. In 1979 Arcata secured \$300,000 for the pilot study. Accurate records were kept that documented the effectiveness of the novel plan. Full approval was given for the new system in July 1983, and the main system was completed in 1986. It was less expensive, yet more effective than the mechanical treatment system the state had originally planned.

Klopp stated in SIERRA May/June 1987, "But what we have really saved is water quality." Gearheart is quoted in INSIGHT/January 16, 1989;

" After two years of operation, it has proven to be an effective and efficient process, producing water that exceeds the standards and is even cleaner than the seawater it is going into." Dissolved oxygen, suspended solids and biochemical oxygen demand were reduced to levels at or below required standards. It was concluded that properly constructed wetlands can remove bacterial and viral indicators of pollution at efficiencies of 90-99% (Gearheart et al., 1986).

Constructed wetlands are cost effective and efficient waste water treatment systems, and can be added to or combined with existing municipal water treatment systems. The wetland systems are much lower in cost for construction and maintenance, and they include many side benefits. The system built and operated by Arcata is used as a city park and also furnishes habitat for numerous species of wildlife. Many people of all ages are able to study the plants, birds, fish and other forms of life. Yet, the use of this technology is not always adopted in some cases where it might be beneficial.

During late 1995 and 1996 two Oregon cities considered the possibility of using constructed wetlands to treat some of their waste water which could not be purified by the existing systems. Both cities were responding to regulatory notice from the Oregon Department of Environmental Quality (DEQ), that their waste water treatment systems were inadequate and must be upgraded. City A adopted a tentative plan to construct a wetland to

upgrade their waste water treatment system. City B rejected the idea in favor of a mechanical waste water treatment system.

Definition of Terms in the Context of This Study

1. Beliefs: conventional ideas that “correspond to knowledge or information about an object or social norm, principle, field of interest, specific content, etc.” (Zeidler, 1984, p. 341).
2. Values: are specific attitudes held by a person and prioritized on the basis of his/her individual belief system.
3. Initial Core Beliefs (ICB): are subjective and deeply rooted personal beliefs based on individual moral or ethical convictions (Zeidler, 1997).
4. Critical Thinking Operations (CTO): “a repertoire of specific (thinking) operations, somewhere between major thinking strategies and micro thinking skills in their complexity and function” (Zeidler et al., 1992, p. 439).
5. Fallacious Thinking Pattern (FTP): “is any argument that purports to be correct and is psychologically persuasive but that proves, upon scrutiny, to have violated some rule of logic which renders it incorrect” (Zeidler et al., 1992, p. 440).

Statement of the Problem

The purpose of this study was to analyze some personal beliefs and samples of thought of the people involved in the development of the waste

water policies for City B and City A. The outcome of one process was opposite from the other, yet the problems of the two cities appeared to be similar. It is recognized that local concerns such as political and economic interests of the citizens could have influenced the final decisions; however, such factors were not within the scope of this study. The two local decision processes provided a unique opportunity to explore the individual beliefs and reasoning of each subject in the context of his/her official duty, permitting prior theory to be tested in an actual, as opposed to a contrived setting.

Personal beliefs, individual reasoning ability, attitude toward the environment, scientific understanding, and reasoned argumentation have all been found to be relevant in separate past studies of persons when reasoning about socio-scientific dilemmas (Zeidler, 1984a; Zeidler & Schafer, 1984; Zeidler et al., 1992; Kuhn et al., 1988; Kuhn, 1991; Zeidler, 1997). However, it has not been conclusively determined how these concepts might be linked with official actions in real life settings of community leaders during the formation of public environmental policy. Three questions have emerged from a review of the current literature:

1. Can specific "critical thinking" operations be identified in the reasoning used by each subject to explain his/her decision regarding a wetland waste water treatment policy?

2. Can any "fallacious thinking" patterns be identified in the reasoning used by each of the community leaders to explain his/her decision regarding a wetland waste water treatment policy.
3. Can a pattern be identified between each subject's initial core beliefs, and the reasoning he/she used to explain a decision regarding a wetland waste water treatment policy?

Kuhn (1991), believes that the reasoning or thinking used by individuals to make judgements may be indexed by their arguments. Zeidler et al. (1992) have stressed the importance of argumentation and discourse in evaluating the reasoning of students in the context of socio-scientific dilemmas, scenarios or problems. An emphasis was placed on the particular significance of critical thinking for people in all walks of life. Zeidler et al. (1992) and Zeidler (1997) have also emphasized the importance of recognizing thinking fallacies in student discourse and argumentation. A goal of this research was to examine each policymaker's argument for or against the wetland waste water treatment alternative.

Significance of the Study

In recent years much public attention has been focused on water quality. State and Federal regulations for waste water management have increasingly required cities and towns in the United States to upgrade their waste water treatment systems. Costs for constructing and operating conventional mechanical treatment systems are often prohibitive. James T.

Watson a senior environmental engineer for Tennessee Valley Authority (TVA), estimates that towns opting for wetlands treatment systems instead of a mechanical plant can expect to save 50 percent or more in capital costs and an even greater percentage in ongoing expenses (INSIGHT/January 16, 1989).

Government leaders can avoid excessive costs for providing essential services, while still complying with environmental and health regulations. In the early 1970s Arcata, California began developing a constructed wetland system for the purification of municipal waste water. Arcata's initial cost for construction of the settling ponds and sewage wetland was only \$5 million compared to an estimated \$12 million for the mechanical treatment plant. The technology used on this project contributed to a realization that natural or "green" treatment of secondary waste water is not only cost effective and efficient, but has the extra benefit of preserving green space and wetland ecosystems.

There is public interest in more green space and wetland areas. Gregory et al. (1995) found that college students placed a monetary value on the quality of environmental amenities such as wildlife habitat preservation, sport fishing and hiking. A "green value" was a salient factor in their research findings. However, wetlands treatment technology must be better understood by decision makers, if the use of these systems is to be widely accepted. Perhaps the greatest obstacle before sewage wetlands is winning

the confidence and support of consulting engineers who design sewage treatment projects in the United States and abroad (World-Watch July/August 1988).

Gregory and Slovic (1996), stated that economic impacts are an important component of the tradeoffs that public officials must contend with. Problems exist for evaluating the nonmonetary impacts of environmental policy decisions. Gregory et al. (1992), argued that a better assessment of proposed government actions could result from more clearly articulated environmental impact statements. This study identified factors to improve discussion and communication in environmental policy decisions and will provide understanding of the socio-scientific dilemmas faced by public officials.

This information may be used for planning better ways to present decision alternatives to public policy makers to encourage a more analytical and rational approach for solving public policy problems. Gaining more insight about each subject's understanding of the wetland water treatment alternative could also be important from an educational perspective. An analysis of each subject's core beliefs and reasoned arguments as they relate to a specific context will add to the knowledge base of science education. The findings may have implications for future curriculum development to encourage scientific habits of mind in both students and community leaders.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

Decision making research is of great interest to people from diverse professions and academic disciplines. As may be expected the research literature is representative of this diversity in both theoretical and methodological focus. "From these basic strains, the study of community decision making has evolved into something of an intellectual maelstrom, epitomized by debate not only at the level of research design and methodology, but also by polemics and ideology" (Bolan & Nuttall, 1975, p. 9). This statement is as true today as it was in 1975. Each theory contains certain biases and assumptions reflective of the purposes for which the research was intended or the academic discipline from which it originated.

For example, economic based theories focus on improving the quality of management decisions and they embrace assumptions that efficiency or correctness is the goal. Social and political based decision theories are focused on why or how collective decisions are made and they include assumptions that social values and norms are the driving force behind decision behavior. Theories developed by psychologists are focused on conditioning and learning behavior with assumptions that decisions are motivated by self interest and individual survival.

The sundry methods used in decision making research have been shaped by the prevailing theories as well as the difficulty experienced in isolating each aspect of decision behavior. Carroll & Johnson (1990) classified decision models as either descriptive or prescriptive and either alternative or attribute based. An alternative is defined as the sum total of a certain set of attributes. Descriptive models seek to find an explanation or understanding of a decision made by an individual or group. In comparison, prescriptive models strive to improve the future decisions of individuals or groups by analyzing and changing the procedures that are used.

Early case studies of group decisions were mainly descriptive in design. These studies led researchers to view decision behavior as a series of distinct stages in a linear process. An outline of the basic process stages is: (1) structuring and defining of ideas as proposals; (2) identifying alternatives; (3) structuring of the decision field; (4) engaging in social transactions and selecting alternatives; and (5) carrying out the decision consequences.

The process approach attracted the pragmatic interests of economists and management scientists, and has become known as the Expected Utility Theory. Some economists and management science theorists apply these ideas in a prescriptive fashion in an attempt to improve the decision making techniques of individuals or groups. Predictive judgements are mathematically calculated to minimize the risks regarding management choices. It is assumed that analytical reviews of each alternative will reduce the probability

of human error. Included in this paradigm is the belief that human emotion and affect may contribute to error in a decision process.

Some researchers diverted from the assumption that decision behavior is a highly efficient process, because human cognition is limited for a variety of reasons. This led subsequent research in several directions. One common thread that connects the various strains of decision research is the view that risk is involved in making a decision. Numerous researchers have explored this aspect of the decision process over the past 20 years. This line of research traces back to Expected Utility Theory, Prospect Theory and Conflict Theory which was the focus of Janis & Mann (1977).

Galaskiewicz (1979) argued that a study of collective power must focus on how decisions are made by the individual actors in the group process. Research in the field of functional or adaptive psychology has focused on a rational choice perspective of decision behavior. Implicit in the rational choice paradigm is a focus on individual cognition, and psychologists have shown interest in this aspect of decision behavior. The study of cognition has primarily been experimental and most research has taken place in a laboratory setting. A notable exception, however is the analysis of reasoned arguments by some researchers.

By using argumentation to conceptualize the cognition used by individuals while making decisions, a body of knowledge has been developed by (Zeidler, 1984a; Zeidler & Schafer, 1984; Zeidler, 1985; Kuhn et al., 1988;

Kuhn, 1991; Zeidler et al., 1992; Zeidler, 1997). Included in this paradigm is the connection between the causal theory used by an individual to explain a phenomenon, and the evidence used to defend the causal theory. An important feature of this framework is the concept of fallacious thinking within the decision context. This review will examine this base of knowledge as it relates to science education.

The ultimate goal is to provide a framework for the current study. There are several studies included in this review with some relevant points such as a person's perception of social compulsion or risk connected to a particular course of action. A recurring theme pertinent to the study is a suggestion of disparate cognitive modes used by individuals to make reasoned choices. The paradigms are meant to establish a basis to extend an investigation of reasoned action into the realm of social policy as it relates to scientific thinking.

It should be noted that the theories and studies included in this chapter have been selected for their relevance to reasoning in a social or an environmental context. The first section gives some history about studies of group decisions with social implications. The second section introduces some studies and claims regarding the perception of risk by people regarding their environmental beliefs or personal values. The third section recounts some studies and claims made regarding scientific thinking related to social issues.

In combination these three sections are intended to provide a basis for further investigation.

Early Studies of Social Decision Making

Two sociologists, Bolan & Nuttall (1975) recognized a need to study community decision making from a different perspective than other contemporary researchers from their academic field. They maintained a view of the process that went beyond the structural-functional approach which was in vogue with sociologists at that time. Yet, they were not fully satisfied with emerging views from other disciplines such as the popular transactional approach from the field of political science or the biographical study of individual political figures currently favored by psychologists. It was their contention that the strengths of each divergent theory could be blended into a single comprehensive framework.

Bolan & Nuttall (1975) set out to synthesize a theoretical and methodological design which focused on individual decision makers within the context of their social environment. They acknowledged power and social pressure as important factors in decision outcomes, but were also aware that needs and attributes of individual actors could be relevant. Their theory includes four sets of independent variables: (1) Process Roles; (2) Decision Field Characteristics; (3) Planning and Action Strategies; (4) Issue Attributes. The model identifies decision outcomes as dependant variables.

To test their proposed new method and theory, Bolan & Nuttall (1975) embarked on an ambitious multiple case study of the urban decision process. The four cases they selected were chosen for the similarity in potential social change that each process represented. All cases were concerned with changes in delivery of important urban services. Two involved significant modification of principal transportation systems in large metropolitan centers. Another was an effort to transform a municipal school system and the fourth was a bid to create a civic hospital center.

Municipal governing bodies were declared as the units of study in this research project, however four sets of variables were defined to give a more precise description for each of these units. Variable Set 1 included a list of major roles filled by actors in each group decision process, combined with a depiction of individual levels of motivation, opportunity and personal skills related to the decision task.

The process roles were characterized as 1) Community Knowledgeable, Informant; 2) Initiator, Planner; 3) Technical Expert, Analyst; 4) Expert on Process, Strategist; 5) Public Leader; 6) Mediator, Arbitrator, Negotiator; 7) Judge, Evaluator; 8) Possessor of Veto Power; 9) Coalition Maker, Organizer. Motivation and opportunity were related to private circumstances regarding social values or status and economic factors such as money or free time. Skills included group decision experience; high intelligence and knowledge of the issues; writing and speaking competence combined with good inter-

personal capability; specific experience with legal and legislative matters; and particular social/professional contacts.

Variable Set 2 included features of the decision field specified as characteristics of the decision environment and the decision unit. The decision environment consisted of the formal legal structure such as government agencies or the informal structure of private interest groups and political partisanship. Decision unit elements included such groups as formal legislative bodies with long standing traditions or special committees and citizens groups which were temporarily formed. In either example the group can be strongly influenced by prevailing social or moral values of the group members.

Variable Set 3 involves the way information is presented, the amount and type of information and the individuals who present it. This set of variables is listed under two headings with three subcategories in each. Planning strategies include planning position, which concerns the relationship with a certain power center for guidance in the process. Planning method where problems that are solved incrementally instead of comprehensively are considered as less complex. The last category under this heading is a concept of selective or strategic information in which planners focus on immediate results instead of long term goals.

Action strategies relate to the amount of disturbance to the status quo such as distribution of resources, behavior of individuals or society in

general, and basic organization of principal institutions. It was hypothesized that vast changes to existing conditions would meet with greater resistance than actions which caused less disturbance to the status quo.

Variable Set 4 contains six variables associated with the public agenda. The degree of ideology in a proposed change is the first in this set, with action being less likely as ideological content increases. Next is the number of people impacted and the degree of personal gain or loss they anticipate from a proposed change. Third is whether an action is considered flexible or inflexible over time, with inflexibility being associated with a choice for inaction. Fourth is the focus of action programming, which is related to the complexity of implementation. Fifth is the amount of perceived risk or uncertainty, with low risk supporting decisions for change. Last is the level of difficulty in communicating the features of the proposed change. If the concepts are easily understood and conveyed to others, they are considered more inclined to favor a decision of action.

Bolan & Nuttall (1975) employed a series of steps to describe the community decision process, which is similar to the classical model for study of individual decision behavior. These steps are: 1) structuring and defining ideas as proposals; 2) identifying alternatives; 3) structuring the decision field; 4) engaging in social decision-making transactions; and 5) carrying out the consequences of the process (p. 23). They consider these steps to be idealized in either the individual or group process, but still a serviceable

component for a rational attempt to analyze decisions. They also contend that these steps have greater significance for the group process because of the intrinsic social interaction in a collective decision.

The dependant variable in this model is the decision outcome, which may be more complicated than a simple acceptance or rejection of a proposal. Often there are compromises or modified proposals for various dimensions of the choices being considered. For example, the means to achieve a goal is viewed as different from the original goal. To deal with this, each of these two dimensions is represented on a continuum between total acceptance and total rejection. The outcome is graphically shown with the goal position on a horizontal axis and the means to achieve on a vertical axis.

Only two of the four variable sets were used in the original study. Set 1 (The Properties of Process Roles) and Set 2 (Decision Field Variables) were selected because the four cases had less similarity in these than in Variable Sets 3 and 4. The cases were chosen initially because they were in fact similar in the characteristics represented by Set 3 (Planning Methods and Set 4 (Issue Attributes). The researchers believed this arrangement would allow for more understanding of the correlation between Variable Sets 1 and 2 and the decision outcomes.

Bolan & Nuttall (1975) recognized that the project was at best a qualitative test of their theory and that only general tendencies might be

identified. They aspired to use quantitative measures to link the dependant variable to such independent variables as the degree of influence from specific individuals or organizations. They were interested to learn of the perception individual decision makers had of their own role, the roles played by other persons and the sequence of events which led to the final outcome of the community decision process.

To accomplish this, interviews were used to begin gathering data. The selection of interviewees initially began with lists of names from such sources as newspaper articles, reports, files and minutes of meetings. As the study progressed, more subjects were added to the list of interviewees if they were reputed by their peers as important members of the community decision process. The purpose of this was to learn how the decision process was perceived by the participants and not just by making assumptions from official public records. This sampling method was quite effective because actors in the process were judged by both allies and opponents who were interacting with them.

The interviews consisted of two parts, first information was collected regarding the person's reason for participating in the decision process and intensity of this participation. Questions were asked to determine whether their involvement was part of their regular job or as a community volunteer. Their level of intensity was measured by the number of hours they spent

during various phases of the total process and they were questioned about their perceptions of the roles played by other participants in the process.

An additional part of each interview was a questionnaire used to gain information for quantitative analysis. To gather this data three ratio scales were devised by the researchers, but no reference was made to a validation process. First each interviewee was asked to rate all organizations involved in the decision process on nine attributes related to variable set 2. The organizations of all individuals were given a value of 100 for each attribute and the person was then asked to proportionally rate the same attribute of every other organization in comparison.

A second scale was provided for eight personal skills of 20 to 30 other individuals who were known to be involved in the decision process. For this data set the person was asked to compare his or her own ability with the ability of every other person being rated. Again the base value was 100 for each skill of the respondent and a ratio value was used to express the perception they had for the skills of the others they rated. For example 200 represented twice as much ability and 50 represented half as much ability.

The last scale had seven points which represented verbal phrases describing the respondent's perception of other actors in the process. These phrases were based on the following social and affective considerations: 1) acquaintanceship with them, 2) like or dislike of them, 3) their importance to the issue, 4) their position on the issue. A low numerical rating meant less

importance and less agreement with the position of the other person and high numerical ratings meant more importance and more agreement with the position of the person.

From the four case studies, 135 people were interviewed and 62 returned completed questionnaires. A variety of techniques were used to analyze the data (see Bolan & Nuttall pp. 80-120). Findings of the study identified 11 variables which played an important part in the four cases. Four were from the role variables, three were from the skill variables and four were from the organizational attributes. It was concluded that the motivation and opportunity variables did not play a part. A general ranking in order of importance was: 1) Roles; 2) Skills, 3) Organizational Attributes.

Hammond (1955) began modification of the theory known as Probabilistic Functionalism conceived by Brunswik (1952, 1955, 1956). This line of decision research began in the early 1930s and continues today. The concepts of Brunswik's theory were combined in his "Lens Model," which was created as a device to represent both the internal and external factors that influence human judgement and decision making. The model was of minor interest to scholars until Hammond began building on Brunswik's ideas.

The concept of probabilistic functionalism was proposed by Egon Brunswik (1952) as a result of his life's work as a research psychologist. A notable aspect of his theory was the notion of representative design which he argued is a necessary requirement for any study of human behavior.

Pertinent to this notion is his contention that behavior is always some form of an organism's interaction with its environment. He believed that the environment consists of variables such as other organisms, objects and events. These variables were categorized by the region in which they relate to the organism.

Brunswik (1952) developed a research method known as the "Lens Model" which reflects the possible impact of environmental criteria on observed behavior. He argued that representative design is an essential step beyond the more simplistic research designs that attempt to link one cause to one effect. He employed the term "regional reference" was to describe the location of a variable relative to the behaving organism.

A variable may be distal which means it is deeply hidden in time or location with relation to the individual being studied. If the variable is an object which is easily measured it is considered overt, but if it is some intangible concept or idea and cannot be directly observed or measured it is a covert variable. In order to investigate the environment of each organism or individual, the researcher must identify both overt and covert distal variables.

The next layer of the individual's environment is the location of proximal variables. These proximal variables are directly connected with the sensory surface of the behaving organism. The central region of the environment is regarded as the internal portion where individual attitudes, motivation, intelligence, etc are found. Brunswik (1952) argued that other

contemporary theories and research methods were incomplete because no allowances were made for possible effects of the distal variables for a complete depiction of the environment.

In order to interact with an ambiguous environment, complex organisms such as humans use multiple ecological cues to function in uncertain situations. With this line of reasoning it is thought that cue-object relationships are not clear cut, which makes it necessary for vicarious mediation of many cues through the layers of the environment. It is also postulated that a comprehensive perception of the environment may be induced by several partial causes with less than perfect correlations. These factors may contribute to the causal texture of the environment. In order to sort out this complex behavior, Brunswik (1952) and Hammond (1966) believed that research must focus on the specific cues used by each individual to discern the distal as well as the proximal variables in the environment.

Through the combined efforts of Hammond (1955), Smedslund (1955), Hoffman (1960) Hirsch et al. (1964), Tucker (1964), Hammond et al. (1966) and Hammond et al. (1975) a cognitive paradigm known as Social Judgement Theory (SJT) was synthesized. Brehmer (1979) continued building on the axioms of SJT with a focus on theoretical and methodological improvement. The Lens Model and the concept of representative design are now regarded by some researchers as very worthwhile and an important step toward the development of more rigorous methods for the study of human

behavior. The research methodology contained in the Lens Model of SJT provides a range of formulas to profile individual cognitive patterns within some very specific decision contexts and environments.

Janis & Mann (1977) and Janis (1982) argued that people experience some level of psychological stress while making an important decision. The stress caused decision makers either individually or as a group to falter in the cognitive processing of information that was pertinent to high quality decision making procedures. They identified seven major criteria that must be satisfied to attain high quality decisions for the achievement of multiple long-term objectives. The seven ideal criteria were the following:

The decision maker, to the best of his ability and within his information-processing capabilities

1. thoroughly canvases a wide range of alternative courses of action;
2. surveys the full range of objectives to be fulfilled and the values implicated by the choice;
3. carefully weighs whatever he knows about the costs and risks of negative consequences, as well as the positive consequences, that could flow from each alternative;
4. intensively searches for new information relevant to further evaluation of the alternatives;
5. correctly assimilates and takes account of any new information or expert judgement to which he is exposed, even when the

information or judgement does not support the course of action he initially prefers;

6. reexamines the positive and negative consequences of all known alternatives, including those originally regarded as unacceptable, before making a final choice;
7. makes detailed provisions for implementing or executing the chosen course of action, with special attention to contingency plans that might be required if various known risks were to materialize (Janis & Mann, 1977, p.11).

