EVALUATING A WATER CONSERVATION EDUCATION PROGRAM: A MENTAL MODELS APPROACH

By

TING-BING WU

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Ting-Bing Wu

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Water is essential for all forms of life. When water demands exceed supplies, it has the potential to create a crisis. However, given that water is a renewable resource, the public tends to be unaware of potential water supply problems. Besides a shortage of water, it is also important to address other problems of water quality and disappearing water-based habitats. The Florida Yards and Neighborhoods (FYN) program is an informal educational program designed to educate the public with water conservation messages and Florida friendly landscape designs to promote sustainability at the homeowner level.

The purpose of this study is to compare mental models about water conservation between: FYN interpreters (experts); non-FYN participants (Florida homeowners); and FYN homeowner participants. Mental models are a conceptual representation of a perceived situation. By examining the differences in mental models, potential communication gaps can be revealed. Focusing on identified communication gaps when presenting educational content can be a partial solution to increasing the efficacy of the programs.

Through face-to-face, in-depth, semi-structured interviews with nine FYN interpreters, twenty non-FYN participants (Florida homeowners), and ten FYN participants, influential diagrams representing their perceptions of water conservation themes were developed. The

findings indicated that four major themes: resource aspects, consequences, contributing factors, and actions were revealed in the experts' mental model. Based on the expert model, non-FYN participants and FYN participants' water conservation mental models were constructed after interviewing samples of those segments.

This study revealed an expert water conservation mental model that represented an active diagram of 35 distinct variables. Moreover, discrepancies were identified between experts and non-FYN homeowner participants. In addition, FYN participants demonstrated better awareness of water conservation actions when compared with non-FYN homeowners.

By continuous comparison between these mental models, discussions from theoretical perspectives, water conservation behavior perspectives, informal educational aspects, and a FYN program perspective addressing the identified mental model gaps are presented. The results provide recommendations for improving the FYN water conservation educational program as well as a better understanding of Florida homeowners' awareness of key water conservation concepts and actions.

CHAPTER 1
INTRODUCTION

Introduction

Across the world, 70% of the Earth is covered by water. Oceans contain 97% of the earth's water, while only 3% of the remaining is fresh water. Food, water, shelter, and space are the four components of habitat for all living things. Food can provide energy; water is necessary for metabolism (and space, in many cases); shelter is important for protection; and space is required for living things to exist in. Water provides the Earth with the capacity to support life. From a human perspective, the human body is 70% water. Water plays a role in body temperature regulation, digestion, muscle formation, brain functions, and almost every aspect of human body physiology. Without water, organisms cannot exist.

However, global issues are increasingly presented in our daily lives. Urbanization, pollution, biodiversity loss, environmental sustainability, water crises and climate change are all issues that directly affect us. Pollution and waste make water more and more scarce. We, human beings, all have recognized the importance of water. A lot of effort has been put into fulfilling the increasing demand for fresh water. Dams, reservoirs, pumps and pipes are constructed to store and ensure our drinking water.

Thus, water usage should be a central environmental concern. UNESCO (2003) estimated the fresh water situation for 2025. There will be over 8 billion people in the world and 3 billion of them will not have easy access to fresh water. Yet, given water is a renewable natural resource, water conservation is not as urgent as other shortages for most people, e.g., energy supplies. This attitude is common for the eastern USA, since water resources, climate factors and landscapes are different from the West. Even so, the scarcity of freshwater and the need for promoting water conservation for the Eastern USA is a critical problem. Florida is no exception.

For example, the South Florida Water Management District announced that the water level of Lake Okeechobee in Southern Florida is about 3ft. below the historical average for this time of year (South Florida Water Management District, 2008). A water shortage order is still in effect for the Suwannee River Water Management District (Suwannee River Water Management District, 2008).

The importance of water conservation motivates decision makers to strive for understanding factors related to water conservation behaviors as well as developing effective projects to reduce water consumption. For instance, social science scholars have suggested using legal restrictions or normative frameworks to influence people's natural resource consuming behaviors (Van Vugt & Samuelson, 1999). Education is another way to broadcast water conservation concepts.