Janis & Mann (1977) assumed that failure to meet any of the criteria resulted in a defective decision with possible setbacks or post decisional regret. They theorized that in order for decision makers to avoid serious miscalculations, "vigilant information processing" must occur, and that the more adequately each of the seven criteria is met, the less likely immediate objectives and long-term values would be jeopardized. An important component of their theory was that the stress experienced while important decisions are being made is caused by certain decisional conflicts. Janis and Mann (1977) believed that conflicts generate feelings of distress that are displayed as hesitation, vacillation or uncertainty over alternative courses of action.

Some possible sources of decisional conflict were believed to be:

First, any situation where the decision maker expects to gain or lose social or self-approval as a result of the alternative selected; and also, whether something of significant utilitarian value is at risk. Second, if the person has made some level of commitment to a certain course of action, but discovers new information regarding possible opportunities or threats which prompts a different choice. Third, if all available choices suggest serious risks, and cues provide little hope for finding a satisfactory alternative. Fourth, when conspicuous cues suggest that serious losses cannot be avoided because insufficient time is available to find a more satisfactory course of action.

The fifth type of stress is the only situation described by conflict theory as suitable for optimal coping behavior. It is assumed that this occurs when the person is challenged by the situation, yet also expects a satisfactory resolution. The first four situations are believed to foster coping patterns that can have undesirable consequences. The last situation is presumed to have a moderate degree of stress that motivates the individual to find a good solution for the dilemma.

Five basic coping patterns are linked to the five sets of circumstances as people react to the stress or decisional conflict. The theory does not discount other possible grounds for error in important decisions such as political or other group pressures, organizational constraints, information overload, prejudice, human limits in ability to process information and

ignorance regarding pertinent facts. However, the major cause of most serious errors is regarded as some attempt to avoid the stress related to each situation.

Of the five coping patterns the first four are generally regarded as maladaptive if vital choices are being made. In some cases with minor or routine decisions a savings in time, effort or emotional stress may result from one of the flawed coping patterns, but usually it will increase the chance of error. The four defective patterns are labeled unconflicted adherence, unconflicted change, defensive avoidance and hypervigilance. The fifth pattern, which is perceived as adaptive coping behavior, is termed vigilance.

The presence or absence of the following three conditions is associated with the coping pattern which may be employed by each person at any particular time. If the person believes there is: 1) serious risk with each alternative being considered, 2) hope of finding a better alternative or 3) enough time for further search and deliberation before the final choice must be made.

These concepts were explored by Janis & Rausch (1970), who designed a field study to investigate the coping modes of college men who were opposed to the Vietnam War. The subjects of the study were students of Yale University who were resisting the military draft. The researchers wanted to identify the relationship between the various decisional stands taken by the students, and whether they preferred the communication of information that

was favorable or unfavorable. Antidraft pledges were being declared in writing; then circulated and signed by hundreds of students.

Civil disobedience was escalating rapidly and the morality of the war was being questioned by many people. Some religious and political leaders were critical of the country's involvement in the war and were asking for support from the students. The newspapers were regularly publishing the antiwar pledges with the names of the signers. Controversy was at a high level over the political and legal aspects of the resistance movement. The adherence of the students to their public pledges constituted a high level of risk for them. Their future careers and continued education were bound to be impacted by the moral positions they chose to take.

The purpose of the study was to discover the variables that had a mediating effect on the tendency of the subjects to accept or reject opposing communication about the antiwar controversy. The goal was to specify whether the coping behavior of each student was avoidance or vigilance. An important consideration was to find the function of how this variation of interest in positive or negative information changed in relation to the way each man had decided to participate in the draft resistance movement.

Sixty-two men were given a standardized interview which was used to classify them into four groups. Group (1) had signed a We-Won't-Go pledge, which was published with their names in the local newspaper; group (2) were potential signers who had not made up their minds; group (3) had

been undecided about signing, but then declined; group (4) never considered signing. After their interviews the subjects were asked to read a 50 word summary of each position; they were then asked about their interest in reading four pro-draft and four anti-draft articles. They were then asked to read two six hundred word articles, one for and one against, the resistance movement.

As the resistance level of the groups increased the difference in each group's agreement with the two articles widened. The group with the strongest commitment to the draft resistance, had both the strongest agreement with the anti-draft article and the strongest disagreement with the article in favor of the draft. The magnitude of agreement and disagreement became progressively less as each group's level of draft resistance declined toward an almost neutral rating for both articles by the group which had never considered signing the pledge.

When decisions are made in a coping mode of vigilance it is believed that the level of stress or conflict is moderately high, but not so intense that the cognitive processes are impaired. In this mode the level of stress can fluctuate moderately and a medium to high rate of vacillation between alternatives is often observed. Other conditions necessary to foster vigilance are the perception of serious risk from the current situation and from other courses of action under consideration. It must also be the conviction of the

decision makers that a better solution may be found and that there is enough time to find it.

Two of the four maladaptive coping patterns occurred under conditions of low stress with no vacillation between choices. These patterns are unconflicted adherence and unconflicted change. With unconflicted adherence there is no perception of risk from the current course of action. In the pattern of unconflicted change there is a perception of risk from the current course action, but no risk is perceived from the proposed change.

Hypervigilance is accompanied by persistent anxiety and high stress. The amount of vacillation between alternatives is usually very great. High risk is perceived from the current course of action as well as all alternatives under consideration. The person believes there is a possibility of a better choice, but believes there is not enough time to find it. In this case the processing of information and other decision behavior may reach a state of panic. This pattern is often connected with crisis situations such as during natural disasters or with medical decisions, where severe personal loss may result from any decision. However, in the case of public decisions, hypervigilance is not as common as the pattern of defensive avoidance.

The conditions which foster defensive avoidance are typical in many facets of everyday life. Janis & Mann (1977) list the two essential mediating conditions as: (1) the decision maker is in a state of relatively high decisional conflict resulting from two clashing types of threat that make it impossible for

him to adopt any easy resolution, and (2) he has lost hope of finding a solution better than the defective ones he is considering.

The antecedent conditions for the loss of hope may include cues from any of the following: (1) a trustworthy expert's judgement that all the available information has already been obtained by the decision maker, (2) markedly diminishing returns from prolonged information search, indicating that the information supply has been exhausted, (3) impressive warnings about unacceptable losses from adopting any of the proposed alternatives, and (4) a consensus of pessimism among those from whom the decision maker seeks advice about arriving at any promising new ways to resolve the conflict.

Depending on how the decision environment is perceived by an individual, defensive avoidance behavior may be manifest as either procrastination, shifting of responsibility, or bolstering one of the alternative solutions being considered. Any one of the three forms is believed to be an attempt to escape the stress which may result from being caught between two sources of threat. While it is possible that personality traits may influence the form of defensive avoidance, the main determinants are the situational variables.

If the person believes that a decision may be postponed as a way to escape the feeling of distress, then procrastination occurs. The amount of perceived risk from postponing action is a major determinant for this form of

defensive avoidance. If the person believes there will be no penalty for an indefinite delay, then attention will be given to other matters involving less stress. In this event, an individual will not speak or think about the matter, and will avoid social situations where this might be expected.

On the other hand, if the decision can be passed on to someone else, then avoidance of the decisional conflict might take the form of shifting the responsibility. In this circumstance a person may begin to rationalize that other individuals such as colleagues or family members should make the decision. Attempts to get others involved will be made on the pretense that they are more qualified to make the decision or that someone else should take the blame for any negative consequences.

Bolstering an alternative may occur if the decision maker believes there is no way to avoid the decisional conflict by shifting responsibility or procrastinating. With this form of avoidance, the least objectionable alternative is bolstered by exaggeration of the desirable attributes. Information that is being processed by the person will be distorted and selective. All other alternatives are dismissed as unacceptable and any negative aspects of the chosen alternative are minimized. The person's thoughts and discussion of the topic will be biased in favor of the positive consequences for adopting the selected alternative.

Festinger (1957, 1964) recognized bolstering as an integral component of decisional behavior, but believes it to be related to inconsistent

cognition regarding the alternatives. He assumes that cognitive dissonance always follows a decision, because certain aspects related to the choice become more obvious after the selection has been made. He surmises that when this occurs, the attractiveness of the chosen alternative is magnified, while the desirability of the other choices is diminished.

Mann and Taylor (1970) found some evidence of predecisional bolstering, vigilant information processing and defensive avoidance in an experimental study. A real-life choice situation was modeled as a decision such as consumers make when shopping for a household object. The decisions were to involve a variety of art styles with no real value, but it was assumed that the subjects would take personal pride in the choices they made. The researchers also believed that a mild threat to the self esteem of the subjects was possible, because of possible differences in the artistic tastes of their friends and relatives.

Six groups of 19 female college students were asked to rate a set of 12 art prints. After the ratings were made, each woman in five of the groups was shown a pair of the prints and told that she could keep one of them. The subjects from three of the groups were asked to make a difficult choice between pairs of art prints which they had rated almost equally. The subjects in two groups were given easy choices between two prints which they had rated very unequally. The sixth group was a control group, and those subjects were not offered the choice of a print to take home.

Decisional conflict was created at unequal levels for the subjects by varying the difficulty of the choices. One group was told that the choice was revocable, and that they could take their selected art home for a few days. Then, if their minds changed, it could be returned and exchanged for the other print. The second group was told that the choice was irrevocable and the subjects were asked to sign for the print. The third group was given an irrevocable choice and asked to write a 200 word essay to justify the choice. For the two groups with easy choices, one was given the revocable option, and the other the irrevocable option.

The results of the study showed that the two groups with the easy choices experienced little or no decisional conflict, and the subjects made the choices faster than most of the other subjects. For the group with the easy and revocable choice, the mean for the decision time was 2.8 seconds, and the predecisional bolstering mean was 0.50. For the group with the irrevocable easy choice, the mean decision time was 7.8 seconds, and the mean for predecisional bolstering was .00. The control group made no choice, but they had a predecisional bolstering mean of 0.25. In the control group, the subjects showed no sign of decisional conflict.

For the three groups with the difficult choice, there was some decisional conflict observed. For the subjects with the revocable choice, the mean decision time was 7.0 seconds, and the group mean for predecisional bolstering was 1.11. The researchers observed a degree of defensive

avoidance in this group. The mean decision time for the group with the irrevocable choice was 13.1 seconds, and the predecisional bolstering mean was 1.40. A minimal level of vigilance was observed in this group. There was a moderate level of vigilance observed in the group with the irrevocable choice, and the requirement to justify the choice. The mean decision time was 24.9 seconds, and the predecisional bolstering mean was 0.70.

Janis & Mann (1977) incorporated the phenomenon of bolstering into Conflict Theory with a different perspective than some other researchers. They assume that the motivation for bolstering is defensive avoidance as previously described and is not cognitive dissonance. They also argue that bolstering may occur before as well as after a commitment has been made to an alternative. While some researchers disagree with cause of bolstering, most agree that some process of cognitive restructuring occurs.

Janis & Mann (1977) identified six rationalization patterns that individuals often use in cognitive restructuring while making important decisions. The basis of bolstering is assumed to be a set of defensive beliefs which may be quite obvious or very subtle in the way they are manifest by the person. They are labeled as: 1) exaggerating favorable consequences, 2) minimizing unfavorable consequences, 3) denying aversive feelings, 4) exaggerating the remoteness of action commitment, 5) minimizing social surveillance, and 6) minimizing personal responsibility.

The first two tactics are quite obvious and need little explanation. However, detection of other defensive beliefs is more difficult and requires further interpretation. If undesirable consequences cannot be denied, then the decision maker might argue that they are attractive or desirable because of some other ideology or value system. In this situation the decisional conflict is minimized by tactic number three, denying aversive feelings. In the case of tactic number four, exaggerating the remoteness of action commitment, the presumption is made that no action on the decision will be required in the foreseeable future.

Tactic number five, minimizing social surveillance, is a mental distortion that other people will not know or will not care about the action or choice that the individual is about to make. The last bolstering tactic in the list, is minimizing of personal responsibility, and it should not be confused with the form of defensive avoidance labeled as shifting of responsibility. In the former, the person admits that the choice is his, but attributes the reason for the choice to social pressure from others. With the latter, the actual decision is passed on to another person.

Janis (1972, 1983) identified and described a collective form of defensive avoidance which he labeled "groupthink." This is a situation where defective decisions sometimes result from strong social pressure for the unanimous support of a certain course of action. In this condition it is still assumed that the individuals involved in the group may respond with any

of the coping styles contained in the conflict model, but the pressure to conform is in much greater proportion. The groups that are the most vulnerable to groupthink are moderately to highly cohesive where the members share a strong need for affiliation.

It is believed that when groupthink occurs in highly cohesive groups with concurrence-seeking tendencies, bolstering is often manifest. The concept is an extension of the earlier theories that describe strategies of consensus building among individuals and groups that share influence and power in the context of a specific decision environment. When the personal biases or irrational beliefs of a strong leader are collectively embraced by a cohesive group of decision makers, it is highly probable that some serious errors in judgement will occur. One major point of this ideology is that vital decisions in the real world are often less than optimal with regard to radical changes in policy.

In a review of five case studies, Janis (1983) found some compelling evidence supporting the notion of a groupthink syndrome. These representative cases were selected because they exhibit the group conditions that he believes foster the flawed decision styles postulated in conflict theory. All five cases have been widely recognized as bad decisions made at a high level in the government of the United States. In each case a fiasco resulted that caused a high degree of regret for those who were involved in the decision

process. A brief summary of some representative case studies will give more clarity to the components of conflict theory described above.

A classic example of the groupthink syndrome is the decision made by President John F. Kennedy and his close advisors to invade Cuba. In a case study of this decision, known as the Bay of Pigs incident, Janis (1972, 1983) identifies six major miscalculations, that were the result of assumptions made by highly intelligent, yet misinformed men. In retrospect, all six of the assumptions were based on very irrational thinking and faulty planning. A form of bolstering was also present in the group, and it was manifest as reassurance by the Central Intelligence Agency (CIA), that the plan of action had very little risk of failure.

The six assumption were: 1) most people will believe the CIA's cover story and no one will know what really happened; 2) the Cuban air force was weak and could be destroyed before the invasion; 3) the 1400 Cuban exiles who were to make the invasion had high morale, and would not want support from troops of the United States; 4) Castro's army was weak and small; 5) the invasion would start an internal revolt against Castro that would support the efforts to overthrow Castro. All of these assumptions were not based on any facts, but were bolstered and affirmed by Kennedy's advisors.

When the invasion failed, the official explanation placed the blame for the failure on the following four factors. First, the invasion plan was derived from political thinking and not military strategy. Second, the new Kennedy

administration was not yet in harmony with the existing bureaucracy. Third, the secret nature of the mission had excluded the experts from the planning process. Fourth, the policy-makers were reluctant to openly oppose the high level leaders because it might damage their personal status. Janis (1983) does not agree that these four factors fully explain the miscalculations.

The rationale that Janis (1983) gives after reviewing some authoritative accounts of the Bay of Pigs decision is not meant to replace the four factors of the official explanation. Instead he identifies other symptoms that indicate the possible presence of a groupthink syndrome. There was an illusion that Castro's forces were weak and that the opposing forces were invulnerable. The policy-makers believed that the enemy was incompetent and immoral, while the resistance forces were fighting for democracy and against communism. Therefore, any person who spoke against the invasion plan was not showing support for the moral purpose and goals of the group.

There was also an illusion of unanimity and mutual respect for the opinions of the group members. Critical individual thinking was replaced by a consensual validation of the leader and the plan that he favored. Personal doubts were suppressed and some members of the group had fear of possible disapproval from the leaders and the other members. Social pressure was put on any doubtful group members by self-appointed mind-guards, to say nothing that might discourage the leaders. The group agenda was manipulated to prevent any open discussion of dissenting views about

the proposed invasion plan. A taboo was created against antagonizing valued new members of the Kennedy administration.

Janis & Mann (1977) identified the following eight major symptoms as indications for groupthink to be exhibited: 1) a collective illusion of invulnerability; 2) collective efforts to rationalize in order to discount warnings; 3) an unquestioned belief in the inherent morality of the group; 4) stereotyped negative views of rivals; 5) direct pressure on any member who expresses dissenting views or arguments; 6) self-censorship of doubts or deviations from group consensus; 7) a shared illusion of unanimity and false assumption that silence implies consent; 8) the emergence of self-appointed members who protect the group from adverse information which threatens the complacency of the group.

The symptoms of groupthink postulated by Conflict Theory closely match the group dynamics observed in reviews of the policy decisions for the Bay of Pigs invasion. Janis (1983) analyzed the Kennedy administration's decision procedure in another important foreign policy-making process known as the Cuban Missile Crisis. This crisis was handled by essentially the same group of leaders, but the outcome was recognized as much more effective than the Bay of Pigs incident that had occurred just over a year earlier. Janis (1983), believes this comparison is an extraordinary counterpoint to use as further evidence of the groupthink syndrome. President Kennedy made four important procedural changes after his earlier mistakes

had been recognized. First, he redefined the roles of the participants as critical thinkers in the decision process. Instead of the group members confining their comments to the areas of their own specialty, they were expected to become skeptical generalists, and examine each problem as a whole. He also appointed his two most trusted advisors to become the devil's advocates, and relentlessly pursue every aspect of contention in order to prevent mistakes from a superficial analysis of the issues.

The atmosphere of the group was changed by organizing the meetings in a completely different way. A formal agenda was not followed, instead, frank and open discussions were encouraged. New advisors and outside experts were routinely introduced in order to obtain fresh points of view. Critical thinking was facilitated by breaking up the executive committee into subgroups, then debates were encouraged among the groups when they joined together again. President Kennedy was intentionally absent from some meetings to allow the committee to conceptualize the problems without undue influence from his presence.

There is evidence that groupthink was avoided, and a new group norm was established by the procedural changes that Kennedy made. The group experienced a high level of stress and a great deal of subjective discomfort during the policy planning period, yet the group members were all very cautious about rationalizing in order to speed up the process. This

vigilant appraisal of the situation is a sharp contrast to the attitude of invulnerability that was present in the Bay of Pigs decision process.

Janis (1983), found four general characteristics that were manifest in the process for the Cuban Missile Crisis that indicate vigilant appraisal instead of the concurrence-seeking behavior of the Bay of Pigs decision. First, was recognition by the group members that grave dangers existed, even after the plan of action was decided. Second, was the explicit and direct discussions of the morale issues connected with the decision alternatives. Third, was the open manner that each member used to express the confusion and indecisiveness they felt when trying to reach an acceptable balance of all pertinent aspects. Fourth, was a strong commitment and resolve by the group members to adhere to the policies as they were implemented.

The concept of a contextual perception of the choices, when decisions are being made by individuals, is described by Yates (1980) as affective versus cognitive encoding. Dawes (1988) describes this mental representation of decision alternatives as framing, where associations are made with something in the context of the situation, which serves as a reminder of past learning and experience. This cognitive image or framing of the summaries of the person's past experience and knowledge are described by Beach (1990) as a value image, which includes a combination of values, standards,

ideals, precepts, beliefs, morals and ethics. He also defines a trajectory image as a set of abstract and concrete goals for an ideal future.

Studies of Risk Perception and Environmental Values

Hogarth (1980) maintained that evaluations and predictions are major parts of decision making behavior. He believes that, on the basis of belief and preference, people give meaning to information, and that it is essential to understand the way individuals conceptualize the world in order to perceive their anticipation of each decision milieu. Gregory and his colleagues depict an individual's perception in relation to public policy and environmental issues as closely connected to the cognitive concepts of mental images and framing of decision alternatives described by Yates (1980), Dawes (1988), and Beach (1990).

Gregory et al. (1993), explored the mental points of reference that individuals use to decide whether to support or reject policy alternatives. The focus of their study was to measure the effects of the framing of alternatives as either restoration of a loss, or as a gain when, when compared with the current conditions. They hypothesized "that an improvement program that is framed in terms of returning to an earlier, better status will be evaluated more favorably than will an otherwise identical program that is framed around the current status." (Gregory et al., p. 197, 1993).

Decision problems were selected for two domains that the researchers considered important areas of public concern. In the context of these

domains, realistic policies were designed to propose changes in health and in the availability of environmental goods. Six pairs of statements were designed to reflect a possible change. In each pair, one was framed with reference to the present and one was framed with reference to the past. In each pair, both changes were the same regarding the proposed improvement, except for the difference in reference to the status quo. Each respondent was asked to rate the desirability of the change on a seven point scale, with least desirable "1" and most desirable "7".

The statements in the present form were simply proposals for a change from a present condition to a better condition, but with a tradeoff or cost for the change. The tradeoff was the same in each pair, but in the past form information was included regarding a past condition that was actually equal to the present condition, yet it was framed as the restoration to a past state. This totaled 12 policy problems from the six areas. Three of the problem areas were realistic and three were fictional. Just one question was asked of each subject along with a short description of the proposed change. The 983 volunteers for this study were recruited from the community of Eugene, Oregon, and the majority were students from the University of Oregon.

The first fictional problem concerned pollution of the atmosphere from manufacturing detergents and soaps. In the present form the Detergent problem was whether the subjects supported a policy that would reduce the

pollution by 15 percent at a cost increase of ten percent. The past form used the same cost increase, but framed the reduction in pollution as a return to levels of the past. For this problem, 44 subjects were given the present form of the question, and 43 were given the past form. The subjects in both groups were asked to evaluate their respective policy options on the seven point scale described above. The group mean for those subjects who rated the present form was 5.02 with a standard deviation of 1.45. The group mean for the past form was 6.14 with a standard deviation of 0.77. The t-score was 4.46 $p=.01$.

The second fictional problem area was Public Health where a hypothetical infectious disease was blamed for the deaths of 143 children in 1989. The decision was whether to spend limited funds for a vaccination program. The question in the present form was framed as an elimination of the disease by two years in the future. The past form was framed as a restoration to a prior status, before the disease first appeared. For this problem, 46 subjects were given the present form of the question, and 45 were given the past form. The group mean for the subjects who rated the present form was 4.13 with a standard deviation of 1.49. The group mean for the subjects who rated past form was 5.47 with a standard deviation of 1.25. The t-score was 4.63 $p=.01$.

The third fictional pair of questions concerned an Operation problem regarding two hospitals with different failure rates for operations. In the

present form the question was framed as a possible change from the hospital with the low success rate to the one with the better rate. The past form reversed the scenario to a move from the better hospital to the one with the lower success rate. For this problem, 92 subjects were given the present form of the question, and 91 were given the past form. The group mean for the subjects who rated the present form was 4.11 with a standard deviation of 2.20. The group mean for the subjects who rated the past form was 4.93 with a standard deviation of 2.02. The t-score was 2.64 $p=.01$.

The information included in each realistic area in reference to the past was actually a true description of a past condition in each problem area. River, Air and Auto were the realistic areas. For the three realistic areas, it was found that the information given in the past form questions was already familiar to the subjects. New facts were not presented for the realistic areas, but the information already known to the subjects was only emphasized for the past form.

The Auto problem area was treated as a control by including some past information about conditions which were actually worse than the present state in addition to a general reference to the clean air of the past. The reasoning for this was that if the old condition was used as a reference point, the proposed change would be rated less favorable by the Present group. The results, however, indicated that when this prior state was added there was no effect. For this problem, 89 subjects were given the present form of

the question, and 67 were given the past form. The group mean for the subjects who rated the present form was 5.43 with a standard deviation of 1.54. The group mean for the subjects who rated the past form was 5.22 with a standard deviation of 1.82. The t-score was 0.75.

For the River problem, 101 subjects were given the present form of the question, and 98 were given the past form. The group mean for the subjects who rated the present form was 5.67 with a standard deviation of 1.32. The group mean for the subjects who rated the past form was 6.02 with a standard deviation of 1.06. The t-score was 2.04 $p=.05$. For the Air problem, 135 subjects were given the present form and 132 were given the past form. The group mean for the subjects who rated the present form was 4.74 with a standard deviation of 1.79. The group mean for the subjects who rated the past form was 5.19 with a standard deviation of 1.82. The t-score was 2.03 $p=.05$. For the past and the present forms of the six problems a possible improvement was proposed at some cost. All ratings were based on the seven point scale described above, with 1 representing the least desirability and 7 representing the most desirability.

The researchers concluded that their predictions were correct and in accordance with the premises of prospect theory. It was found that the subjects responding to the past forms of the River and Air problems gave significantly higher desirability ratings than those for the present forms of these two problem areas. Both forms of the Auto problem had no significant

difference in ratings. The areas of River and Air suggested different reference points on the basis of whether or not the proposed improvements were viewed as the restoration of a loss, but because the past form of the Auto problem actually described a worse condition, the reference point appeared to be the same as for the present form.

For the fictional problem areas of Detergents, Operations and Public Health, the contrast between past and present forms was greater than in the two realistic problems for Air and Water. It was surmised that this was because some subjects from the present forms of the two realistic areas might have used their own prior knowledge of the past status to frame the problem. This however, was not intended by the design of the study.

The results of the study show evidence that a cursory choice of words to express the values for policy alternatives, can shift the reference position of some people. It also suggests that these underlying values may not be clearly structured until information is actually sought by policy makers. It appears that minor changes in wording can elicit significantly different perceptions of the same problem. Public policy makers might wish to learn what the public's perception and values are regarding important issues yet be unaware that shifts can be caused unintentionally by the way a problem is structured.

It is believed that a major component of the public concerns about policy changes is risk perception. MacGregor (1994) contrasts two view-

points regarding risk communication in the context of community relations. First is the form and content, which he states is a matter of providing understandable technical information. This is usually done by experts and is primarily educational. Often there is an attempt to minimize risks and convince the public that risks are small. This process creates open communication, but does not usually empower members of the public to participate in policy changes.

The other viewpoint is described by MacGregor (1994) as "what the public typically expects would be done in a normal and appropriate process for managing anything in society" (MacGregor, 1994, p. 5). He argues that for risk management by policy makers it is important to consider the public's perception of risk based on social norms and values even when these might have little or nothing to do with technical assessment of the risks. Often the quantified and technical factors that define risk for experts are much different from the social and psychological attitudes that are held by members of society who have no expert knowledge. These feelings of inexperienced people regarding risks and benefits are frequently measured in the context of their own experience.

A study of risk perception by Gregory & Lichtenstein (1994) explored some quantitative and qualitative risk factors associated with public concerns about policy changes. The purpose of this study was to measure the willingness of subjects to make tradeoffs between quantitative risk factors such as

dollar amounts, and numbers of injuries or deaths and certain qualitative risk factors. To conduct the study, four versions each were written for two problem stories. One version was given to each of 373 volunteer subjects from the Eugene, Oregon area. The stories were varied by changing the factors for two response modes and the presence or absence of some qualitative risk information. In all versions the respondents were invited to make written comments to clarify their answers.

The topic of the first set of four problem stories was a new type of bicycle brake that are supposed to work better in rainy weather. For the two quantitative versions of this story, there was a tradeoff between a higher cost for the new type of brakes and a reduction of personal injuries. The added cost for the brakes in the "injuries" version was \$50, and the subjects were asked what the reduction of injuries must be for their acceptance of the added cost. The "dollars" response version reframed the tradeoff to a 50% reduction in injuries. For this version the subjects were asked the highest extra cost they would pay for this reduction of injuries. The reduction of injuries was described as either a general reduction of 50% or half the chance for an individual to crash.

For the two qualitative-risk versions of the Bicycle Brakes story, more information was given to the subjects in addition to the same basic story. These subjects were told that a new material was used for the better brakes which was not completely understood by scientists. These two groups were

also told that some of the new material is released into the atmosphere as the brakes are used, and that there is disagreement among scientists whether it could be harmful. It was alleged that a large majority of scientists believe the material is completely harmless, and the small number who do suspect a problem, are not able to predict definite details about the harm it might cause. It was also reported that the scientists with concerns about negative impacts in the future believed that any possible bad effects would not become health hazards for several generations.

For the second problem story, the topic is Plastic Car Bodies. In the two quantitative versions of this story, the subjects were told that a new kind of plastic could be used to make better auto bodies, which would save lives. The extra information for the two qualitative-risk versions added that little is known by scientists about the new plastic. The subjects were told that most scientists believe it is completely safe, but a few speculate that junked cars will begin to disintegrate in about 100 years, which might release small amounts of toxic chemicals into the groundwater.

For both response modes, and in each story version, the subjects were asked to respond as policymakers. The "Lives" version asked for the number of lives saved per year which the subjects would need to approve the use of the new plastic. For the "Dollars" version the subjects were told that the new plastic would reduce the cost of cars. They were then asked the average dollars per car needed for them to approve the use of the new plastic. The

questions for this problem area were framed to infer the tradeoffs between quantitative and qualitative risk factors, but not specific tradeoffs between dollars and lives.

For the Bicycle Brakes problem, a 50% reduction of injuries was the median response from the 45 subjects given the no perceived risk, quantitative information. The median demand for reduction of injuries increased to 75% for the 41 subjects who received the additional qualitative perceived risk information in the injuries version. For the "Dollars" response mode, \$20 was the median willingness to pay for the 45 subjects in the no perceived risk group. The willingness to pay median decreased to \$5 for the 44 subjects who received the additional qualitative perceived risk information.

For the "Dollars" response mode of the Bicycle Brakes problem, 50% of the subjects in the perceived risk group refused to make the proposed tradeoff and 10% from the no perceived risk group rejected the tradeoff. In the perceived risk group of the "Injuries" mode, a small number of subjects made extreme written responses which were considered by the researchers to be refusals of the tradeoff. A greater number of the subjects from the groups which received the qualitative perceived risk information made written comments, than the subjects from the other two groups. The common theme of these comments was that the status quo was better than a change with possible bad side effects.

From no perceived risk group, with the "Lives" response mode, 58% of the subjects accepted the Plastic Car for a tradeoff of less than 1,000 lives saved. The same tradeoff was accepted by only 18% of the subjects who received the additional qualitative perceived risk information. The median required number of saved lives was 100 for the no risk group and for the perceived risk group, the median number was 20,000. For the "Dollars" response mode, 23% of the subjects in the no perceived risk group required \$1,000 savings per car or less, as a tradeoff for accepting the Plastic Car, 4% of the subjects from the perceived risk group accepted this same tradeoff. The median required cost savings was \$2,000 for the no risk group and \$5,000 for the perceived risk group.

The data for the Plastic Car problem were more difficult for the researchers to interpret than for the Bicycle Brakes problem. Some subjects from all four groups of this problem area made comments which were obvious protests or refusals of the proposed tradeoffs. There was also some difficulty in determining whether other responses were realistic tradeoffs or complete rejections of the ideas presented in the problem. Environmental anguish was clearly apparent in some subjects from all versions of both problem areas. However, when qualitative descriptions of possible harmful side effects of the proposed new technologies were presented as concerns for some scientists, many subjects refused to consider any tradeoff for the perceived risk.

The implications of this study are that most subjects will pay a price in money or as a tradeoff of quantitative risks in order to avoid certain qualitatively perceived risks. It was found that the inclusion of these psychometric risk factors altered the acceptable tradeoffs for some of the subjects, and for others it completely changed the way they thought about the new technology. The study revealed certain concerns that the researchers had not expected, such as distrust for people who are charged with managing the risks which can have serious harmful effects on the environment. In fact in some more extreme responses, the subjects expressed a general disgust for science and new technology, even when there was only a hint of some potential risks.

In a study by Gregory et al. (1995), the willingness to pay for environmental amenities was explored. The monetary value that society places on such things as hiking, sport fishing, or habitat preservation is known as the contingent value (CV). While these environmental goods are not for sale in the normal sense, they have a certain value to most people. This study was based on the idea that while some people have strong feelings and place high a value on environmental amenities, they are not able to precisely represent the value in dollar amounts. The researchers were also concerned about the context sensitivity of these CV responses.

The participants for this study were 425 people from the Eugene, Oregon area. The majority were students of the University of Oregon, and of the subjects had answered an advertisement in the University of Oregon

newspaper. These subjects were paid \$8.00 to complete a six-page questionnaire during a 90 minute session. The instrument was developed in several focus group discussions involving 32 participants. The questionnaire contained a list of 12 proposed environmental projects, 5 computational items and the instructions. The 12 proposed projects described a context such as a local area or issue which was familiar to most people, and some possible good which the project might cause. The subjects were asked how much they would be willing to pay each year for each proposed project.

The researchers were not attempting to determine the actual dollar amounts, but were exploring for differences in the expressed values from five experimental conditions. The critical elements were the understanding a subject had of each project, and whether the proposed range of budgetary units was appropriate. A survey was previously made of 32 subjects to determine whether these elements were understood. To ensure that the 12 items on project list were understood, some changes were made. Two focus groups had some in-depth discussions and then a second survey was made of 200 subjects. The second survey also evaluated the computational abilities of the respondents.

For each of the five versions of the final test, a different magnitude of the budgetary unit was used. These units were said to equal \$1, \$2, \$5, \$10, and \$20, the subjects were told that state legislators used the units to plan how yearly expenditures would be divided among competing projects.

It had been determined by the pre-testing that the budgetary units made sense in the context of the proposed projects. The design of the questionnaire gave four possible answers for each of the five versions of the 12 proposed environmental improvements. The subjects could refuse to pay any amount, pay less than the unit, pay more than the unit, or they could agree to pay an amount equal to the unit. If the option of more or less was selected, then a factor to multiply or divide the budgetary unit was requested.

Based on the five computational questions, about one third of the 425 subjects were dropped from the sample. This reduced the number to a total of 277 for the final sample. The criterion for rejecting a subject was failure on at least one of the questions in the computational part of the questionnaire. The stated purpose for this study was not to elicit an actual willingness-to-pay value, but to test for differences of expressed values in the context of different magnitudes of a budgetary unit. The results were not to be used for generalization of dollar amounts or to represent the general population.

For the purpose of comparison, the budgetary unit values of all responses were converted to a dollar amount for each condition. The median willingness-to-pay for each of the five conditions in all 12 proposed projects was used for analysis of the data. The mean response values were not used because the distributions were skewed. One of the 12 projects was discarded because 57% of the subjects refused to pay anything for it. In three of the remaining 11 projects, the median responses were identical to

the budgetary units assigned to each version. A total of six projects had responses which increased with the magnitude of the budgetary units. Two items did not show a substantial variation across the payment methods. The remaining three items all showed a steady increase across the first four budgetary units, but on the last unit they collapsed.

A systematic change in the response values was observed, together with a strong preference for the budgetary unit suggested in each version of the 11 projects. The original hypothesis was that people have no readily accessible cash value for environmental amenities. Gregory et al. (1995), have refined their thinking as a result of this study. The data suggest that people do in fact have a concept of the value within a broad range. An assumption is made that these concepts are not precise, and therefore, a response equal to the suggested budgetary unit was common when it was within the broad range conceptualized by the respondents.

It was concluded that any suggested amount that falls within a broad range is acceptable to an individual if it represents the concept that environmental quality has some degree of importance. Within this range, the context of each situation appears to have a strong influence on the maximum willingness-to-pay which may be elicited from respondents. It appears that when people have only a vague concept of the monetary value of some non-market good, they will accept an arbitrary cash value if they lack precise knowledge or experience in the situation. These imprecise estimates of value

were constructed by the individuals during the decision process. It is recommended by Gregory et al. (1995), that value-structuring strategies and techniques be used in resource policy decisions.

Satterfield and Gregory (1996) provide further insight in the quest for a link between public policies and environmental values. They argue that situational details are often missed by standard survey techniques. To gain a perspective of the environmental values held by the public, decision makers need to consider many dimensions. The search for this information must be personally meaningful; additionally it must be pragmatic and theoretically defensible. They maintain that the cognitive reasoning that connects values with actions can be traced through other methods and analytical procedures. Their contention is that when the expressed values of individuals fail to correspond with their related actions in the decision context, it is crucial to define what reasoning takes place between the two points.

A paper by Satterfield and Gregory (1996) described an experimental questionnaire designed to mimic decision-pathways. It was used as part of a large survey study done in the province of Ontario, Canada in 1994. The primary study consisted of several surveys related to forest management, and was conducted for the Ontario Ministry of Natural Resources. Samples were taken from two different populations in the Ontario area. The largest sample (n=1500) was randomly selected from the general population, and consisted of mostly urban dwellers. The other sample was randomly selected

from timber dependant rural communities, and was divided into two groups. The first group (n=642), were residents who were not employed by the timber industry, and the second group (n=159), all lived in households with at least one person employed in the timber industry.

A subset of the respondents were then asked to respond to a decision-pathways survey. For this experimental survey the sample size from the general population was (n=301), from the non-timber employed rural residents (n=167), and from the timber employed rural residents (n=167). A broad set of values related to common beliefs about natural systems, the environment and the role people should play in nature was the essence of the study. Based on these ideas, some focus-group discussions, other previous research and the findings of some pilot studies, 25 questions were written. No reference was made to a validation process in the research report.

The 25 questions were linked in various combinations to form a total of 13 potential decision-pathways. Many respondents selected certain pathways and others pathways were chosen by only a few people. Certain paths were quite similar and there were wide differences in others. Some of the original 13 pathways were combined with others that were similar and some were eliminated to create a final representative set of five distinct pathways. The first split of pathways was based on a question of value judgement regarding the desirability of controlling nature or not. All of the

respondents were asked this question that divided people who supported forest management in general from those opposed to it.

Based on the general principle of forest management there were two paths with subsequent resistance to any practice of controlling unwanted vegetation in replanted forest lands. For one of these, path 1 (n=19), there was a general distrust of technology and forest managers. For path 2 (n=53), the reason was that nature is so complex that it is better at self-management. A total of 41.6% of timber workers selected paths 1 and 2, compared with 24.5% of urban dwellers and 27.2% of non-timber employed rural residents.

For the three paths with no objection to some vegetation control, there were smaller differences between the responses. Path 3 (N=42), supported aerial spraying. Paths 4 and 5 were opposed to aerial spraying of herbicides, but path 4 (N=102), was in favor of directly applied herbicides. Path 5 (N=65), favored controlling vegetation in more natural ways such as managed fire, cover crops, grazing or natural toxins. Human health was the underlying reason for the resistance of spraying in paths 4 and 5. Paths 4 and 5 included information about the possible invasion of harmful non-native weeds which could have adverse effects on the forest, but despite this possible threat the respondents were not supportive if the aerial spraying.

The conclusions reached for this decision pathways experiment were that a large percentage of people will make tradeoffs when they understand

the complexities of real life moral decisions. Significant numbers of respondents were willing to compromise their strongly held environmental ideals for practical reasons. A common theme of the concerns regarding management practices, was lack of confidence in technology and forest managers. An important aspect of this new survey approach is the departure from a description of values in sharp declarative statements. The researchers found that instead of dealing with controversial uniform value declarations, it was better to examine the values deeply embedded in the data.

The analysis of the decision-pathways revealed very complex opinions held by the respondents. It was found that expressions of environmental values are not always followed by strong support for related management actions. While most people were found to care deeply about the environment, they did not always agree about the level of management intervention that was appropriate. Often the individual perceptions were not complete in regard to the natural systems or the proposed interventions by managers. It was found that people will sometimes change their opinions when more complete information is clearly communicated to them. The most important point of this study is that it is possible to find quantitative and qualitative methods to explore the cognitive processes that occur between the expression of strongly held ideals and the final acts of support or resistance for related interventions.

Studies of Social Issues and Scientific Thinking

Zeidler (1984a) conducted a study to examine the mediating effects of science content knowledge, moral reasoning ability, attitudes, and past experiences on the formation of judgements in regard to social environmental dilemmas. The subjects in the study were two groups of college age students. One group was comprised of third and fourth year environmental science majors. Their mean age was 21.7 years, with 23 females and 63 males. The students in the other group were first through fourth year non-science majors, with fewer than 12 credit hours of science. This group contained 66 females and 39 males, with a mean age for the group of 19.3 years.

The three main objectives of the Zeidler study were: first, "to determine if environmental science majors exhibited higher levels of moral reasoning on nontechnical social issues than on general social issues and if they also reason at higher moral levels on environmental problems than nonscience majors." Second, "to examine the extent to which possible mediating factors (environmental attitudes, knowledge and personal experience) account for the difference in moral reasoning." Third, "to examine how, in addition to what extent, such factors are revealed as people form moral judgements" (Zeidler & Schafer, 1984. p. 2).

The study was conducted in two phases. Phase one was a battery of four standardized tests used to measure each subject's level of moral reason-

ing within environmental and social contexts, and in relation to his/her knowledge, interest and experience. The Defining Issues Test (DIT) measured moral reasoning on general social problems. The design of the DIT consisted of stories about social dilemmas, and each was accompanied by statements reflecting different levels of moral judgement. The subjects were asked to rank these statements according to their perceived importance. The criterion group validity of the DIT is 50%. The test has significant longitudinal change validity ($p < 0.0001$). Test-retest reliability is 0.80, and the internal consistency is in the upper 0.70s (Zeidler & Schafer, 1984, p. 3).

The Environmental Issues Test (EIT) was used to measure moral reasoning on specific environmental issues that do not require any specialized technical knowledge. The EIT has significant criterion group validity ($p < 0.001$) across various ages. The EIT has 0.73 convergent validity with the DIT, and the test-retest reliability is 0.79 ($p < 0.001$). The Test of Ecology Comprehension (TEC) was used to measure interrelated environmental concepts. It has a test-retest reliability of 0.67 (Zeidler & Schafer, 1984, p. 3).

The Ecology Attitudes Inventory (EAI) was used to measure the verbal commitment, actual commitment and affect of each subject for the environment. The significance of criterion group validity for the EAI on various subscales ranges between $p < 0.01$ and $p < 0.05$. The test-retest reliability is 0.92 for the composite of all subscales ($p < 0.001$). The composite of the EIT, TEC

and EAI scores for each subject was used as his/her environmental attitude score (Zeidler & Schafer, 1984, p. 3).

The four instruments for phase one were administered in two sessions one week apart. The order of the tests was randomly assigned to the subjects. Half from each group were given the EIT first and half from each group were given the DIT first. In the second session the two tests were switched so that all subjects responded to the EIT and the DIT in one of the two sessions. The EAI was given to all subjects in the first test session and the TEC was given to all subjects in the second test session.

A 2 X 2 ANOVA was done to find group differences in moral reasoning on social and environmental dilemmas. A multiple regression analysis was performed to find the mediating effect of each subject's DIT, TEC and EAI scores on his/her EIT score. The data were factor analyzed to generate a standardized factor score for each subject. From a scattergram of each subject's performance on the attitude and moral reasoning factors, 11 pairs of subjects were selected for phase two of the study. The pairs were chosen for similar attitudes toward the environment, but different levels of moral reasoning.

Phase two was designed to gather qualitative data from the reasoning of each pair of subjects as they engaged in conversations while forming moral judgements. The subjects were asked to decide which of their original responses to the EIT was most appropriate as a final response to the EIT

representing the combined opinions of both members of the pair. The subjects were allowed to have their original responses on hand while working as pairs. Each pair was asked to discuss their individual responses before reaching a consensus for their final response. The conversations of the 11 pairs were tape recorded and transcribed.

Phase one results showed no significant differences between the two groups on the DIT scores, however there were significant differences between groups on the EIT scores. The environmental science majors scored higher than the nonscience majors on the EIT.

Significant differences were found for both groups between the DIT and the EIT scores, with the environmental science majors and the non-science majors scoring higher on the EIT than the DIT. There was no difference between groups on affect. However, there were significant differences between groups on Environmental Attitude, Verbal Commitment, Actual Commitment, and Ecology Comprehension. The environmental science group mean was higher than the nonscience group mean for these four variables.

Within group differences were also found for another variable identified as "decision commitment." More decisive decisions were made by both groups on environmental issues (EIT) than on general social issues (DIT). This was determined by the number of times each subject answered "yes" to a course of action for solving a dilemma instead of "no" or "can't decide."

The verbal commitment and actual commitment variables had no predictive validity for EIT scores, but affect toward the environment, science orientation, ecology comprehension, and performance on the DIT were positively correlated with performance on the EIT.

Phase two of the study revealed that the person with the higher reasoning ability was generally able to influence the opinion of the other person in the pair. When a consensus was reached in the discussions by the pairs, the final combined EIT score was most often higher than the mean of the combined high and low scores from the two members of each pair. In 20 of the 26 cases where the pair members originally disagreed on a course of action to solve one of the five dilemmas, their final consensus was in favor of the person with the higher reasoning ability. Zeidler & Schafer (1984) believe that this indicates a persuasion factor is associated with higher stage arguments.

Four reasoning trends were identified from the phase two data by analyzing portions of the conversations between the subjects. By doing this the subject's interpretations of the environmental-moral dilemmas were revealed. The four trends were based on transcripts from the taped conversations of 10 pairs of subjects. Normative Reasoning is when frequent referrals are made to personal experience that is seen by the subject as normal, and in agreement with social norms or personal subjective values. Casuistical Reasoning is when hypothetical considerations are subtly altered

and construed by the person as facts and result in a false type of reasoning. These two trends were unique in the mediating effect they had, because of the influence of education and social experience.

Resolving Means and Ends is described as a pattern where some subjects looked at the broad consequences of an issue, and then tried to determine whether the proposed solution was justified by the expected result. Stage Response Differentiation was manifest by the way statements from the EIT were construed by the subjects. The variation in responses was thought to reflect the underlying developmental stage of moral reasoning for each subject. Zeidler & Schafer (1984) stated that these two trends confirm developmental stage theory as advocated by Piaget (1948) and Kohlberg (1973, 1976, 1978).