Local, state, and federal governments are eager to implement water conservation ideas to create sustainable environments. It is also true for private organizations. A variety of programs or agreements are developed to promote the idea of water conservation. For instance, the Florida Department of Environmental Protection had a "Joint Statement of Commitment for the Development and the Implementation of a Statewide Comprehensive Water Conservation Program for Public Water Supply". All Water Districts in Florida and many environmental associations were the signatories to set up a series of specific works related to water conservation and to help ensure the sustainability of Florida's water resources (The Florida Department of Environmental Protection, 2002). The Florida Water Star Certification program was developed to encourage home builders and new home owners to install water-efficient appliances at home (St. Johns River Water Management District, 2008). Informal settings are good opportunities to address environmental issues with the public. The Florida Yards and Neighborhoods (FYN)

program is a public education and outreach program that educates the public about Florida landscapes, water conservation and protecting water quality. In this program, strategies such as workshops, demonstration gardens, youth camps, and informal garden tours combined with interpretation are used to promote water conservation and Florida friendly landscape ideas.

In this dissertation, a mental models approach was adopted to address the issue of communicating key water conservation concepts for an informal educational program – the FYN program. This research can help the understanding of both interpreters' and homeowners' mental frameworks about water conservation and suggest ways to promote more effective water conservation communications.

Need for the Research

"Florida is blessed with fresh water. Though the state is surrounded by salt seas, the clouds that gather moisture over the ocean are made up of fresh water. Rain falls abundantly on this beautiful green state, often dropped in thunderstorms. Because Florida has no mountains and few hills, its flat surface keeps water on the land rather than allowing it to run rapidly to the sea." (Peggy Lantz, 1998, p.1-2)

Yes, Florida is blessed with the fresh water renewal cycle. However, because of Florida's weather patterns, droughts and floods are still common. Plants and wildlife have processes to adapt to these situations. Droughts and floods are situations that they have adapted to and some even require. On the other hand, these events can have negative impacts and are more severe when the human population is rapidly growing. Due to population growth, the presence of large numbers of tourists, immigration and in-migration, Florida's demand for fresh water has become even greater. Human activities need fresh water for agriculture, recreational desires, hygiene, cooking, and daily life. When floods and droughts occur, the potential for water quality problems and stormwater runoff increases.

The Florida Yards and Neighborhoods (FYN) program was designed to address the problem of educating residents about water shortages and stormwater runoff, among other things. Homeowners and the public can get lessons from local county extension offices about water conservation concepts, tools for designing Florida-friendly landscapes and assistance in protecting Florida's important natural resource – water. This informal environmental education program targets Florida homeowners and the general public. Since it is informal, no standardized evaluation criteria exist to assess the audience's understanding before and after attending the program. In addition, diverse strategies in terms of delivering information to the public were used for different offices. Did people learn something from attending the program? Was the information conveyed to the public effectively?

"Any interpretation that does not somehow related what is being displayed or described to something within the personality or experience of the visitor will be sterile." (Freeman Tilden, 1957, the first principle of interpretation)

Knowing the target audience is one of the critical keys for successful conservation outreach programs (Ham & Krump, 1996; Jackson, McDuff, & Monroe, 2006). Most of the time, people have experiences or beliefs about specific conservation behaviors. Rather than asking what they know and what they do not know, environmental interpreters or managers should design program content on the basis of the program's objectives. In order to tie new concepts with previous experiences, interpreters make assumptions about what audiences already know. Unfortunately, the correctness of these assumptions is unknown (Taft, 1995).

Interpretation is "an educational activity which aims to reveal meanings and relationships through the use of original objects, by firsthand experience, and by illustrative media, rather than simply to communicate factual information" (Tilden, 1957, p.8). Interpretation is a

communication process that forges emotional and intellectual connections between the interests of the audience and the inherent meanings in the resource (National Association for Interpretation, 2004). Since interpretation is an educational activity and a communication process, it is important to integrate different perspectives from both nodes of the communication chain – interpreters and the program participants (Silverman & Barrie, 2000).