This study suggests that the level of reasoning used by the subjects was situationally determined. It was concluded by Zeidler & Schafer (1984) that both science and nonscience majors exhibited higher levels of reasoning on environmental issues than on general social issues. They suggest that this was influenced by the higher affect of both groups toward the environment than toward general social issues. However, it was not clear whether this was because of a genuine understanding of the issues or because of contemporary social norms. It was also suggested that each individual is able to reason at a range of levels on a quantitative continuum that is determined by the context of the problem.

It was proposed by Zeidler & Schafer (1984) that reasoning is not a value-free intellectualizing task, and that the attitude and personal beliefs a person has about the content of a problem might influence his/her reasoning about the problem. They also assumed that Ecology Comprehension is a major contributing factor in the resolution of environmental dilemmas, even though DIT, Affect, Group Membership, and Environmental Attitude outwardly appeared to be better predictors of environmentally related moral issues. The rationale for this is that Ecology Comprehension had the second highest correlation of all variables with the EIT, and had higher correlation with the DIT than the remaining variables.

An unanticipated trend was identified in the transcripts of the conversations between the 10 pairs of subjects. This pattern was termed "normative reasoning" and relates to the internalized social experiences of the subjects. These social experiences were believed to influence their personal values and their individual objective views of reality. The subjects sometimes defined their own values as social norms that were rooted in strong emotions. In six of the 10 pairs, the moral reasoning of the subjects was shaped or mediated by their normative experiences.

Zeidler & Schafer (1984) also referred to another trend that was identified in phase two of the study. This pattern relates to the perceptions the subjects had of the moral dilemmas on the EIT, and was termed "casuistical reasoning". During the discussions, of the 10 pairs some of the subjects

with both high and low reasoning ability had a tendency to construe the hypothetical aspects of the problem material as matters of fact. It was argued that subjects who exhibited this pattern were using a type of false reasoning to resolve the moral dilemmas. One conclusion of this study was that the subjects revealed both inhibiting and facilitating reasoning patterns in their argumentative encounters.

Kuhn et al. (1988) provided more insight on the nature of scientific reasoning. They conducted five studies to determine how students made choices about everyday matters. The studies were designed to investigate the thinking skills used to make everyday decisions, and the intent was to identify generalized patterns of cognition. A key concept used as a basis for the studies was that in order to coordinate a theory with evidence, a person must view them as separate from one another. It was also asserted that this coordination requires a person to evaluate new evidence and other possible theories. To achieve this requires a high level of metacognition, which was defined as the ability to reflect on one's own cognition.

Kuhn et al. (1988) argued that people represent the reality of the world with causal theories that are a result of their own personal interpretations of fundamental cues about how the world works. They believe that this can have a powerful influence on the way individual cognition is organized. It is maintained that these causal theories are repeatedly revised as an

individual gains more experience in the world. The results of this on going process can be both naive and sophisticated causal theories.

The methodology used in this series of studies was distinctive in two ways. The intent was to depart from a domain specific view of cognition and also from any concern with the origin of the cognitive skills being examined. Another point stressed by the researchers was a basic assumption that scientific reasoning is influenced by the exclusion as well as the inclusion of evidence. inclusion was defined as an inference that a body of evidence is an indication of a causal relationship between a potential antecedent variable and an outcome variable. Exclusion was defined as an inference that the evidence indicated no relationship between an antecedent variable and an outcome variable.

For study 1a there were 65 subjects equally represented by sex. There were 20 from a mixed fifth- and sixth-grade classroom in an urban school system. This group had a median age of 11 years, 8 months and was referred to as the sixth-grade group. Another group of 20 subjects came from a ninth-grade classroom in the same school system and their median age was 14 years, 7 months. A third group of 20 adult subjects was selected through personal contacts with the interviewers for the study. Their median age was 29 years and most of them were employed in sales or office occupations. They were all high school graduates and 4 had attended two years or less of college. A separate group of 5 adult subjects was included and

referred to as the philosophers. All 5 subjects were advanced-level Ph.D. candidates from the department of philosophy at Columbia University.

The problem material for the first study pertained to the way that children's diets affect their susceptibility to colds. During the initial session the subjects were told that some scientists had done a study at a boarding school where everyone ate the same food at each meal. The school was asked to serve certain food at each table for six months and the school nurse was asked to keep records of any colds the children had during that time.

Evidence was then presented sequentially and cumulatively to each subject in the main interview session. After each of eight presentations of evidence an evaluation was elicited from each subject and information was given about a binary outcome and the status of four variables. Two of the four binary variables were covaried perfectly with outcome and the other two variables had no covariation with outcome over the eight instances. The covariation evidence was used to test for an inference by inclusion of evidence to support a causal theory. The noncovariation evidence was used to test for an inference by exclusion of evidence against a causal theory.

For each subject the two variables with covariation evidence that were used by the interviewer in the second session were chosen because of the individual's responses in the first session. One of the variables was related to a causal theory and one was related to a noncasual theory revealed by each subject in the first session. The two noncovariation variables were

selected on the same basis as the covariation variables. This provided two variables for which each subject held a causal theory and two variables for which each subject held a noncausal theory. For the two causal theories, one was presented with covariation evidence, and one was presented with noncovariation evidence. Likewise, one noncausal theory was presented with covariation evidence, and one noncausal theory was presented with non-covariation evidence.

This design made it possible to examine the same theories with different evidence, and different theories with the same evidence for each subject in the study. The procedure for the first session was to present each subject with a sequence of 35 types of foods portrayed on flash cards, with a label and three possible choices for the subject to select as a response. The three verbal options were: 1) "Very sure the food makes a difference"; 2) "Don't know whether or not the food makes a difference"; 3) "Very sure the food makes a difference." In the second session approximately 1 week later, the interviewer repeated the same introduction as in the first session, but then added more information.

The additional information for the second session was that the nurse had reported that some tables of children had gotten lots of colds and that others had gotten very few colds, with none of the cases falling in between. These outcomes were shown in squares on a large piece of cardboard in picture form. One of the four levels of the variables was shown in each

corner of the squares. As each set of information was presented to the subject, the interviewer would summarize it verbally and then ask for a response. After each response the interviewer would probe for an explanation of how the subject had arrived at his/her answer. It was the intention of the interviewers to present the questions in a way that would allow each subject to refer to evidence in his/her own individual style.

After study 1a was completed, the same procedure was repeated in study 1b. For this study there were only 15 fifth/sixth graders and 15 ninth graders used in the sample. These subjects were from the same population and had similar sex distribution, age ranges and medians as the same two groups in study 1a. The adult groups were not used in study 1b. For study 1b there was a minor change in the instructions given to the subjects by the interviewers. In the second session the subject was reminded before each response to answer the question on the basis of the scientist's findings, and not based on his/her own personal knowledge about foods.

There was a very slight improvement in performance for study 1b by the sixth graders, but not by the ninth graders. A combined two way analysis of variance was done for age by condition for the 1a and 1b groups of sixth graders and ninth graders. A significant effect was not found for age or condition on the covariation or the noncovariation evidence. All of the results from study 1a and 1b were comparable for evidence-based responses whether spontaneous or elicited. Any responses with no reference to evi-

dence were labeled theory-based responses, and across all age groups 21% of the first responses were evidence based, but the percentage rose to 66% for the latter responses.

For all age groups the spontaneous evidence-based responses increased as more evidence was given. This was found for both the covariation and the non-covariation evidence and as the age of the groups increased, the frequency of the evidence-base responses also increased. There was more variability in the younger subjects, and some gave no evidence-based responses. The philosophers shifted to the evidence-based responses sooner than the other adults, but each adult made some evidence-based responses. There was no significant difference in performance by gender. The cause of the variation in the performance of the younger subjects was not clear, but it was suggested that differences in verbal ability might have had some effect.

For study 2 of the series there were 100 subjects in five groups of 20, and equally represented by gender. Three of the groups were from third, sixth and ninth grade classes in an urban school system. The fourth group was comprised of adults mostly in their 20's who were enrolled in a commercial business school. Four of the adults had attended some community college classes and all except two of the group were high school graduates. The fifth group were all graduate students in education. This study was focused on two main issues; first, was whether the subjects were able to

make prediction judgements based on implicit evaluation of evidence. The second issue was to find how knowledge and beliefs related to sets of evidence and theory.

Study 2 was designed to examine two parallel sets of problems. One set of problems were foods problems similar to those in the 1a and 1b studies, except that the versions were abbreviated. The second set of problems was selected to minimize the possibility that the subjects had any prior beliefs or knowledge of the issues.

The topics selected were a stains problem and a plant problem. One change in the design was that only five evidence instances were presented to each subject with only two of the four variables for each instance. The procedure for the presentation of each problem instance and the questions about the variables were similar to the procedure in the 1a and 1b studies.

The results of study 2 showed that there were more overall evidence-based responses for the stains problem than for the plant problem. However, the new problem material did not eliminate the theory-based responses. The level of theory-based responding was most prevalent in the youngest group and decreased as the group age increased. The subjects were categorized by the type of response they gave most often. Those subjects who gave the theory-based responses most often or equally split with evidence-based responses were unable to correctly answer the prediction questions at better than a chance level.

The results from the studies 1a, 1b and 2 showed that most of the subjects did not have highly developed metacognitive skills. They were all able to recognize a difference between noncovariation and covariation evidence, but most were unable to use the evidence for their responses. Most responses were inferences of inclusion based covariation evidence. About one fourth of all the subjects inferred a causal relationship on the basis of one co-occurrence of antecedent and outcome. The subjects believed with certainty that this was enough evidence to prove their causal theories.

The noncovariation evidence was not correctly used by most of the subjects to make inferences of exclusion. The researchers were unsure whether this was because they ignored the evidence or could not interpret it correctly. For whatever reason, these subjects were very prone to make fallacious inferences. Another root of the fallacious inferences was a strong tendency for these subjects to make false inclusions based on consistent covariation evidence even in the presence of multiple covariates. This occurred some of the time for all subjects except the philosophers.

Study 3 of this series was based on a new set of problem material. It was designed to present a set of sports balls to the subjects to handle and examine. There was a total of 16 balls with four different dimensions; size, color, texture and ridges. These features were combined in different sets to present as variables to the subjects. The subjects were told that a sports

company was developing a new game, and wanted to find out which type of ball was best for making serves. Initially they were asked about their theories in regard to the best type of ball for serving.

Study 3 was designed to replicate the previous studies in this series, but more concrete evidence was used to reduce the chance that subjects would be confused about the outcomes as they were depicted by the interviewers. Another difference was that each subject was only asked to decide the least important variable and the most important variable. There was not an effort to ask subjects about theories they were moderately certain about as had been done in the previous studies. Because of this design, only two variables were used for each subject. These were the two that each subject had selected as least important and most important.

The subjects were equally represented by sex and the groups of children were from several urban parochial schools. There were 30 third graders, 30 sixth graders, 30 ninth graders and a group of 30 adults age 18-26 years, that were recruited from a business training school. The subjects were told by the interviewers that the new game was not completely developed and that the rules were not yet decided. They were told that the company had learned that some of the balls were good for serving and some were bad for serving, but there were really not any balls in between. The variables were described verbally before the subjects physically examined them.

To assess the subject's casual theories the interviewer picked up one ball at a time and asked each subject to suppose that he/she had just tested the ball by serving it over a net with a special paddle. The subjects were asked which of the features made a difference in how serves could be made. In addition, they were asked to give reasons why, for the features mentioned, and if any feature was not mentioned by a subject he/she was asked if it made any difference. Each individual was then asked to rate the four variables in order of most importance. Some subjects said that no variables made a difference and they were excluded from the study. All subjects who were interviewed maintained that at least one variable did not make a difference.

For the evidence evaluation phase the interviewer would hold one ball at a time and ask the subject to make an evaluation. Only the two variables he/she had selected as most important and least important were to be considered as evidence for the evaluation. As a determination was made by the subject, the ball was placed in one of two baskets labeled either good serve or bad serve. For this phase the questioning was identical to the form used in the other studies previously done in this series. For half the subjects in each age group the evidence was covariation evidence and for the other half it was noncovariation evidence.

The main focus of this study was to determine the stability of the subject's theories and the presence of theory changes as a mode of resolving

discrepant evidence with their theories. The results showed that for all groups except the third graders the stability the subject's theories was high. The results showed that all of the subjects in Study 3 tended to reconcile their theories with discrepant evidence by either ignoring it or by evaluating it in a biased manner. The subjects in this study did not attempt to use new theories as a means to maintain theory and evidence alignment.

Study 4 of this series used the same set of sports balls as used in Study 3, but was focused on more complex reasoning skills. The subjects in Study 4 were 20 third graders, 20 sixth graders, 20 ninth graders, 20 noncollege young adults, and 20 undergraduate college students. The first two phases were identical to those in Study 3 and, additionally each subject was asked to generate four sets of evidence. The subject was asked to consider the two causal theories based on his/her most favored and least favored variables. For each of these two variables, two sets of evidence was requested from each subject. Two sets of evidence were to support the causal theories and two sets of evidence were to refute them.

The subject was allowed to take a short rest and then given a brief review of the four features of the sports balls. Two causal theories were then presented on the basis of two variable features of the sports balls. He/she was told that the two theories were supported by different experts from the sports company and was also shown sketches depicting some tests with the balls. The subject was then asked three questions in regard to the two

theories. 1) Do these tests help show that one person's theory is right rather than the other person's theory? Why? 2) Do the results of the tests prove the theory is right? (If yes) How do they prove it? (If no) Why not? 3) What do the test results say about the other person's theory? Do they say nothing, do they prove it wrong, do they show that it is a little bit right?

Each subject in Study 4 was given 15 different problems in the form described above. The evidence in each problem was tailored to each subject based on that individual's responses during the theory assessment phase of the interviews. The problems could fall into four categories: 1) Insufficient Evidence, 2) Equal Evidence, 3) Unequal Evidence, 4) Asymmetric Evidence. Problems from all four categories were presented to every subject in a constant order. A multiple set of evidence was presented for the final phase of the procedure. The multiple evidence was presented for evaluation in conjunction with only one theory in order to analyze the generation of evidence by the subject.

The results of each interview were analyzed first to determine if a response was theory-based or evidence-based. The frequencies of evidence-based responses were comparable with the results of the prior studies in this series. Each category of evidence was then considered in relation to the responses. It was determined that in the groups below the ninth grade level, the subjects were rarely able to recognize a lack of variation for a feature as a reason not to make an inference of a causal relationship between a theory

and that feature. The college group of adults performed best for this type of evidence, but many of them were also unable to achieve this recognition of insufficient evidence.

There were two basic forms of problems with mixed evidence. One form portrayed a very modest covariation between variable and outcome, and the other portrayed a stronger covariation. Many of the subjects had great difficulty with the interpretation of the mixed evidence. More than half of them used inclusion of evidence to prove a theory even when covariation was not strong between an antecedent and an outcome. Group age was a factor in the inclusion errors, with the older subjects making them more often than the younger subjects. Some subjects made qualified inferences of inclusion when covariation evidence was weak, but most subjects treated all levels of covariation evidence as equal.

An important conclusion reached in Study 4 was that a biased evaluation of the equal or the unequal evidence problems was most likely to occur with covariation evidence than with noncovariation evidence. Also, there was more bias found in making the inclusion inferences than the exclusion inferences. These biases were more likely in the younger groups than the older groups, with the ninth graders and the college adults showing the least bias. The most bias of all was found in the interpretation of the insufficient evidence problems. It was found that this type of error was the result of an

interaction between the individual theories and the vague or incomplete evidence.

The asymmetric evidence problems were most strongly influenced by the individual theories of the subjects. This theoretical bias increased most in the group of college adults who had been able to perform with fewer errors on the problems with the other three types of evidence. It was found that within the groups there was a greater variation between individuals in the third graders, the sixth graders, and the noncollege adults. Some subjects in these groups showed a bias toward their own theories in every problem or every problem but one. Others in these three groups showed a bias toward their own theories on only one of the 15 evidence evaluation problems.

A significant result of Study 4 was the distinctive performance by the ninth graders and especially by the college adults. The researchers postulated that this finding is an indication that the experiential backgrounds of the subjects affected their evaluation of the evidence more than their age differences. There was also a wide difference between the groups for the generation of evidence. The ninth graders and the college adults performed better in this aspect than the younger groups and the noncollege adults. All of the subjects were requested to generate covariation evidence and noncovariation evidence in connection with the causal theories they were evaluating.

All subjects performed better when generating covariation evidence to defend a causal theory than when they were generating noncovariation to disprove a causal theory. Over 90% of all the subjects were able to generate some covariation evidence, only the college adult group reached that level for non-covariation evidence. For the other groups the percentage for the noncovariation evidence was about 66%. Many subjects were unable to confine their focus to only one variable at a time. Another major difficulty for many of them was their inability to focus on a causal theory other than the one they believed was true. This caused these subjects problems in generating any form of evidence for theories other than their own.

The focus of Study 5 was the skill used by the subjects for coordinating theory and evidence. The subjects were 20 children from a mixed fifth- and sixth-grade classroom in an urban school district. The subjects were divided into two groups, a control group and an experimental group. Each of the 10 subjects in the experimental group was presented with the balls problems once a week for 9 weeks. Each of the 10 subjects in the control group was presented with the balls problems once in the first week and once in the ninth week. The problems were identical to the evidence evaluation problems used in Study 4.

Study 5 used a sample too small for the researchers to make broad generalizations, but the results showed an improvement in the skill of the subjects in the experimental group. These individuals were gradually able to

generate more noncovariation evidence and covariation evidence as the study progressed. These subjects also made improvements in recognizing insufficient evidence and also in coordinating theory and evidence. They were able to progress to a skill level where they could coordinate the same body of evidence with contrasting theories and avoid the biasing effects of their own causal theories. None of the same progress in skill level was observed in the control group.

Study 6 was designed to explore the effects of divergent evidence on the subject's thinking by presenting them with two discrepant pieces of evidence regarding one specific event. In Study 4 there were two conflicting theories presented with only a single body of evidence. Both studies were intended to examine a subject's ability to objectively evaluate evidence and a theory as separate entities. For Study 6 the problem material was changed to a war between two fictitious countries. The event was called the Fifth Livian War, and was recorded in writing by a historian from each country.

The Study 6 subjects were 20 sixth graders, 18 ninth graders, 20 twelfth graders, all from a large urban school district. There was also a group of 19 graduate students in education at a large urban university, and a group of 20 nonstudent adults recruited by an interviewer from the general population. The nonstudent adults had more diverse and overall higher education than the nonstudent adults in the previous studies of this series. Two of them had a high school diploma, 8 had some college, 4 had college

degrees, and 6 had done some graduate work. The total of the subjects in the five groups was 97.

The two brief accounts of the Fifth Livian War were read to each subject and the subject was invited to read along on printed copies of the two different accounts. The subject was then asked to describe in his/her own words what had happened. When finished the subject was asked two questions. 1) Are the two accounts of the war different in any important way? (If yes) How are they different? 2) Could both accounts be right? (If yes) How can that be? Each subject's account was evaluated to find whether or not a single account had been constructed. Then each statement made by the subject was classified as either a simple statement, which was defined as two descriptions of the event; or a metastatement, which was defined as one statement about one or both of the accounts.

On the basis of the two probe questions the responses of each subject were classified at one of six response levels. Level 0 was used for responses with no differentiation between the accounts of the war and the war itself. Level 1 was used for responses with a distinction between the two accounts and the war, but without any mention that either or both of the accounts could deviate from what actually happened. In Level 2 responses a partial discrepancy was acknowledged between the two accounts, but no attempt was made to reconcile this. The subjects who gave level 2 responses regarded the discrepancy as simply incomplete records of the facts.

In the remaining three response levels, there was an awareness that theoretical interpretation played a role in the construction of the two different accounts, but different weights were assigned to this role at each level. At Level 3 the role was seen as only the personal opinion of each writer. At Level 4 the discrepancy was seen as reconcilable because the two writers had superficial differences in their perspective of the same facts. At Level 5 the different backgrounds in history, culture and the belief systems of the two writer were considered to be the causes of the discrepancy. These differences were recognized by the subjects who gave Level 5 responses as major problems for reconciliation of the two accounts.

Study 6 results showed that the subjects responding at Levels 0, 1 and 4 always gave a single account of the Fifth Livian War, and they only noted minor differences in the two written accounts. The subjects responding at Levels 2, 3 and 5 did not attempt to reconcile the two accounts into a single version. The percentage of metastatements rose from 0% at Level 0 to 45% at Level 5. No gender differences were found. The data showed a trend for level of response by age group. Sixth and ninth graders responded mostly at Levels 0, 1, and 2. Most twelfth graders responded at Levels 2, 3, and 4. Both adult groups responded mostly at Levels 3, 4 and 5.

In concluding this series of studies, "the present results may point to the possibility that patterns of developmental change leading to adult modes of thinking have the potential for providing insight into the nature of adult

functioning as well as providing a framework for conceptualizing individual variation among adults" (Kuhn et al. 1988, p. 234). A claim was made by the researchers that an academic environment facilitates and supports the kinds of thinking skills examined in the studies. The key elements needed for developing these thinking skills are claimed to be recognition of the possibility of alternative causal theories, and recognition of the possibility of evidence that does not fit a causal theory.

An important component of scientific thinking specified in these studies was the ability to think about theories and how the evidence bears on them, in contrast to merely thinking with the theories. This was believed to be especially important in regard to any new evidence and the effect that it had on the individual theoretical perspectives of the subjects. It was asserted that the basic scientific thinking skills that were the focus of the studies are not limited to any specific context, and may also be applied to everyday decisions and in a wide variety of decision contexts. It was concluded from these studies that scientific thinking skills are developed through experience and may be improved with practice.

In another study, Kuhn (1991) investigated individual thinking skills by analyzing the argumentation of the participants. In this study the subjects were interviewed individually in two sessions. The sessions were 45 to 90 minutes in length and took place from one to several days apart. These interview sessions were recorded and transcribed for analysis. Locations

familiar to the subjects were selected for the interviews such as workplace, school, or the subject's home.

The subject samples came from four age intervals: teens, age 14-15 years; 20s, age 20-29 years; 40s, age 40-49 years; and 60s age 60-69 years. Two variables, sex and education level, were used to separate each age group into four categories of 10 subjects for a total of 40 subjects in each age group. The adult groups were divided into 10 college and 10 noncollege for each sex and age. For the teen group the education variable was 10 noncollege bound and 10 college bound for each sex. In addition to the 160 subjects in the main sample, a group of experts was selected to participate in the study. These experts were five parole officers, five school teachers, and five advanced candidates for PhD of Philosophy.

The philosophers were selected as general reasoning experts, while the parole officers and school teachers were selected for the expertise in their respective fields. Three social problems were selected as topics for the study. The first interview was designed to elicit and probe the reasoning of each subject on these social problems. The following questions were asked to elicit a causal theory from the subjects for each problem topic. 1) What causes prisoners to return to crime after they're released? 2) What causes children to fail in school? 3) What causes unemployment?

The topics were selected because they involve phenomena with true causal structures that are complex and uncertain, yet there is a possibility for

a wide range of personal knowledge involved that the subjects may have acquired. The individual knowledge of each subject was not measured directly, but they were asked to give a self-report of their own personal knowledge of each topic. After a subject had responded to the initial questions about each of the three social issues, the interviewer inquired how he/she had come to hold this theoretical view. The subject was then asked to give supporting evidence to justify each viewpoint or causal theory.

In the next segment of the interview each subject was asked for an opinion on each issue that opposed his/her own three causal theories. Sometimes an opposing theory was offered and sometimes a counterargument was given for the subject's own theory. When another theory was not provided, the interviewer asked for one. If the subject was still unable to provide an opposing theory, one was suggested by the interviewer and the subject was asked to rebut it. The series of questions was ended by inquiring about the subject's reflections on his/her own thinking, such as: 1) How sure are you? or, 2) Do experts know the cause? The subject was then asked some questions about the importance of each issue to him/her personally and to society.

In the second session the subjects were asked to evaluate evidence on two of the three topics from the first interview. The two topics were crime and school failure, and two types of evidence were presented for each topic. First, was undetermined evidence that was in effect nonevidence. Second,

over-determined evidence that was presented as three broad causes, each advocated by a different authority figure. The three causes were presented as operating in conjunction with each social outcome, but with an undetermined effect on the outcome or on the other causes. After the subjects had evaluated the evidence they were asked questions about their certainty and the influence of the evidence on their own thinking.

The main purpose of this study was to identify the type of argument presented by the subjects in regard to their own thinking. A rational argument was conceptualized by the researchers as not just what the subjects thought, but why they thought what they did. This argumentative thinking was considered to be an indication of an underlying set of beliefs that could influence many decisions. When the reasoned views of a subject contained opposing assertions with evidence supporting both, it was considered to be a complete rhetorical argument. A distinction was made between a rhetorical argument as in the above example, and a dialogic argument between two individuals with opposing viewpoints. Both types of argument may be considered reasoned arguments if the two opposing views are supported by evidence.

The causal theories presented by the subjects were analyzed first by content. This part of the theory analysis was considered to be of lesser importance, but the classification of the content of each theory was subsequently used for the structural analysis of the theories. There were 19 causal

lines identified for the crime topic, and 30 causal lines identified for the school topic. There were differences found for these variables between the genders and the age groups, but not the group educational level. In the more important structural analysis, the form of argumentation used to support a theory was partially defined by the number of different causal lines included in the subject's theory.

The theories were classified as single cause, multiple cause with parallel causal lines, or multiple cause with alternative causal lines. For the crime topic the percentages of subjects that showed each causal theory type were 49% single cause, 38% multiple parallel cause, and 12% multiple alternative cause. For the topic of unemployment the percentages were 21% single cause, 54% multiple parallel cause, 26% multiple alternative cause. For school failure the percentages were 28% single cause, 46% multiple parallel, and 27% multiple alternative cause. It was concluded that the multiple cause theories were not necessarily more complex than the single cause theories, but the multiple cause theories reflected a greater awareness of the causal complexity of the social problems.

A major concern of this study was the supporting evidence used by the subjects to defend their theories. All subjects did not produce genuine evidence, and the evidence they did provide came in various forms. The most common form was covariation evidence that was either: 1) correspondence, indicating some weak co-occurrence of antecedent and outcome; 2)

explicit covariation, which indicated a comparison and quantification; or 3) indicating a correlated change of antecedent and outcome. A second form of the genuine evidence invoked an external factor to establish a link between antecedent and outcome. A third form was indirect evidence which was either: 1) an analogy, 2) an assumption, 3) discounting of an alternative, or 3) partial discounting of an alternative.

Less than half of the subjects produced any form of genuine evidence in any of the responses to support theories. The most prevalent type of response included a scenario or script depicting how the social phenomenon might have occurred. This was defined as pseudoevidence and it was usually not sharply distinguished from the description of the causal sequence in the subject's depiction of the theory. These scripts were either generalized or specific in form, and at best were an elaboration of a causal sequence. A few of the subjects gave nonevidence responses by: 1) declaring the evidence was unnecessary, 2) providing evidence not relevant to the topic, or 3) restating the social phenomenon itself as evidence.

When a subject's response contained pseudoevidence it was deemed to be a suggestion that a certain scenario of events was the way a social phenomenon happened, with no regard for other possible explanations. The subject was then prompted for an alternative explanation. Some subjects attempted to provide an alternative causal theory distinct from their original causal theory and the supporting evidence. These responses were consid-

ered successful, partially successful, or unsuccessful. Some of the subjects would not attempt to generate an alternative theory. It was found that the ability to provide an alternative theory was consistent across topics for a subject, or absent for all topics.

It was concluded that the subjects who produced alternative theories were less likely to rely on pseudoevidence. The subjects who did rely on the pseudoevidence seemed to perceive their own causal theories as a description of reality or the way things are. It was suggested that reasoning was facilitated for the subjects when they had first-hand experience with a topic, but that some subjects often showed competent reasoning without it. The subjects were then asked how sure they were about their causal theories and whether experts could know for sure what the cause of a social problem was. On the basis of their responses to these questions the subjects were categorized as either absolutists, multiplists, or evaluative.

Subjects who fell into the absolutist category believed that an expert either knows with certainty or can learn with sufficient study, the cause of a social problem. The absolutists considered themselves as either less knowledgeable, equally knowledgeable, or sometimes more knowledgeable than an expert. The multiplists were more skeptical and denied the possibility of expert certainty. In addition to doubting the experts, the multiplists claimed that they could be as certain as anyone about the causes of social problems. The subjects who were evaluative denied the possibility of certain knowledge

just as the multiplists did. However, these evaluative people regarded themselves as knowing less than the experts know about their specific topics.

A general conclusion of this study was that the forms of informal reasoning used in everyday decision making varies widely among individuals. The study explored some basic skills used by ordinary people with average intelligence to argue their points of view. The forms of thinking that were identified were not domain specific, however the content was believed to have some effect on the ways the subjects thought about the different content domains. This was obvious in the small sample of domain specific experts. Both the school teachers and the parole officers appeared to have difficulty recognizing opposing points of view in their respective areas of expertise.

While there was some effect of attitude shown in the reasoning of most groups in the study the philosophers were an exception. In this group the reasoning was consistently perfect for all subjects, in all segments of the study. Likewise, there was consistency seen in form of the reasoning process of some individuals across content domains. Kuhn (1991) believes this indicates that the individual's reasoning process is independent of the content area to which it is applied, and that it is possible for an individual to become expert in the reasoning itself. She further contends that both the valid and invalid informal reasoning examined in this study are relevant to

the thinking strategies of formal reasoning that are studied in a laboratory setting.

The examination of the reasoned arguments in this study has both societal and educational ramifications. Social behavior is connected to the internal thought processes of each individual in a group. By conceptualizing the argumentative reasoning structure of an individual it is possible to identify underlying attitudes. This study did not focus on the interactive dialogue of argument, but the methodology identified some cognitive aspects of argument that are involved in the social process of argumentative discourse. From an educational perspective the concepts examined in the study provided a pattern of skills that may be useful for evaluating the individual development of informal reasoning competence.

Discussion

The combined studies in this review have provided the basis for the current study. While each of them was unique in design and focus, there are certain features of each that contributed to the framework for this research. The most obvious of these is the exploration of decisions made by individuals within a social context. Many early case studies were process oriented with an emphasis on the social environment, yet some of those earlier researchers recognized the importance of personal skills and the abilities of specific individuals. Bolan & Nuttall (1975) argued that power and social influence are important factors in community decision making, but they stressed that

the personal attributes and special interests of the individuals who are involved in any decision process must be considered. They used personal interviews to gain a better understanding of the differences between the individual decision makers.

Brunswik (1952) recognized that many variables outside of an individual may have an influence on the decisions he/she makes. In his lens model for decision analysis he made allowances for both internal and external factors to help understand the behavior of each individual. The theory of Probabilistic Functionalism that was developed by Brunswik was the basis of Social Judgement Theory that was advocated by Hammond (1955). While these theories are both behavioristic in general, it was acknowledged by Hammond (1966) that even the basic survival behavior of humans has a more complex cognitive aspect that he defined as social judgement. This was an important step toward the cognitive views of later researchers such as Janis & Mann (1977) and Janis (1982), who recognized that when people make decisions, they will use their information processing abilities to the best of their ability. These researchers made some important contributions to a line of research regarding social factors that influence group decision making.

Janis & Mann (1977) developed Conflict Theory on the premise that some people cognitively restructure a decision context to accommodate personal biases they may have. They argued that an individual will base

his/her cognitive restructuring on any ideology or value system that is in agreement with these personal biases. A unique social concept that resulted from this line of research is the notion of groupthink. Janis (1972, 1983) described this as a situation where strong social pressure causes individuals to conform with influential members of the group during a decision making process. In a study of timber dependent rural communities, Satterfield & Gregory (1996) found group differences in attitudes and beliefs about the management of timber resources and the environment. Zeidler (1997) stated that shared knowledge is socially constructed, and he suggested that an appeal to popularity may contribute to fallacious reasoning. Janis (1983) and Zeidler (1984a) found that the level of critical thinking and the quality of group decisions increased when participants were encouraged to debate with one another and develop arguments to support those decisions.

Kuhn et al. (1988) found that the quality of rhetorical arguments used by people to support their viewpoints on various issues was affected by their individual epistemology. They also found that individuals will often reflect on their own personal experiences as supporting evidence when making decisions or evaluating new ideas. This style of reasoning appears to be connected with some of the fallacious reasoning patterns implicated by Zeidler et al. (1992) and Zeidler (1997). Kuhn (1991) and Zeidler et al. (1992) contend that the reasoning styles of individuals are independent of the content area, and that their reasoning patterns are acquired through educa-

tion and other social processes. Satterfield & Gregory (1996) concluded that when making complex real life decisions, most people will compromise their environmental ideals for practical reasons. Both the societal and educational implications of the other studies in this review give credence to the work of Zeidler (1984a, 1985, 1992; Zeidler and Schafer 1984) on socio-scientific reasoning.

Zeidler (1997) provided a list of analytical or inferential claims that he contends are implicated in socio-scientific thinking. He affirmed that these claims provide viable paths for additional investigation. The seven claims listed by (Zeidler, 1997, p. 493) are summarized as follows:

- The tacit beliefs that students hold interact with the nature of the problem at hand to affect students' initial conceptualization of moral, ethical, or social problems.
- Similar to scientific misconceptions, students find ways to discredit evidence that conflicts with their initial core beliefs about moral, ethical, or social problems.
- The likelihood of reconciling personal beliefs with discrepant evidence (anomalous data) decreases as the conviction to one's beliefs increases.
- Heuristic strategies that require less investment of cognitive energy are generally favored over more formal strategies that are deductive or inductive in nature in evaluating mixed evidence.

- The degree of polarization (i.e. belief persistence) that may occur is directly related to the strength of initial core beliefs.
- Instruction across disciplines often fails to make clear what evidence counts as legitimate support for various problems and arguments. Additionally, a lack of functional understanding of probabilities and statistical information contributes to inadequate sampling practices.
- Premise conversion is a subtle and dominant form of unwittingly adding, deleting, or misrepresenting information central to a problem that students are attempting to resolve.

Zeidler (1997) pointed out the importance of an individual's core beliefs on his/her pattern of argumentation and discourse. He stressed the particular importance of these core beliefs when the individual is confronted with an argument or opinion that is not congruent with his/her own. When the position of another person is incompatible with an individual's prior beliefs, he/she may respond by ignoring, rejecting, or excluding the conflicting features of an opposing argument. Two other responses to the anomalous features may be abeyance or reinterpretation rather than a complete refusal to acknowledge them. In other instances the response could be a peripheral shift in position with the core beliefs remaining the same, or perhaps a total change of the individual's position and core beliefs.

Zeidler (1984a) studied the argumentation and discourse of students by confronting them with a socio-scientific dilemma and then asking them to critically analyze their reasoning as well as the reasoning of other students. Often these arguments were constructed with a flawed form of reasoning or the student had an erroneous conception of the problem issue. Zeidler et al. (1992) contend that the most common forms of fallacious reasoning are prevalent in student argumentation regardless of the content area. A distinction was made between formal fallacies that superficially resemble valid deductive arguments, and informal fallacies that deceive with ambiguous language or an intentional design to cause acceptance of the argument. Informal fallacies are encountered more often than formal fallacies in both academic settings and in everyday life.

Some informal reasoning fallacies commonly found in student argumentation were described by Zeidler et al. (1992) as: 1) Ad hominem arguments that attack a person's character or worth instead of his/her argument. 2) Appeal to popularity, when a claim is made that most other people accept a certain viewpoint. 3) False Dilemma, when an argument is based on the assumption that there are only two possible options rather than many options. 4) Begging the question is an argument based on a different form of the claim made in the original argument. 5) Hasty generalization, based on a sample not randomly selected, not representative, or too small. 6) Appeal to authority of a person who has expertise in one field, but not in

the field for which the information or advice is being sought. The above six examples are fallacies of relevance.

Zeidler et al. (1992) described five other reasoning fallacies as: 1) Fallacies of ambiguity, when an argument contains a word or term with ambiguous meaning. 2) Fallacy of equivocation, when a word or term appears in the context of an argument and has more than one meaning, but is purported to have the same meaning. 3) Normative reasoning, when social norms or experiences restrict the objectivity or comprehension a person has about an issue. 4) Naive conceptions of argument structure, when a person prefers to use an approach that requires minimal skill or effort to argue an issue, such as a probabilistic conclusion or a heuristic strategy. 5) Altering the representation of the argument by an inadvertent modification or subtle change to one of the original premises of the argument.

Zeidler et al. (1992) and Zeidler (1997) stressed the great importance of science literacy as an ideal and the definitive goal for educators to cultivate "scientific" habits of mind in their students. "Understanding the central role of fallacious thinking is fundamental to the eventual success of realizing this goal in science education" (Zeidler, 1997, p. 483). Zeidler provided a framework to examine "samples of thought" related to the "social thinking" of students in the context of scientific problems. A central component of this framework is the analysis of discourse and argumentation. By examining

thinking in this way the focus has changed from how an individual acts on a problem to the cognitive structure of the individual in relation to a task specific goal.

CHAPTER III

DESIGN AND METHOD

Introduction

This study was focused on the decisions made by the leaders in two Oregon cities with similar waste water treatment problems. Our educators and philosophers have repeatedly stressed the importance of quality thinking and of knowing what people think. The search for a better understanding has moved from learning not only what people think, but also why they think as they do. The literature has indicated that the initial core beliefs held by students can influence their solutions to socio-scientific problems in their classrooms. The purpose of this study was to investigate the role of initial core beliefs held by the leaders of the two communities as they found solutions for the socio-scientific problems in their respective communities.

To address the three primary questions in this study, the reasoning of each individual who participated in the two group decisions was analyzed. Other factors such as local political and economic interests were not within the scope of this study. A questionnaire was employed to ascertain each subject's initial core beliefs about wetlands and their use for waste water purification. Linguistic information was collected by audiotaping interviews with the subjects. In the interviews each subject was asked to explain his/her decision to support or oppose the wetland waste water treatment alternative. Transcripts of those interviews were then analyzed qualitatively to identify the

reasoning patterns used by each subject to explain his/her action in the group decision process.

It is appropriate at this point to disclose information regarding personal interests and experiences of the researcher. A lifetime of work and recreation in the outdoors as well as many undergraduate courses in the life sciences has cultivated an interest in ecology. An interest in local and global environmental issues has been the logical connection to these interests and experiences. Another relevant aspect of the researcher's personal background is prior involvement in the local political process. Three years as a city councilor and an appointed member of numerous local boards and committees has provided certain insight with regard to community decisions. An interest in the individual reasoning of community members as they are involved in the development of local environmental policies has been a result of these factors. This background has clearly been a motivation for the design of this study. It is recognized that these same factors may also be a cause of some level of researcher bias.

Efforts were made while analyzing the data to minimize the effects of any such bias. Numbers were used to identify the audiotape of each interview and the questionnaire that was completed by each subject. No audiotape was transcribed for several months after the actual time that the interviews occurred, and the analysis of the responses to each interview question was completed for all 24 of the subjects before moving on to the next

question. The goal of this method was to accomplish an objective rating of each response with a minimum of interference from the other responses by the same subject. The lapse of time between the personal meeting with each subject and the analysis of his/her responses was intended to help eliminate some of the nonverbal information that might have had an effect on the ratings given to the responses.

Research Questions

1. Can specific "critical thinking" operations (CTO) be identified in the reasoning used by each subject to explain his/her decision regarding a wetland waste water treatment policy?
2. Can any "fallacious thinking" patterns (FTP) be identified in the reasoning used by each of the community leaders to explain his/her decision regarding a wetland waste water treatment policy?
3. Can a pattern be identified between each subject's initial core beliefs (ICB), and the reasoning he/she used to explain a decision regarding a wetland waste water treatment policy?

Subjects

The units of analysis were elected city officials and some volunteer citizens who participated in the two group decision processes. The elected

officials were City Councilors from City A and City B who were in office at the time each group decision was made. The elected officials from each city worked closely with volunteer citizens in their respective decision processes. Members of each volunteer group are included as subjects in the study. The City B group consisted of seven elected officials and four volunteers. The City A group included five elected officials and eight volunteers. The total number of subjects in the study was 24.

The sample was derived from the recorded minutes that each city had on file for the public records of each respective decision process. Letters of informed consent were mailed to all of the people who were listed as members of the decision making group for each city. Within a period of 15-30 days, these individuals were contacted by telephone and asked to participate as subjects in the study. From the City A group, one individual was unwilling to participate, and three were unavailable. From the City B group three individuals were unwilling to participate, and four were unavailable.

For those who agreed to participate, an appointment was made to meet with them for a short interview. Each subject was asked to suggest a place to meet. From the City A group, ten subjects suggested their homes, two subjects suggested their offices, and one subject suggested a restaurant. From the City B group, ten subjects suggested a conference room in the city library, and one subject suggested his home. Each interview lasted between 30-60 minutes. At the beginning of each interview, the subject was asked to

fill out a 20 question written questionnaire. When this was completed the subject was asked to respond to seven open-ended interview questions. At this time the subject was asked if it was okay to turn on the tape recorder. There were no objections expressed by any subject who participated. After the response was concluded for the final question, the recorder was turned off, and the interview was ended.

Data Collection Methods

A paper and pencil questionnaire with a four point scale was filled out by each subject at the beginning of his/her interview. The questionnaire consisted of 20 questions about wetlands in the context of waste water purification. Ten questions were each written to reflect a positive attribute of the wetland waste water concept. Ten more questions were each written to reflect a negative aspect of the same concept. The content validity of this instrument was established by a panel of five experts.

The validation process was accomplished by giving each panel member a copy of the questions that were proposed for the questionnaire. Each of the 20 questions was defined in writing for the five panel members regarding the intended purpose of the question. The panel members each made written comments about any concerns he/she had about any of the questions. The concerns were addressed by revising the questions, and the process was repeated until there was an agreement on each question by four of the five panel members on all 20 questions (see Appendix B).

Audiotapes were then made of the reasoning used by the subjects to explain their decisions regarding the new policies they developed for local waste water management. In these face-to-face interviews the subjects were asked to respond to seven open ended questions. The main objectives of the interview questions were: to encourage each subject to discuss his/her content knowledge, to obtain some insight about the basis of the content knowledge, to have each subject state his/her position and present some evidence to support the position, and to determine whether each subject was aware of alternative positions and evidence that could be used to support them.

Data Sources

The first objective of the study was to collect data regarding each subject's initial core beliefs in the context of his/her role in the community decision process. The questionnaire was used to score the initial core beliefs (ICB) of each subject regarding the use of a constructed wetland treatment system to purify municipal waste water. The ICB scores were calculated by using a four point scale to determine the strength of each subject's core beliefs, and whether his/her belief index was positive or negative. This method was advocated by Ajzen & Fishbein (1980).

The second objective of the study was to collect linguistic information about the reasoning of each subject related to his/her involvement in the community decision process. Each subject was be asked to discuss his/her

reasoning in the context of the local group decision process. This method was advocated by Kuhn et al. (1988) and Kuhn (1991).

Analysis of Data for Research Question One

The reasoning of each subject was examined for ten critical thinking operations (CTO) conceptualized by Beyers (1988). Zeidler et al. (1992) stated that the ten operations were derived, and synthesized from the literature of science, language arts, and social studies instruction. They are presented from simple to complex as follows:

- 1) distinguishing between verifiable facts and value claims;
- 2) distinguishing relevant from irrelevant information, claims, or reasons;
- 3) determining the factual accuracy of a statement;
- 4) determining the credibility of a source;
- 5) identifying ambiguous claims or arguments;
- 6) identifying unstated assumptions;
- 7) detecting bias;
- 8) identifying logical fallacies;
- 9) recognizing logical inconsistencies in a line of reasoning;
- 10) determining the strength of an argument or claim (p. 439).

The ten CTOs shown above are listed in hierarchical order, and numbered from simple to complex. The corresponding numerical value was used to represent each of them, advancing from 1 for the simplest to 10 for

the most complex. The transcript of each interview was reviewed and rated with the number of the most complex CTO that could be identified in parts A, B and C. The three scores were totaled to obtain a cumulative score for the responses that each subject gave. (See examples in Chapter IV.)

Analysis of Data for Research Question Two

The reasoning of each subject was examined for any of the 11 reasoning fallacies described by Zeidler et al. (1992). A subject's reasoning was considered flawed if any of these 11 reasoning patterns were used to explain his/her decision. The 11 fallacious reasoning patterns (FTP) are identified as:

Pattern A: Ad hominem argument

Pattern B: Appeal to popularity

Pattern C: False Dilemma

Pattern D: Begging the question

Pattern E: Hasty generalization

Pattern F: Appeal to authority

Pattern G: Fallacies of ambiguity

Pattern H: Fallacy of equivocation

Pattern I: Normative reasoning

Pattern J: Naive conceptions of argument structure

Pattern K: Altering representation of argument

Analysis of Data for Research Question Three

The highest levels of reasoning used by each subject were used to determine a CTO value for research question one. The number of fallacious thinking patterns used by each subject was used as the FTP value for research question two. The numerical values for these two variables, and the ICB scores were then quantitatively analyzed to identify any possible patterns. A regression analysis was performed in sets of two for all three variables. For the CTO and FTP variables there was a significant negative correlation indicated. No significant correlation was indicated for any other combination of the three variables. Another pattern was suggested between the ICB scores and the FTP variable. All findings of the study are discussed in Chapters IV and V.

CHAPTER IV

RESULTS

Introduction

The purpose of this study was to examine the reasoning of the decision makers in two communities, as they worked to solve local waste water problems. The data were collected for this study in two parts and are described both qualitatively and quantitatively. They were analyzed to identify the critical thinking operations (CTO) employed by each subject during the taped interviews, and to determine if the initial core beliefs (ICB) of each subject can be linked to his/her reasoning or actions in the decision process. The basic framework for collecting and analyzing the data is based on the earlier work of other researchers discussed in Chapter II. Other factors such as local political and economic interests were not within the scope of this study.

Part one of the data was collected by asking each subject to fill out a questionnaire that was designed to measure his/her core beliefs regarding the use of constructed wetlands for purifying municipal waste water. An index score for each subject's initial core beliefs about the wetland waste water treatment alternative was calculated on a four point scale, modified from the seven point rating scale advocated by Ajzen & Fishbein (1980). The purpose of an index score of each subject's initial core beliefs is to compare and contrast with the qualitative features of his/her reasoning (see Table 1).

Table 1. Questionnaire scores.

City B ICB range was from 2-31	City A ICB range was from 18-39
31	39
30	33
27	31
26	30, 30, 30
25	26, 26
24	25
20	21
19	19
14	18, 18
6	
2	

224 = total of City B ICB Scores

346 = Total of City A ICB Scores

The content validity of the instrument was established by a panel of five experts from the field of science education. Dana Zeidler is from the University of South Florida. Randy Bell is from the University of Virginia. Norm Lederman, Barbara Crawford, and Larry Flick are from Oregon State University. The validation process was accomplished by giving each panel member a copy of the questions that were proposed for the questionnaire. Ten questions were each written to reflect a positive attribute of the wetland waste water treatment concept. Ten more questions were each written to reflect a negative aspect of the same concept.

The 20 questions were each defined in writing for the five panel members, regarding the intended purpose of the question. The panel members each made written comments about any concerns he/she might have about

any of the questions. The concerns were addressed by revising the questions, and the process was repeated until there was an agreement on each question by four of the five panel members on all 20 questions (Appendix B).

Part two of the data was collected in audio-taped interviews where each subject explained his/her knowledge and reasoning about a local decision to adopt or reject a policy for construction of a wetland to help purify waste water. In a face-to-face interview, each subject was asked to respond to seven questions grouped into three parts. They were as follows:

Part A: Personal Content Knowledge

Question 1: What do you know about the use of constructed wetlands for the treatment of municipal waste water?

Question 2: Have you learned more about this since becoming involved in the decision process of your city?

Question 3: What did you know about the subject before you became involved?

Part B: Decision Commitment

Question 4: Did you support or oppose the adoption of this water treatment method in your city?

Question 5: Why did you take this position?

Part C: Alternative Epistemology

Question 6: Were there other points of view in the group you worked with?

Question 7: Can you give some examples of those other points of view?

Overview of Interviews

The interviews revealed that most of the subjects knew very little about the decision context before they became involved in the decision process. A majority of the subjects stated that most of what they had learned was while they were involved in their respective decision processes. Yet, there was a wide variation in the way each subject explained his/her personal understanding of the wetland waste water treatment concept. Additionally, there were distinct differences between the two groups regarding how the new information was obtained. In City B, some staff members from Public Works presented the new information to the decision makers. In City A, a small group of volunteers presented the new information to the decision makers.

In the City B interviews, there were four subjects who supported and seven subjects who opposed the use of a constructed wetland to treat local waste water. In the City A interviews one subject opposed, and 12 subjects supported a pilot project with a constructed wetland as part of an upgraded system to treat local waste water. Within each community group, a specific

concern was expressed about local resources that was different and unique to each city. In City B, there was a general concern about the high cost and limited amount of land that would be suitable for constructing and maintaining a wetland treatment facility. In the City A area, the resource of most concern to the subjects was the water in the local streams.

The effluent from a waste water treatment plant was described as a valuable resource by most of the subjects from the City A group. In contrast, most of the subjects in the City B group described the effluent from a waste water treatment plant as a liability. In addition to the general concerns from each group that were described above, there was a wide range of reasoning expressed by the different individuals from both groups regarding the use of a constructed wetland for treatment of the local waste water. The participants in the study have diverse backgrounds and occupations, as well as differing types and levels of education. The design of this study did not specifically focus on the individual features of each subject however, some anecdotal details may be useful.

Some subjects were reluctant to answer questions regarding their education, and for that reason there was no further attempt to ask such questions. It is entirely possible that some or all of the subjects were selective in their responses to the interview questions. For example, some might have been aware of differing viewpoints or opposing arguments, but chose not to discuss them in the interview. Any information that was obtained from the

subjects about their personal experience and backgrounds was given in their responses to the first three questions under the Part A: Personal Content Knowledge section of the audiotaped interview. A short review of the responses will provide some insight about each subject. The responses will not be evaluated in this review, and the individuals will be referred to by subject number only. If the occupation of a subject was revealed during the interview, it is included in the following demographic summaries.

Subject #1 was a volunteer who is a restaurant owner and specialty farmer with a high school education. This subject referred to other projects as the main source of information about the wetland concept.

Subject #2 was a volunteer who is a retired engineer. This subject referred to past work experience and a technical background as the main sources of information about the wetland concept.

Subject #3 was city council person with an unknown level of education. This subject referred to involvement in the decision process, and personal reading as the main sources of information about the wetland concept.

Subject #4 was a city council person with an unknown level of education. This subject referred to personal experience in the outdoors as the main source of information about the wetland concept.

Subject #5 was a volunteer who is retired from a career in aviation. This subject did not reveal any specific educational background, but referred

to government documents and some experts from other projects as the main sources of information about the wetland concept.

Subject #6 was a volunteer who is a retired sewage treatment plant manager. This subject did not reveal any specific education, but referred to past work and other personal experience as the main sources of information about the wetland concept.

Subject #7 was a city council person who owns and operates a local bed and breakfast business. This subject referred to other projects, and to some personal observations as the main sources of information about the wetland concept.

Subject #8 was a volunteer who is an environmental planner. This subject referred to a personal friend who is an engineer, and other projects as the main sources of information about the wetland concept.

Subject #9 was a city council person with an unknown level of education. This subject referred to personal study, involvement in group discussions, and projects in other areas of the world as the main sources of information about the wetland concept.

Subject #10 was a volunteer with an international background and diversified education related to environmental issues. This subject referred to projects in other countries and local experts as the main sources of information about the wetland concept.

Subject #11 was a volunteer with a B.S. degree in engineering. This subject referred to other projects and personal reading as the main sources of information about the wetland concept.

Subject #12 was a city council person with a PhD in political science. This subject referred to the local citizens who advocated wetlands as a means to purify waste water as the main source of information about the wetlands concept.

Subject #13 was a retired volunteer with a B.S. degree in botany. This subject referred to past work experience for the Road Department in California, and other projects as the main sources of information about the wetland concept. This subject also mentioned that some species of wetland plants are useful for cleaning up the petroleum residues along highways. This individual was involved in constructing three wetlands to remove various chemical pollutants from runoff water.

Subject #14 was a city council person with an unknown level of education. This subject referred to various personal observations and other experiences as the main sources of information about the wetland concept.

Subject #15 was a city council person with an unknown level of education. This subject referred to some discussions in the public decision process, and a visit to a constructed wetland as the main sources of information about the wetland concept.

Subject #16 was a city council person with an unknown level of education. This subject referred to projects in other cities, and to presentations by staff members during the local decision process as the main sources of information about the wetland concept.

Subject #17 was a city council person with a strong background in life science, who was also working on a M.S. degree in a related field. This subject referred to the local decision process as the main source of information about the wetland concept.

Subject #18 was a volunteer who works as a chemical engineer. This subject referred to presentations by another engineering firm that was providing consulting services during the decision process, as an important source of information about the wetland concept. This individual also mentioned some personal work experience which involved a detailed evaluation of various constructed wetlands, and their effectiveness for removing industrial wastes.

Subject #19 was a volunteer who has done engineering in the waste water treatment field. This subject referred to personal reading about projects in other cities as the main source of information about the wetland concept.

Subject #20 was a volunteer who has a professional background as a consulting engineer. This subject referred to personal work experience,

seminars, and other private studies as the main sources of information about the wetland concept.

Subject #21 was a city council person with an unknown level of education. This subject referred to a personal acquaintance, and to city staff members as the main sources of information about the wetland concept.

Subject #22 was a city council member with an unknown level of education, who owns an automotive repair business. This subject referred to reports as the main source of information about the wetland concept.

Subject #23 was a city council person with an unknown level of education. This subject referred to reports by the citizens as the main source of information about the wetland concept.

Subject #24 was a volunteer who is an engineering professor. This subject referred to reading, personal analysis, reports from an engineering firm, and group discussions as the main sources of information about the wetland concept.

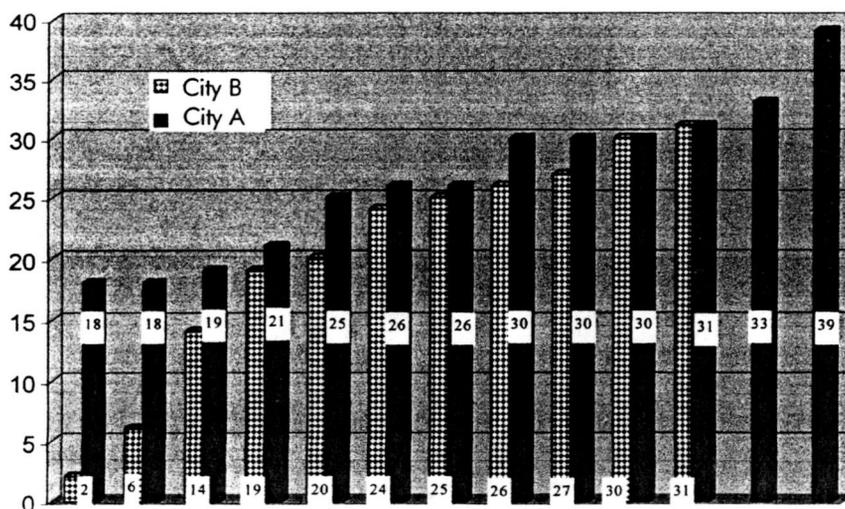
Subjects 1-13 were from the City A group, and subjects 14-24 were from the City B group. Each subject's audio-taped interview was transcribed and qualitatively analyzed to identify Critical Thinking Operations (CTO) or Fallacious Thinking Patterns (FTP) that were employed in his or her reasoning. The distribution of ICB scores was analyzed quantitatively for each separate community group, and for the two groups combined. The descriptive statistics appear in Table 2. The range of ICB scores for both communi-

ties combined was +2 to +39. The range of scores for the City B subjects was +2 to +31, and the range for the City A subjects was +18 to +39. These distributions are illustrated in a bar graph on page 126.

Table 2. Descriptive statistics for City B and City A ICB values.

Variable	City B ICB	City A ICB	City B and City A combined ICB
Sample size	11	13	24
Average	20.36	26.62	23.75
Median	24	26	25.5
Mode	24	30	30
Geometric mean	16.52	25.89	21.07
Variance	90.25	40.76	70.63
Standard deviation	9.50	6.38	8.40
Standard error	2.86	1.77	1.72
Minimum	2	18	2
Maximum	31	39	39
Range	29	21	37
Lower quartile	14	21	19
Upper quartile	27	30	30
Interquartile range	13	9	11
Skewness	-0.95	0.17	-0.91
Standardized skewness	-1.29	0.26	-1.8
Kurtosis	-0.05	-0.50	1.19
Standardized kurtosis	-0.03	-0.37	1.19

Distribution of ICB scores for City B and City A.



Analysis for Research Question One

Can specific "critical thinking" operations be identified in the reasoning used by each subject to explain his/her decision regarding a wetland waste water treatment policy?

To objectively rate the responses of each subject regarding his/her personal knowledge and reasoning about the wetland waste water treatment concept, section A of each interview was rated on a scale from 1-10, based on the 10 critical thinking operations (CTO) cited by Zeidler et al. (1992). Also, the reasoning of each subject in both sections B and section C were rated by the same set of critical thinking operations and scored on the 1-10 point scale. These critical thinking operations are presented as follows:

- 1) distinguishing between verifiable facts and value claims;
- 2) distinguishing relevant from irrelevant information, claims, or reasons;
- 3) determining the factual accuracy of a statement;
- 4) determining the credibility of a source;
- 5) identifying ambiguous claims or arguments;
- 6) identifying unstated assumptions;
- 7) detecting bias;
- 8) identifying logical fallacies;
- 9) recognizing logical inconsistencies in a line of reasoning;

10) determining the strength of an argument or claim (p. 439).

The ten CTOs shown above are listed in hierarchical order, and numbered from simple to complex. In this analysis, a corresponding numerical value was used to represent each of them, advancing from 1 for the simplest to 10 for the most complex. Parts A, B and C of each interview were rated with the number of the most complex CTO that could be identified in that section of each interview. The three scores for the responses in parts A, B and C were totaled to obtain a cumulative CTO value for each subject.

The following two examples will illustrate the scoring of the responses. One example is a subject from City A, and the other is a subject from City B. These two subjects achieved a different level of reasoning in each of the three parts of their interviews. The content of these two interviews is somewhat representative of most of the other interviews in their respective communities. It should be noted that neither of these two subjects displayed any of the fallacious thinking patterns identified in the analysis of the data for research question two.

Example One: Subject #17

Part A: Personal Content Knowledge

Question 1: What do you know about the use of constructed wetlands for the treatment of municipal wastewater?

Response: I have a real basic understanding of the process. Um... in a totally non-scientific way. I know that the storm water would be conveyed into the wetland where it would basically sit there for a while... while the biological processes broke down the different toxins then it would, I believe it would then go into a second settling pond before it would be moved back into the rest of the system. And it would be used as an alternative to a pipe and process system.

In the response to question 1, this subject made a claim that biological processes were a relevant part of the wetland treatment process. Yet, the subject did not present reasons why this was a factual statement.

Question 2: Have you learned more about this since becoming involved in the decision process for your city?

Response: I've learned everything I know about it since we began.

Question 3: What did you know about the process before becoming involved?

Response: Before? Well before the process I knew nothing about it.

Based on the response to question 1, part A was scored at a CTO complexity level of (2).

Part B: Decision Commitment

Question 4: Did you support or oppose the adoption of this water treatment method for your city?

Response: I don't think it was really either. I was interested in pursuing it as an option, but in terms of it being a real decision making point, it really never was... I'm not even sure at the community level if it really ever was. It was brought to the large group and everyone said, "let's just not worry about it then."

Question 5: Why did you take this position?

Response: What I remember is that staff came forward with a series of piping processes to deal with the CSO's and a group of citizens came forward and said, "Hey wait a second, there are constructed wetlands that may be able to do this." And then staff and the consultant and some citizens went on and had a separate work group, but I wasn't able to attend, to look at how likely that was to work here given the infrastructure cost, the DEQ and EPA permits, and just the sheer size of the problem that we had. And the decision was made by that group that it was not a viable option for this city

because... we... nobody including EPA or DEQ came out and said "you are never going get a permit,"... Yeah, they said, it's um... it's at that point it was too untested, the technology for them to be willing to risk the public's health and that if we wanted to do a test project we could but it would need to be really small and it became so cost prohibitive that it was taken off the list of options pretty early.

In the response to question 5, this subject expressed some doubt about the credibility of the wetland treatment option. On this basis, the subject did not believe that the city should rely on a large treatment system that would use untested technology.

Based on this reasoning, part B was scored at a CTO complexity level of (4).

Part C: Alternative Epistemology

Question 6: Were there other points of view in the group you worked with?

Response: Um... Well are you talking about the city council or the community as a whole. A lot of the folks that came to those work sessions um... didn't want to go with untested technology.

Question 7: Can you give some examples of those other points of view?

Response: They didn't think it was worth the infrastructure cost. They didn't want to have to deal with the land that it would be required. It would take productive land out,...or they saw productive land being taken out of the buildable lands inventory um... let's see, uh that's probably the big reasons.

In the response to question 7, this subject identified some concerns of other people about using land for the construction of wetlands, that could be used for other development. This was an assumption that was not clearly stated, but was just identified as what, "they saw". Based on this response, part C was scored at a CTO complexity level of (6).

The cumulative CTO score for subject #17 was (12).

Example Two: Subject #3

Part A: Personal Content Knowledge

Question 1: What do you know about the use of constructed wetlands for the treatment of municipal wastewater?

Response: I know in certain areas it's worked very well, but you know we have slightly different standards than where its been used before. And, that's what we're trying to test out is whether it can meet different kinds of standards. Essentially the main one is, or the main problem that we... the main

problem that we have is uh, is that we have a pretty stringent phosphorus limit for what we can discharge into the... into Bear Creek, and uh, there's a question as to whether or not constructed wetlands can bring that down low enough to meet that standard. But, there may be other benefits that we can still use it for, whether it's directly related to our waste water or, or, the storm drains, that we may be able to use constructed wetlands to help clean and polish that water. So, that's basically what I know right now about how they work.

This subject was careful to point out some specific details about the local waste water problems, and to give reasons why the local situation was different from others where the wetland method had been used successfully.

Question 2: Have you learned more about this since becoming involved in the decision process for your city?

Response: Yeah. It's been about a two and a half year program, and it's just sort of really right at the stage right now where we're probably starting to get some data out of it. I haven't yet directly gotten any, received any reports on it. So, uh I don't really know yet, exactly how, what, how it's working or what it's effects are on our particular situation yet.

In the response to question 2, the subject was cautious about making a statement about new knowledge without providing evidence to support the statement.

Question 3: What did you know about the process before becoming involved?

Response: About wetlands? Nothing. I mean I knew what wetlands were, I mean normal, natural... wetlands, and I had a general sense of what their role was in the ecosystem, and that sort of thing. And, that they were uh that natural wetlands had been constructed over and drained, and you know basically were on a decline in the country, as a whole. But, as far as a part of an actual city municipal waste water treatment facility, I knew nothing about it until we got into that.

Based on the responses to questions 1 and 2, part A was scored at a CTO complexity level of (4).

Part B: Decision Commitment

Question 4: Did you support or oppose the adoption of this water treatment method for your city?

Response: Well, uh I was in favor of it, yeah.

Question 5: Why did you take this position?

Response: Well one, because actually you know, one of the other problems that we have in ours is that we have a creek... especially, you know our major problem is, is uh, is summer discharge into Bear Creek, that's when we don't meet the new standards. And, uh, because it's a flow problem... you know, basically in winter there's much more water that runs down Bear Creek, and so like they say, dilution is the solution. And, uh so, you know what, we discharge the same kind of water year round it's just that in the summer there is much less water flowing through Bear Creek. Therefore, it becomes a bigger share of the creek, and then it's, and then it goes over the standards, for not only phosphorous, but for some other ones. But, those are some new standards, I mean before that came up seven or eight years ago we were meeting what the current standards were in all the national clean water standards. But, those are changed and updated... and uh so, we didn't meet those new ones. And, basically summer time is when we don't meet them, and that we have to either clean it to the point where we can continue to discharge, or we have to pull it out of the creek. And, the problem with that then, is that it is, there are times when it's fifty to seventy five percent of the total flow of Bear Creek, is our discharge. So, it's just kind of funny to us that uh... it would be not... you know we didn't think it was really good that we would uh that... we would have to pull out of the creek

and then there would be even less water. We didn't think that would be real helpful for the fish. And, if there was even less water it would probably heat up even more, and the temperature problem would get worse. So, so uh, we've always made a commitment that one way or another we would replace the water if we had to pull out. But, what we're hoping is that the wetlands will polish it enough that we will be able to continue to discharge even during the summer.

This subject was able to articulate the local problems with the clean water standards in such a way that some logical fallacies were identified. The subject recognized logical inconsistencies in the line of reasoning that would require the water to be reduced at a time when the greatest harm would be caused to Bear Creek.

Based on the responses to question 5, part B was scores at a CTO complexity level of (9).

Part C: Alternative Epistemology

Question 6: Were there other points of view in the group you worked with?

Response: Uh, well just that uh, well I mean, there were some people that thought we just ought to just hook up to the regional sewer plant and be done with it.

Question 7: Can you give some examples of those other points of view?

Response: Oh, just, just, generally that they thought a regional solution was probably better. And, too at the time when we first started it looked like it was the cheapest solution. In the long term it turned out that wasn't correct. At the time when we were first beginning the discussions, and near the end of the time when we were starting to make our decisions, uh... it appeared that it was a cheaper solution, and that's not necessarily the case anymore. I mean what we found when we actually got in to the construction time... that it's actually, with everything that we're doing, pretty close to the same. Over a twenty year life it will, you know with our plant hooking up to that system, cost was down to a point where there wasn't really that big of a difference. That would be my sense of it. I don't think that anyone in the general sense opposed the wetland part of it, other than that they thought that it may not work, and that it was uh... that we had a cheaper alternative. But, there was some social value, and some potential value of our own effluent that we would have been giving up. For instance, that wetlands provide wildlife habitat, and they obviously provide an open space area. So, again we were talking value, not in an economic sense, but in a community sense. Also, in the future, technology might change and we might find other ways to use our effluent. We just thought it was best to keep control of that resource.

In the response to question 7, this subject was able to identify some ambiguous claims and unstated assumptions of those who were initially opposed to the wetland treatment method.

Part C was scored at a CTO complexity level of (6).

The cumulative CTO score for subject #3 was (18).

The table below illustrates the CTO complexity levels of all subjects.

The range of CTO scores for the 24 subjects was 0-22. Seven of the subjects scored in the lower quartile range 0-2. Seven of the subjects scored in the upper quartile range 9.5-22. The other 10 subjects had CTO scores located within the interquartile range from 2-9. The average score was 6.9, and the median score was 4.5.

Table 3. City A and City B CTO scores.

Subject #	CTO Part A	CTO Part B	CTO Part C	Cumulative
	----- Complexity -----			Total
City A scores				
1	5	5	6	16
2	9	9	1	19
3	4	9	5	18
4	0	0	2	2
5	5	1	1	7
6	1	0	0	1
7	1	1	0	2
8	2	2	0	4
9	2	1	2	5
10	0	4	4	8
11	0	1	0	1
12	4	2	3	9
13	2	0	0	2
City B Scores				
14	0	0	0	0
15	3	1	3	7
16	1	2	0	3
17	2	4	6	12
18	5	3	2	10
19	1	2	4	7
20	6	3	6	15
21	1	0	1	2
22	2	2	0	4
23	0	2	1	3
24	7	10	5	22

Data Analysis for Research Question Two

Can any “fallacious thinking” patterns be identified in the reasoning used by each of the community leaders to explain his/her decision regarding the adoption of a wetland waste water treatment policy?

The following are 11 common reasoning fallacies that have been identified in the informal arguments of some science students during classroom discussions. They are the patterns of interest in this study. Each transcribed interview was analyzed to determine if any of these fallacious thinking patterns (FTP) are manifest in the reasoning of each the 24 subjects in this study.

Pattern A: Ad hominem argument

Pattern B: Appeal to popularity

Pattern C: False dilemma

Pattern D: Begging the question

Pattern E: Hasty generalization

Pattern F: Appeal to authority

Pattern G: Fallacies of ambiguity

Pattern H: Fallacies of equivocation

Pattern I: Normative reasoning

Pattern J: Naive conceptions of argument structure

Pattern K: Altering representation of argument

In order to analyze the data in a systematic way, the seven interview questions are grouped as suggested by D. L. Zeidler (personal communication, April 18, 1998), into three parts: A – Personal Content Knowledge; B – Decision Commitment; C – Alternative Epistemology. Part A is the combined responses to questions 1, 2 and 3; part B is the combined responses to questions 4 and 5; part C is the combined responses to questions 6 and 7.

The following three samples will illustrate how the responses were analyzed and rated for FTPs that were identified. The three subjects used as examples were selected because their responses exhibited an array of reasoning that was representative of most subjects in the study who displayed thinking fallacies. These responses also included the FTPs that were identified the most frequently in this study.

Example One: Subject #6

Part A: Personal Content Knowledge

Question 1: What do you know about the use of constructed wetlands for treatment of municipal wastewater?

Response: Well, it will take out the impurities, but at the end of the line the plants will consume it, and take care of the phosphorus and the ammonias. And, what more does the DEQ want?

Question 2: Have you learned more about this since becoming involved in the decision process of your city?

Response: Uh, I don't remember how far back the wetlands... uh, the wetlands, *per se* is down there. I can't remember what year we started working them.

Question 3: What did you know about this before you became involved?

Response: Yes, I've known of different cities and their jobs of what they do. And, I've visited other places to see what they do. Yeah, there's a plant down there in Arcata, California that's doing this. And, I learned a lot from that. And, there's a plant down there, South of Reno, by Lake Tahoe, and that's a great thing. They're pumping their effluent over a mountain, seven miles over there, and I've visited over there. They're putting it in a lake, and when it gets in there, it's purified by air...and uh, by air going across, and the workings of the lake. And, as far as I know, people swim in that lake...

and fish in it, and boat. It's a recreation lake, but if those people knew where it was coming from, they probably wouldn't do it.

Subject #6 made hasty generalizations on the basis of personal experience. The responses in part A, lacked substantial evidence and were based on what this subject intuitively believed to be the case.

Part B: Decision Commitment

Question 4: Did you support or oppose the adoption of this water treatment method in your city?

Response: I think it's a great thing. Yeah, I was sold on it when they first started talking about it. It's just a little walk from the plant to go out through this.

Question 5: Why did you take this position?

Response: To be more efficient, it would be more efficient. And, as a side benefit, it would make a beautiful park down there.

Again, subject #6 made hasty generalizations and used a "make sense" approach in part B. There was a failure to scrutinize the validity or

form of the responses, with use of a more heuristic approach that led to a quick and uncomplicated conclusion.

Part C: Alternative Epistemology

Question 6: Were there other points of view in the group you worked with?

Response: Well, I don't know of anybody that's against it, unless it might be one or two members of the city council.

Question 7: Can you give some examples of those other points of view?

Response: I can't see why they would be against it, and I can't see why any people living in the area...there's nobody living close to it. And uh, I can't see why anybody would be against it, if it could do the job. They got a ridiculous thing down here they just got through building in, to...to pump the effluent back up into the head of this...some kind of a wetlands thing we've got, that cost a heck of a lot of money to build it. It's supposed to flow through that, and when it comes out of that it's supposed to be ready to drink...but it may have to be chlorinated. Now that's another thing, they're talking about going from chlorination to this process of using sunlight or something. Now they're afraid of chlorine! Afraid that uh, the DEQ and everybody is scared to death of chlorine, and I've handled that stuff by the two ton...by the, yeah, my tanks was ton tanks. They held a ton of chlorine,

and I handled that stuff, I've sniffed it...I've gotten the chlorine symptoms, but the people are scared to death of it. But, chlorine is heavier than air, and if you get a chlorine leak in your tank or anything, it's going to go to the lowest area. Well, they end up down there in the creek, there was a bunch of it leaked...and I was never afraid of that stuff. But, people are scared to death of something they don't know about. So, they're going to go...I don't know if they have yet or not...of uh, killing the bacteria in the effluent instead of using chlorine. With some kind of a x-ray thing or ray...some sun's rays into it to kill the bacteria. That's what they say, probably when they get to using it, in a few years, they'll decide it didn't work.

Subject #6 relied on a make-sense epistemology throughout the interview. The responses for parts A, B and C all indicated a naive conception of argument structure. There were hasty generalizations in parts A and B. This FTP was indicated by the statement, "Yeah, I was sold on it when they first started talking about it", and by the subject advancing claims on the basis of personal experience.

The subject made an appeal to popularity in part C response, by the statements, "Well, I don't know of anybody that's against it", and "I can't see why they would be against it". The part C responses also revealed an *ad hominem* argument, with the subject's attack on others with different points of view. This subject also displayed normative reasoning in part C. This was

indicated by the subject's limited ability to objectively comprehend, evaluate, and retain or reject the ideas of others (Zeidler et al., 1992).

Example Two: Subject #13

Part A: Personal Content Knowledge

Question 1: What do you know about the use of constructed wetlands for treatment of municipal wastewater?

Response: Well uh,...I've been very interested in the wetlands project developed by the city of Arcata, California. I studied it and followed it's progress since it was first started. I also became aware many years ago that, uh... some wetlands species of plants are able to clean up the petroleum residues along highways.

Question 2: Have you learned more about this since becoming involved in the decision process of your city?

Response: Yes. I've studied the Mount Angel project in Oregon and, uh...a city in Washington, while we were trying to develop a plan for City A.

Question 3: What did you know about this before you became involved?

Response: Well, uh...actually I have been aware of the value of wetlands for many years. I was educated as a botanist, but...for much of my life, I worked for the Road Department in California. During that time, I was actually involved in constructing three wetlands. Two of them were, uh...near estuaries, and uh...the other one was used to clean up industrial run off.

No FTPs were identified in part A of this subject's interview.

Part B: Decision Commitment

Question 4: Did you support or oppose the adoption of this water treatment method in your city?

Response: Oh, I strongly supported it.

Question 5: Why did you take this position?

Response: Well, mostly because uh...it's environmentally friendly. And,...we are located on the Pacific Flyway and wetland habitat is needed by migrating waterfowl. We liked the idea of an area that could be used by the public as a park, where people can go to see wildlife and plant life, it just makes good sense.

The response to question 5 revealed incorrect reasoning that was based on the vested interests of the subject's own group and a societal viewpoint. Subject #13 used "make sense" approach without giving adequate reasons to substantiate the conclusion. The focus of the response shifted from the purification of waste water to the "idea of a park and wetland habitat for waterfowl."

Part C: Alternative Epistemology

Question 6: Were there other points of view in the group you worked with?

Response: Yes, uh...some people wanted to just pipe it to Medford, and, uh... there were others who wanted to build a new conventional treatment plant here in City A, but uh...most of these people were quite ignorant about wetlands in general, and they knew nothing about the idea of using wetlands to purify waste water.

Question 7: Can you give some examples of those other points of view?

Response: Well, uh...we used newspaper articles and some public speaking to educate those who opposed wetlands and the opposition dissolved. Especially the those that favored the local plant for conventional treatment.

Subject #13 exhibited normative reasoning in parts B and C by an egocentric form of reasoning, and a limited open-mindedness. This pattern was indicated by the response " we used newspaper articles and some public speaking to educate those who opposed wetlands, and the opposition dissolved". A hasty generalization was indicated in part C by the lack of sufficient or appropriate evidence to support the subject's claim. The subject presented an ad hominem argument in the statement, "most of these people were quite ignorant about wetlands in general, and they knew nothing about the idea of using wetlands to purify waste water. In part B, the representation of argument was altered by shifting the focus from waste water to wildlife habitat and a public park. This subject revealed a naive conception of argument structure by presenting some underdeveloped arguments in parts B and C, and by attending to counterevidence in a cavalier manner (Zeidler et al., 1992).

Example Three: Subject #21

Part A: Personal Content Knowledge

Question 1: What do you know about the use of constructed wetlands for treatment of municipal wastewater?

Response: Very little.

Question 2: Have you learned more about this since becoming involved in the decision process of your city?

Response: No.

Question 3: What did you know about this before you became involved?

Response: It was one of the alternatives for treatment, but it was not the best or most effective way.

Subject #21 admittedly knew very little about the constructed wetland treatment concept, and did not seem to be interested in any confirming evidence to support the decision to reject it.

Part B: Decision Commitment

Question 4: Did you support or oppose the adoption of this water treatment method in your city?

Response: I opposed it.

Question 5: Why did you take this position?

Response: I was greatly influenced by a person who attended the hearing who was very much opposed to the idea based on his knowledge. I relied very heavily... how effective it would be based on his knowledge.

Again, in the responses for part B, this subject made a hasty generalization with a lack of personal information to support the decision. Instead, subject #21 relied on advice from an individual who may or may not have knowledge that is relevant to the issue.

Part C: Alternative Epistemology

Question 6: Were there other points of view in the group you worked with?

Response: I can't remember any. Staff were skeptical of it...City Staff opposed it.

Question 7: Can you give some examples of those other points of view?

Response: Some in the audience were very much in favor of it. Environmentally acceptable—I think.

Subject #21 made hasty generalizations in parts A, B and C. This was indicated by a lack of attention to evidence or counter-evidence, and the short responses to the questions. The subject made an appeal to authority in

parts B and C, by relying on an other person to make the decision on the waste water issue. This subject indicated a naive conception of argument structure by attending to opposing points of view with a cavalier attitude. The subject used normative reasoning in the part C responses with an egocentric lack of open-mindedness (Zeidler et al., 1992).

The 24 subjects in the study are listed by number in the table below, with columns for parts A, B and C, and for the total. If an FTP was identified in any of the three parts, it is represented by a letter corresponding with one of the patterns. The total number of FTPs for each subject is shown in the last column.

There were a total of 89 FTPs identified in the 24 interviews. Nine of the subjects displayed (0) FTPs in any of their responses. The average number was 3.75. Six of the eleven FTPs listed above were identified fewer than five times: Pattern B, (1); Pattern C, (0); Pattern D, (1); Pattern F, (1); Pattern G, (1); and Pattern H, (4). Pattern K was identified (8) times. Pattern A was identified (6) times, and only in Part C responses. The three FTPs observed most frequently in this study were: Pattern E, (18); Pattern I, (21); Pattern J, (28).

Table 4. The Fallacious Thinking Patterns identified from each interview.

City A Subjects						
Subject #	FTP Part A	FTP Part B	FTP Part C	Total		
1		0	0	0	0	
2		0	0	0	0	
3		0	0	0	0	
4	I J	2 J	1 A J	2	5	
5		0	0	0	0	
6	E J	2 E J	2 A B I J	4	8	
7	E I	2 E I J	3 I J K	3	8	
8	I J	2 E I J	3 D E J	3	8	
9		0	0	0	0	
10	I	1 J K	2 A I J	3	7	
11	E I	2 E J	2 A J	2	6	
12		0	0	0	0	
13		0 I J K	3 A E I J	4	7	
City B Subjects						
14	G H I K	4 H I J K	4 A H I K	4	12	
15		0	0	0	0	
16	H	1 E I J K	4 E I J	3	8	
17		0	0	0	0	
18		0	0 I J K	3	3	
19		0 E I J	3	0	3	
20		0	0	0	0	
21	E	1 E F	2 E I J	3	6	
22	I J	2 E J	2 J	1	5	
23		0 E	1 E J	2	3	
24	0		0	0	0	

Analysis for Research Question Three

Can a pattern be identified between each subject's initial core beliefs, and the reasoning he/she used to explain a decision regarding a wetland waste water treatment policy?

In Table 5, each of the 24 subject's ICB score is listed in the first column, with the lowest value at the top and ending at the bottom with the highest value. In the second column, the total number of fallacious thinking patterns for each subject is shown. In the third column, the cumulative total of each subject's critical thinking operations is shown. The last column shows the number assigned to each subject for this study. The nine subjects who displayed zero FTPs in their reasoning had ICB scores located within the interquartile range from +19 to +30. The ICB scores for these individuals were closer to the median (+25.5), and the average score (+23.75) than most of the subjects with FTPs in their reasoning. With the exception of subjects #6 and #23, all of the subjects who exhibited thinking fallacies had ICB scores in the upper or lower quartiles of the ICB score distribution.

The table does not show an obvious pattern between the ICB scores and the levels of critical thinking used by the subjects. However, an indirect connection is suggested by the significant negative correlation between the CTO and the FTP variables. A regression analysis using the data from research questions one and two was performed. The results indicate a correlation coefficient of -0.70 , $R^2 = 48.49$ for those two variables. The

Table 5. The values for the three variables shown for each subject.

ICB	FTP	CTO	Subject
+2	3	10	#18
+6	6	2	#21
+14	5	4	#22
+18	8	2	#7
+18	8	4	#8
+19	3	7	#19
+19	0	18	#3
+20	0	22	#24
+21	8	1	#6 *
+24	0	12	#17
+25	0	3	#15
+25	0	7	#5
+26	0	19	#2
+26	0	9	#12
+26	0	6	#20
+27	3	3	#23*
+30	0	16	#1
+30	6	8	#10
+30	5	2	#4
+30	8	3	#16
+31	6	1	#11
+31	12	0	#14
+33	2	5	#9
+39	7	2	#13

numerical values for the CTOs and FTPs of each subject are listed in Table 3 under those headings. On the basis of the regression analysis, and the obvious pattern between the ICB scores and the FTP variable, it is possible that the CTO variable may also be indirectly influenced by core beliefs.

Another possible influence on the CTO variable is each subject's specific educational background. This possibility is discussed in Chapter V.

Summary of Findings

The variables of primary interest in this study were: ICB, CTO, and FTP. Some descriptive statistics for those 3 variables are shown in Table 6 below. The results discussed in Chapter IV, suggest the following patterns of interest within the context of adult reasoning about public policy decisions that may have an impact the environment.

- 1) The initial core beliefs of each person can influence his/her personal perception of a decision context, yet it appears that this perception may be moderated by social influences.
- 2) There is some indication that strong commitment to these initial core beliefs is related to a higher incidence of fallacious thinking, yet this may be moderated by experience and training in critical thinking skills.
- 3) The majority of the fallacious reasoning patterns that were identified in this study were related to errors in the correct use of evidence to support a position on an issue.
- 4) The group distribution of scores for initial core beliefs showed that most of the people who scored within the interquartiles had no fallacious thinking patterns identified in their reasoning.

- 5) The people who scored in the upper and lower quartiles all had fallacious thinking patterns identified in their reasoning.
- 6) There was a strong relationship shown between high levels of critical thinking and a low incidence of thinking fallacies.

Table 6. A summary of the descriptive statistics for the three variables.

Variable	ICB	CTO	FTP
Sample size	24	24	24
Average	23.75	6.92	3.75
Median	25.5	4.5	3
Mode	30	2	0
Geometric mean	21.07	-33	-33
Variance	70.63	39.21	13.07
Standard deviation	8.40	6.26	3.61
Standard error	1.72	1.28	0.74
Minimum	2	0	0
Maximum	39	22	12
Range	37	22	12
Lower quartile	19	2	0
Upper quartile	30	9.5	6.5
Interquartile range	11	7.5	6.5
Skewness	-0.91	1.16	0.46
Standardized skewness	-1.81	2.33	0.92
Kurtosis	1.19	0.37	-0.81
Standardized kurtosis	1.19	0.37	-0.81

CHAPTER V

DISCUSSIONS AND CONCLUSIONS

Introduction

The purpose of this study was to examine some of the reasoning of adult decision makers from two different cities that were faced with similar problems concerning local waste water. The data from the two groups were analyzed to determine the individual patterns of thinking used by the subjects to explain their respective group policy decisions for local waste water treatment. In his inquiry regarding the reasoning of students during classroom discussions, Zeidler (1997) categorized distinct patterns of both critical thinking and fallacious thinking, which he believes are influenced by individual core beliefs.

It was the aim of the current study to determine whether the same thinking patterns can be identified in the reasoning that the adult subjects used to solve local environmental problems. The results pertaining to the three research questions are discussed in this chapter. It should be noted that the focus of the current study was limited to the qualitative features contained in those three questions, and to the specific context of the two community decisions. It is not implied that any of the results or conclusions can be generalized beyond those parameters. In addition to the conclusions and associated discussions are some comments concerning the limitations of

the study, implications for future public policy decisions, recommendations for educational practice, and some suggestions for future research.

Discussion and Conclusions

The samples of thought that were examined in this study revealed that the subjects used a wide range of critical thinking operations (CTO) in their informal reasoning. The variation suggests that the 24 subjects in the study were not equal in their ability to make judgements about the scientific problems they were trying to solve. This situation raises some questions about the basis of individual differences in the development of reasoning ability. All of the subjects are mature adults, and are assumed to be intellectually mature as well. If this assumption is correct, it would be meaningful to examine some reasons for these differences.

Prior studies by Piaget (1948) and Kohlberg (1973, 1976) have suggested that development in reasoning ability may be expected to increase in stages as an individual matures. Rest (1974, 1976, 1979) and Rest et al. (1974) implicated personal value commitments as a determining factor for the reasoning level used by individuals in forming moral judgements. Zeidler & Schafer (1984) argued that, "attitudes toward the content embedded in the issue, the perceived value of the issue, experience in dealing with the issue or related issues, his or her knowledge of content related to the issue" may help determine the level of reasoning used by an individual" (p. 2).

The basis for the range of CTOs employed by the subjects in this study may be that they had different levels of reasoning ability or different levels of commitment toward the issue. The design of the study did not address the means by which the subjects acquired their reasoning skills, but only the level of skill used in one specific decision context. Furthermore, the data give no indication whether each subject used the highest level of reasoning he/she was capable of using. However, in two studies by Kuhn et al. (1988) and Kuhn (1992) it was implied that the skills of reasoning may be learned with training and practice. Accordingly, it should be noted that various types of formal education, personal knowledge related to wetlands, and individual experience in dealing with municipal water treatment may be causal factors that affected the range of CTOs used by the subjects.

It has been the goal of educators to develop their "students as rational beings, capable of informed policy judgements with respect to science and society" (Zeidler, 1984a). The presumption is that formal education, and the daily experiences of life in our society are factors that contribute to the reasoning capabilities of citizens. The findings for research question one imply that all mature individuals are not equal in the skills needed for making policy judgements. The cause of this unequal ability is difficult to assess clearly from this analysis alone. However, it suggests that all of the subjects were not equally trained and experienced with respect to science and society.

An additional assessment of the data in the context of the second research question revealed more information relevant to the variation in reasoning patterns of these subjects. Fifteen of the 24 subjects in this study exhibited one or more fallacious thinking patterns (FTP) in the reasoning they used to explain their actions on the wetland waste water treatment issue. The most prevalent FTPs were: 1) naive conception of argument structure; 2) normative reasoning; 3) hasty generalizations; 4) altering the representation of argument; 5) ad hominem argument. These five FTPs accounted for 81 of the 89 total FTPs identified in the study.

The data from research questions one and two were analyzed qualitatively to determine whether any relationship could be shown between the FTPs and the CTOs in the subject's responses. The results of a subsequent regression analysis of the values for these two features indicated that an apparent connection between them can be shown. The correlation coefficient is statistically significant ($R = -0.70$). The R^2 coefficient is 48.49. The strength of this relationship ($p = <0.05$) is moderate, and indicates that the individuals who exhibited fallacies in their reasoning did not attain levels of critical thinking as high as the individuals who did not exhibit fallacious thinking.

The same fallacies were identified by Zeidler (1997), and others in earlier studies of arguments used by students during classroom discussions. Zeidler et al. (1992), defined fallacies of relevance as, "informally fallacious

arguments that contain at least one premise that is logically irrelevant to its conclusion, thereby, rendering the argument incapable of establishing its conclusion as acceptable" (p. 441). The five fallacies that are the focus of this discussion fit that paradigm on a corresponding basis. In each of these patterns there is an error that is related to relevant use of evidence. A brief description and discussion of those five FTPs follows.

Hasty generalization was described by Zeidler et al. (1992) as a reasoning fallacy that may be employed by some students during discussions when they are confronted with issues in which they have little interest or experience. Zeidler (1997) argues that "people are often called on to advance a line of inquiry into areas in which they have had little experience " (p. 491). When this is the case inadequate sampling may prevent an individual from acquiring enough evidence regarding an issue, or he/she may be "unclear about what constitutes sufficient or convincing evidence" (Zeidler, 1997, p. 491).

Altering the representation of argument and naive conception of argument structure are both patterns of fallacious reasoning that were frequently observed in this study. These two patterns have a similarity that originates from a lack of argumentation skills. The recognition and correct use of evidence and counter- evidence are important components of complete rhetorical arguments identified by Kuhn (1991). The conclusions of her study imply that these components are acquired reasoning skills that may be

learned through education and with practice. The results of the current study add support to this notion.

Kuhn (1991) found that five students of philosophy who were working on advanced degrees were the only group of subjects in her study who were able to construct complete and flawless rhetorical arguments for all three of the topics that were presented to them. She concluded that skills of argument are more highly developed by individuals when they have education and experience in using logic to generate arguments. She further contends that these skills are usually apparent in the reasoning of those same individuals across disciplines. Her conclusions give support to the finding of Zeidler (1984a), who implicated "scientific literacy" of individuals as a factor for resolving environmental dilemmas.

If this is true, we must assume that adult citizens who work as community decision makers and who may cast votes on important political issues are prepared for these important functions. If they have not, we must look carefully at the reason. It is possible that our formal education system is a component in the proper intellectual and social training of all citizens as they develop into responsible adults. If the basic skills needed to make public policy judgements are not well developed in high school and college students, it may be difficult for these individuals to learn them during their adult lives. It is important to recognize that in a democratic society all citizens act as decision makers in some capacity. Public policy is not only

influenced by officials who hold public office, but by any citizen who casts a vote.

This yields more credibility to the ideological goal of science literacy expressed by Project 2061: That scientific habits of mind should be cultivated for all students to:

. . .deal sensibly with problems that often involve evidence, quantitative considerations, logical arguments, and uncertainty; without the ability to think critically and independently, citizens are easy prey to dogmatists, flimflam artists, and purveyors of simple solutions to complex problems. (AAAS, 1989, p.13)

The situation may be rectified in several ways and at various levels. Most importantly, our educators must take action at all levels. At the community level, the problem is more complicated. Our leaders should be presented with accurate information that will enhance them as decision makers to function at the most effective level. To accomplish this we must be cooperative as researchers, government leaders, private citizens and educators. An important starting point is to recognize that improvements are possible, and to understand some of the possible problems that may be resolved. We must confront this matter from two basic perspectives. First, that critical thinking habits may be learned through education and practice. Second, that habits of fallacious thinking are learned and reinforced by a variety of social influences.

Zeidler et al. (1992) described ad hominem argument as an attack on a person with an opposing position on an issue, or an appeal to some special circumstance. It may be that this pattern arises from a lack of skill in developing a rational argument with relevant evidence to defend a position on an issue, so the person who disagrees is attacked instead. Teachers must be watchful for indications of this fallacious pattern, and help their students understand why it is not an effective means to advance an argument favoring or opposing a position on an issue.

Zeidler & Schafer (1984), implicated normative reasoning as a mediating factor that influenced the reasoning of students as they discussed socio-scientific dilemmas. They concluded that normative reasoning is not just an intellectualizing skill, but may also be influenced by norm referenced values of a specific social group and by past experiences. These group values and personal experiences are often substituted as evidence to support or refute a position on an issue. "Hence, many students will fall short of the ability to distinguish correct from incorrect reasoning because of social factors and vested interests which limit the open-mindedness necessary to evaluate compelling counter arguments" (Zeidler et al., 1992, p. 444).

The questionnaire used to determine the initial core belief (ICB) scores for the subjects in this study had a possible range of scores from -40 to +40. The assumption is made that a negative score indicates that the individual is unsympathetic for environmental issues related to wetlands. Conversely, if a

subject scored on the positive side of the scale, it indicates that the individual has some concern for wetland environmental issues. Furthermore, the strength of each subject's views, either positive or negative are indicated by the numerical values of their ICB scores. The numerical value of the ICB score for each subject may possibly be a predictor of fallacious reasoning.

The findings of this study indicate that the subjects can be divided into two discrete categories associated with fallacious reasoning. While the actual CTO scores appeared on a continuous scale, there was a more important distinction between the subjects who exhibited FTPs and those who did not. This is supported by the significant negative correlation of group scores for CTO and FTP as well as the range of ICB scores for the subjects with no FTPs. All of the nine subjects with zero FTPs had ICB scores located within the interquartiles of the group distribution. All of the subjects with some FTPs except two, had ICB scores located in the upper or lower quartiles. A presumption is made that these subjects were biased either for or against the constructed wetland option.

No causal factors were conclusively identified, but the most frequent FTPs and CTOs that were identified in the reasoning used by the subjects are linked to the recognition or use of evidence. It is also suggested that personal bias either for or against the constructed wetland option may have influenced the subjects who made errors in their reasoning. Accurate assessment of evidence may be hindered by such personal bias. This could

be a partial explanation for the distribution of the ICB scores. However, there are many unanswered questions concerning this connection in regard to causal factors.

The ICB scores for all subjects in this study were distributed in a normal curve ranging between +2 and +39, indicating that each of them has some level of concern for wetland environmental issues. The positive regard for environmental issues is supported by the findings of Zeidler & Schafer (1984), that groups of college students in both science and non-science majors were equally concerned about environmental issues. However, when these same scores from the two community groups were analyzed separately, the distributions were skewed in the direction of the respective group decisions. These skewed distributions are consistent with the findings of Satterfield & Gregory (1996) that even when people have different ideas about specific policies, the majority are deeply concerned about the environment. This tends to support the concept of "a joint construction of shared social knowledge" (Zeidler, 1997, p. 485).

While all subjects revealed distinct blends of personal core beliefs as indicated by the ICB scores, the composite of each set of group scores was in accordance with the respective group decisions. It is assumed that discourse and constructive argument was part of the group process that led to the final policy decisions for the two communities. Zeidler (1997) states that when individuals are cognitively challenged by the beliefs of others, "The resulting

discourse leads to a joint construction of shared social knowledge (though not necessarily shared beliefs)" (p. 485). The findings of this study support this notion.

The distribution of the ICB scores for all of the subjects in this study, indicates that a possible link may be shown between fallacious reasoning by an individual and his or her ICB score. As noted above, most of the subjects who displayed FTPS had ICB scores located in either the upper or lower quartiles of the distribution. This suggests that these subjects had more radical core beliefs about wetlands than those subjects with ICB scores in the middle range. All of the subjects who displayed zero FTPs were located within the range of the interquartiles of the ICB distribution. It is not clear what this indicates, but a possible reason may be that those subjects with zero FTPs were less biased in their decisions to support or oppose a wetland water treatment system.

If core beliefs do in fact generate fallacious reasoning as suggested by this study, it follows that these core beliefs were learned at some point in the development of an individual. The social construction of knowledge is implicated by Zeidler (1997) as having a strong influence on the core beliefs of individuals. He further suggests that there are multiple pathways that lead to the social construction of knowledge. "This intellectual baggage has developed over time both formally and informally through a plethora of individual and social experiences" (Zeidler, 1997, p. 485). Some of the ICBs

that influence fallacious thinking patterns may be deeply rooted in people before they enter the school system.

The data were examined for patterns between the values of two qualitative features of each subject's reasoning and their initial core belief (ICB) scores. It is possible that the subjects with zero FTP wanted to find concrete evidence before they made strong commitments either in support or in opposition of the constructed wetland treatment method. There was no clear pattern shown between the ICB scores and the CTO values. However, an indirect connection is suggested by a significant negative correlation between the FTP and CTO values.

There are strong implications that critical thinking habits are learned by people at some point in their development. It is apparent that many adults do not reason at higher levels than high school or college students. This notion is strengthened by some of the differences that are found in the demographic review from Chapter IV. The participants in this study with backgrounds in science or engineering referred to evidence and information sources in ways that were noticeably different than most of the subjects without scientific backgrounds. The design of this study did not include an analysis of the educational backgrounds of the participants, but this trend is suggested by the anecdotal information that was obtained during the interviews.

Directly connected is the assumption that individual core beliefs are developed through various personal experiences and by social influences. Many of the subjects in this study referred to personal experiences and opinions as the evidence to support their decisions. Again, this was not the main focus of this study, yet there appears to be a connection between fallacious thinking, and a lack of ability to recognize or present evidence in support of a personal decision. The habits related to this style of reasoning must also be learned at some point during the development of an individual.

Limitations of the Study

It is recognized that the design of this study has a number of limitations. Certain concessions were made in order to explore a public decision process at the level of individual reasoning, and with as little observer effect as possible. The sample size was small, and each interview lasted only 15-30 minutes. The time spent with the subjects was intentionally short and to the point in an attempt to collect spontaneous responses. This approach has some obvious limitations for obtaining samples of individual reasoning, but the purpose was to keep the interaction between the subjects and the researcher as straightforward as possible. The sample size was relatively small because only certain members of the two groups were available to participate. This possibly had an effect of bias on the distribution patterns that were found in the data. However, the selection of two groups with dissimilar resolutions for similar problems may have mitigated this bias.

Another point that should be acknowledged is the limited information that is known about each subject. It was not feasible to accurately evaluate the background of each subject in either experience or formal education relevant to the decision context. Therefore, the only details about the history of the subjects relevant to their decisions was self reported during the audio-taped interviews. The length of time between the actual decision process for each group and the interviews was approximately three years. This time lapse must have surely affected each subject's recollection of his or her thinking about the original decision. However, the main focus of this study was on the reasoning of the subjects as they explained their decisions during the interviews.

Implications for Future Public Decisions

It may be beneficial to discuss the findings of the current study with respect to future public decisions to be made regarding socio-scientific problems. The intent is not to evaluate the final outcome, but to analyze the thinking that led to the two decisions. While the focus is the individual reasoning of those citizens who made the public decisions, it is meaningful to discuss the context in which these decisions were made. The waste water problems of the two cities had some similarities, but the local circumstances were unique for a number of reasons. The regional and climatic differences between City A and City B are one important point to consider.

City A is located in southwestern Oregon, where the climate is arid and the population density is low. In this region, water is a highly valued resource, but land is plentiful and relatively low in cost. City B is located in the Willamette Valley, where the opposite is true. In this region, there is a much higher rate of rainfall, and runoff water is often a problem for cities to be concerned with. Land is much higher in cost in the City B area, and there is a local desire to reserve this resource for the future residential and industrial needs of that community. In the City A vicinity there is a direct relationship between the lack of water, and the prospects of future industrial or residential development.

In the reasoning of the subjects from City A and City B it was apparent that the specific local conditions helped to influence each city's final policy decision regarding waste water treatment. Cost was obviously an important factor that affected both of the final decisions. For City B the use of land for a constructed wetland was problematic for two cost related reasons. First, was the limited amount of land that was well situated; second, was the preference for it to be used for other purposes. Another problem faced by the City B group was the size of the wetland that would be required to handle the potential volume of storm water overflow.

City A faced a different set of resource related problems. A major factor was the future control of costs to obtain water to replace their waste water, if they did not find a way to reclaim it through a satisfactory purifica-

tion process. One primary option in the City A case was to send their waste water to a regional plant and pay a processing fee, which could be increased in the future. The ramification of City A sending the waste water somewhere else went beyond the problem of cost alone. The output of their sewage plant is the major source of water for two local streams during the summer. These streams are spawning streams for several species of fish, and they are an important part of the natural ecosystems of the region.

Initially both the City A and the City B groups placed a high value on using an environmentally friendly method to solve their waste water problems. In both cases there was pressure from the governmental regulatory agencies to correct these problems from the perspective of preventing pollution of natural streams. Yet, from both groups of subjects there was some expression of anxiety about the inconsistency between the level of environmental demands and the latitude allowed by the regulatory agencies to implement a new and innovative type of technology. Directly related to this is the lack of expert information that was presented to the two groups of decision makers.

In the City B decision, the wetland treatment option was rejected with minimal consideration or discussion of environmental benefits that may be derived from the use of constructed wetlands for the control and treatment of waste water. Health and safety risks to the public were mentioned as a major reason for rejecting this option because of the limited amount of

information that was available about how this treatment method has been used. Another obstacle was that wetland treatment technology is not recognized by governmental agencies as an adequate method for water purification. Because of the various unknown or unproven aspects of the wetland treatment option, the general opinion of the City B subjects was that the constructed wetland option has too many risk factors.

For the City A community, the wetland treatment option was favored by an active and well informed group of private citizens. These people were admittedly biased from the beginning of the city's decision process, and they were an important source of information for the elected officials. This information appeared to be significant in the final decision for City A to adopt a waste water treatment plan that could utilize the constructed wetland method. Several subjects in the City A group stated that a cost comparison between the wetland and conventional waste water treatment methods, showed no significant difference. Furthermore, this group believed that there are added benefits for wildlife and fish habitat, reclaimed water for various purposes, as well as the aesthetic and recreational value for the community.

The evidence or lack of it, used by the subjects in this study was somewhat restricted by a limited availability or understanding of scientific facts related to the constructed wetland option. It was also clear that the decision makers faced a dilemma because of government policies that imposed somewhat arbitrary environmental standards on one hand, yet

restricted any remedial actions to the orthodox practices which have not provided satisfactory results on the other. Some subjects stated that water quality standards are approached in different ways by different government agencies. For example, one may be interested only in the pollution aspects, while another may be only interested in the volume of stream flow.

There was some concern that water quality was not approached by the various regulatory agencies in a more unified manner. It was suggested by some subjects that water pollution problems should be solved on a more regional basis with attention given to sources of pollution other than municipal wastes. Some other sources of that were mentioned by subjects were agricultural and residential runoff, as well as industrial wastes. The majority of the subjects were perplexed by such inconsistencies as strict guidelines for the preservation of wetlands in relation to land development, yet there is a limited allowance by government agencies to use wetlands for the management and purification of waste water.

It is apparent that the decision makers from both cities were faced with complex issues. This study was focused on the reasoning of the decision makers as individuals. Yet, certain other equally important influences must not be overlooked such as the social and cost factors. The regional variations and the multiple political jurisdictions were obvious considerations in the final decisions of both cities. It is a difficult balancing act for community leaders to work under such restrictions while attempting to respond to the

specific needs of local citizens. In short, these decision makers must face certain global environmental problems within the limits of local resources. It would be helpful to consider these facts in the future.

The demands for all regulatory agencies should be coordinated before compliance is expected from local political bodies such as the two cities in this study. It is also very important for local governments to compile complete and accurate information to present to citizens regarding environmental policy decisions. It should be stressed that several alternatives must be provided with legitimate evidence that individual decision makers may use to make informed choices. In order to accomplish this, the community leaders must understand how each decision maker views the local situation as well as the global concepts that will have some influence on the policy decision. Any lack of information or personal understanding will diminish the merit of the final group decision.

Recommendations for Educational Practice

The conclusions of the current study lend support to the contentions of other researchers (Zeidler, 1984a; Zeidler & Schafer, 1984; Zeidler et al., 1992; Kuhn et al., 1988; Kuhn, 1991; Zeidler, 1997) that many people do not have adequate skill in using evidence to support a position on an issue. As was fittingly stated by Zeidler et al. (1992), ". . .what qualifies as acceptable evidence often differs across academic disciplines. Students, therefore, become unclear about what constitutes sufficient or appropriate evidence"

(p. 442). With this in mind, it would be plausible for teachers of science and other disciplines to spend substantial instructional time helping their students develop this skill.

Zeidler has advocated the use of short learning sessions in science classes, where the students are encouraged to discuss and debate issues relevant to the lesson content. This practice would require the students to develop informal arguments to support or oppose a particular viewpoint on an issue. During these group discussions many opportunities would arise where the teachers could help their students identify and define appropriate evidence in order to develop rational arguments. Prudence should be used lest the students become discipline biased or subjective in their efforts to meet the teacher's personal preferences (Zeidler et al., 1992).

The use of these short learning sessions would be helpful in the curriculum of most academic disciplines. However, it is essential that teachers convey their epistemological expectations clearly to the students in the context of the specific class content (Zeidler et al., 1992). Of major importance is a clear understanding about what constitutes appropriate evidence in the various disciplines. A starting point for all content areas would be for the teacher to open a discussion regarding the definition of evidence. As might be expected, each student will define evidence on the basis of his or her own personal background.

Several of the definitions of evidence should be discussed relative to a variety of social and scientific contexts. For example, legal evidence in a civil court is not the same as in a criminal case. Likewise, the scientific evidence recognized by biologists is not the same as for physical or social scientists. After the students are made aware that multiple types of evidence are recognized within a variety of decision contexts, they may be allowed to develop arguments by using the correct type of evidence to support or oppose a variety of issues.

It is vital to inform the students that suitable evidence may be presented in various forms such as empirical, experimental or theoretical. They may also be advised that evidence should be described in a language that is appropriate for the particular decision context. The primary objective should be for students to learn not to rely on just personal experiences for evidence to advance claims. But, rather that, "they could strengthen their positions by pursuing further gathering of evidence appropriate to that discipline (Zeidler et al., 1992). In any case, educators may use these suggestions to enhance their current teaching practices, and hopefully utilize their own creativity to build on these basic ideas.

This practice would enhance the performance based approach recommended by Oregon Department of Education during the 1999-2000 school year. Those enhancement goals for effective science instruction include the use of inquiry as a method for teaching the understanding of

scientific concepts to students. Attention to what constitutes good evidence should be included along with the suggested instructional methods for development of thinking skills and attitudes. Desirable scientific attitudes such as skepticism, respect for reasoning and curiosity would surely be strengthened by helping students acquire a clear understanding of evidence in a variety of contexts. The ability to recognize and evaluate specific types of evidence is an essential skill that is needed by all citizens in a society where public decisions often require some understanding of technical information.

As was stated by Zeidler et al. (1992), the implementation of such changes is "contingent upon the adequate education of preservice and inservice science teachers in critical thinking and reasoning skills" (p. 447). They further argue that these patterns of thought and thinking skills develop over many years, and that changes will not occur from simply informing teachers of their fallacious or inadequate reasoning. Changes at the college or university level must be subtle to minimize any resistance and to achieve long term improvements in the instructional methods and reasoning of teachers in our public school system. It was suggested by Zeidler et al. (1992), that "within the context discussions concerning the classroom use of various scientifically or technologically based societal issues, teachers could be presented with hypothetical samples of students' thoughts (for analysis) which exhibit various fallacious arguments" (p. 447). The same instructional techniques could be easily adapted to other academic areas and integrated

courses at the post-secondary level. All of the above might also be true in regard to other adults who are not teachers. All of our citizens make many personal and societal decisions in their daily lives. It is quite possible that many adults in our communities would be interested in workshops or continuing education courses designed to improve critical thinking and reasoning skills.

Suggestions for Future Research

It is important to note that this was an exploratory study. The inferences are not conclusive nor should they be generalized beyond the context of this study. The results should only be used as guides for additional inquiry. The designs for any future studies may be replications of the current study or a similar design, but in the context of different environmental and social issues. The total amount of time each subject spent in the group process would give more indication of his or her personal commitment to the final public decision (Bolan & Nuttall, 1975). It would be a simple matter to ask each subject to estimate the amount of time spent attending and preparing for the group meetings. The subjects could also be asked some more detailed questions about how they acquired their information about the decision issue.

If at all possible, a study of the process as it occurs in real time would be valuable. Future studies should be more focused on the specific points that were indicated in the data from this study. One suggestion is for further

investigation into any relationship between the level of critical thinking used by the subjects, and the type and level of formal education they have received. Future studies should include interview questions regarding the formal education of the subjects. Each subject could then be rated according to the amount and type of course work he or she completed during high school and college. A numerical value for the rating of each subject would be used as another variable to correlate with the CTO variable.

It would be worthwhile to generate more studies regarding the effects of initial core beliefs on the frequency of the recurrent fallacious thinking patterns identified in the current study. A more detailed analysis of the 20 questions used to formulate the ICB scores may provide more understanding of the causes and the strength of personal conviction in each response. The responses given by each subject for each of the 20 questions should be factor analyzed to identify any patterns or similarities between subjects. Causal relationships could then be explored between the patterns of answers on the questionnaire, and the levels of performance on the FTP and CTO variables.

An additional inquiry about how social factors contribute to the origination and the strength of core beliefs might provide some valuable insight. A questionnaire could be constructed to ascertain subjectivity or academic bias that the subjects might reveal while defining their personal understanding of the appropriate evidence relevant to various issues. The

questions should address why the subjects believe as they do, and how they acquired their beliefs.

The basis of individual differences in basic core beliefs is a complex area to explore. Yet, in order to gain more insight about how members of our society make important public decisions, it would be enlightening to understand the essence of individual bias. Social causes might be as basic as the ideas learned from friends, family members, teachers, ministers, or from the authors of numerous articles and books that each person has contact with during their lifetime. The current study has affirmed that the core beliefs of individuals effect their decisions as adults. It appears that personal bias does not change simultaneously with the physical and mental growth of an individual, but only with suitable instruction and training. If educators could be supplied with more information about these social influences, it would enhance their efforts to cultivate scientific habits of mind in their students and to attain the ultimate goal of scientific literacy in our adult population.

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APPENDICES

APPENDIX A

July 30, 1998

Dear Respondent:

I am a doctoral student from the School of Education at Oregon State University. I am preparing a study for my dissertation. The main focus of my study is the use of constructed wetlands to purify municipal wastewater. I am interested in your views about the use of constructed wetlands in conjunction with the existing facilities in your city. It is my understanding that this idea was discussed by some of your local citizens. You are being asked to take part in my study because your name is listed in the records of your city as a participant in the decision process. It would be helpful if you choose to participate. This would require 30 minutes of your time.

All information that you may provide is strictly confidential. Your responses will be used for analysis of general viewpoints and your participation will remain anonymous. You will be asked to fill out a short questionnaire and then discuss your views in a recorded interview. What you say about wetlands or wastewater treatment will be your choice. The audio tape will be transcribed and your identity will remain anonymous. I will contact you by telephone in the next 30 days to request an appointment for an interview at your convenience. You may choose to abandon the study at any time.

If you have any questions, please call my advisor, Norm Lederman at (541) 737-1819. If he is not available when you call, please leave a message and he will return your call.

Sincerely,

Jerry Nelson
Doctoral Student

APPENDIX B

Please read the following 20 statements and mark a response that is closest to your personal belief about each statement.

- 1) Wetlands have been declining steadily in North America.
 strongly agree agree disagree strongly disagree
- 2) It is generally a good idea to reduce the amount of wetland areas and develop them for agriculture or other purposes.
 strongly agree agree disagree strongly disagree
- 3) The decline of wetlands in North America has been detrimental to wildlife habitat.
 strongly agree agree disagree strongly disagree
- 4) Wetlands may offer a viable means of intercepting and breaking down sewage which can harm fish and other aquatic life.
 strongly agree agree disagree strongly disagree
- 5) Wetland wastewater treatment systems have capital costs similar to those of conventional wastewater treatment systems.
 strongly agree agree disagree strongly disagree
- 6) Wetlands in the United States are not important for wildlife habitat.
 strongly agree agree disagree strongly disagree
- 7) The decline of wetlands in North America has been detrimental to water quality.
 strongly agree agree disagree strongly disagree
- 8) Plants that grow in wetland ecosystems are not beneficial.
 strongly agree agree disagree strongly disagree

- 9) A constructed wetland coupled with a settling pond to remove solids can effectively purify sewage, and provide some recreational value such as hunting, fishing, birdwatching, photography, etc.
- strongly agree agree disagree strongly disagree
- 10) Wetland wastewater treatment systems are a good example of how sewage treatment and ecosystem preservation can be achieved without sacrificing one for the other.
- strongly agree agree disagree strongly disagree
- 11) Wetlands have been over rated for their capability to filter and purify water.
- strongly agree agree disagree strongly disagree
- 12) Mosquitoes and other aquatic insects may be controlled by stocking wetlands with fish that feed on their larva.
- strongly agree agree disagree strongly disagree
- 13) Bulrushes and cattails, the most common plants in a temperate zone wetlands can break down pesticides, industrial solvents, and other organic molecules as well as remove most of the heavy metals from polluted water.
- strongly agree agree disagree strongly disagree
- 14) Wetlands should be considered little more than breeders of disease and pests.
- strongly agree agree disagree strongly disagree
- 15) It is unlikely that a wetland wastewater treatment system can be designed to purify sewage well enough to meet stringent water quality standards.
- strongly agree agree disagree strongly disagree
- 16) Wetlands provide valuable habitat which can protect endangered or threatened species of wildlife.
- strongly agree agree disagree strongly disagree

- 17) Some cities and towns can expect to save substantial capital costs by utilizing wetland wastewater treatment because it is cost effective.
- strongly agree agree disagree strongly disagree
- 18) Wetlands are relatively useless unless they can be drained, filled and put into more productive commercial use.
- strongly agree agree disagree strongly disagree
- 19) Wetland wastewater treatment has not been proven to be an effective and efficient process for purifying water.
- strongly agree agree disagree strongly disagree
- 20) Wetland water treatment is a high-maintenance and costly method that could not significantly improve the purification of wastewater in the United States.
- strongly agree agree disagree strongly disagree