Interpretation occurs in limited time slots. Interpreters need to rectify misconceptions which visitors might have and use time efficiently. In order to initiate positive environmental conservation actions, people need some time to attain the sensitivity, knowledge and attitudes necessary (Hammitt, 1984). Interpretation typically happens in informal settings with a short term experience. As a result, one major shortcoming of environmental interpretation is a lack of time to modify mental and behavioral dispositions (Knapp, 1998). In addition, environmental interpretation often lacks credible program development goals related to specific pro-conservation behavior changes (Knapp, 1998). Therefore, there is a need to communicate effectively between interpreters and the program participants. Communicating effectively means that interpreters need to focus on information that participants need to know and are uninformed about.

The importance of interpretive program evaluation is addressed by many scholars (e.g. Fien, Scott, & Tilbury, 2001; Ham, 1992; Lee, 1998). Evaluation can not only provide information for managers to improve programs and understand their achievements but also the results can be generalized for similar groups and resource agencies. Program evaluation is defined as the use of social research methods to systematically investigate the effectiveness of social intervention programs in ways that are adapted to their political and organizational environments and are designed to inform social action to improve social conditions (Rossi,

Lipsey, & Freeman, 2004, p.16). The most important reason for evaluation is to insure program accountability. Additionally, feedback from program evaluations can be the basis for management and content improvements. One issue that has been raised in evaluating interpretative programs is the lack of appropriate information needed for effective evaluation (Madin & Fenton, 2004). They discussed a lack of available information for evaluating interpretive program effectiveness as a critical problem. Moreover, the need for a systematic approach to the validity of interpretive program evaluation is also emphasized (Munro, Morrison-Saunders, & Hughes, 2008).

Reducing water use and conserving water is a major public issue. Environmental interpretation is a good way to communicate water conservation concepts to the public. However, an improved understanding of the public's knowledge of water conservation beliefs must be established. Moreover, studies regarding the effectiveness of informal learning about water conservation are needed. Finally, using a mental models approach to evaluate an informal environmental education program might reveal a new strategy for informal program evaluation.

Research Goals

Water conservation is a critical issue that has to be more effectively communicated to the public. The purpose of this study is to investigate whether there is a gap between interpreters' and the public's perceptions of water conservation concepts. In particular, this is a study about establishing interpreters' (expert) and homeowners' (lay people) mental models towards understanding water conservation. The focus of this study is understanding how environmental interpretation in an informal setting can promote water conservation concepts more effectively. By establishing the mental models of the major participants, we can potentially identify possible gaps in the communication process. Furthermore, comparing mental models between the participants can be applied as a form of interpretive program evaluation. Thus, managers can

potentially target possible gaps and better understand what people need to know but do not know (or misunderstand) to improve interpretive programs and facilitate pro-conservation behaviors in the future.

Research Questions

The following research questions were addressed:

1. What are FYN interpreters' mental models about water conservation?
2. What are non-FYN participants' (Florida homeowners) mental models about water conservation?
3. Do FYN interpreters' mental models about water conservation differ from non-FYN participants' mental models?
4. What values and expectations do FYN participants perceive when interpreters interpret water conservation?
5. Do FYN participants' water conservation mental models indicate learning concepts and actions from the FYN program?

Theoretical Framework

Mental models are constructs to explain and predict the behaviors of a system (Norman, 1983). It is a psychological representation of real, imaginary, or hypothetical situations (Johnson-Laird, 1983). Such a model is a person's conceptualization or personal theory of some domain or environment (Jih & Reeves, 1992). The idea of mental models can be traced back to 1943. Craik first advocated that by manipulating symbolic representations of external events, humans alter them into internal models. These models assist individuals in explaining and understanding relations between events and their internal meanings. Craik defines the term "model" as "any physical or chemical system which has a similar relation-structure to that of the process it imitates. By 'relation-structure' I do not mean some obscure physical entity which attends the model, but the fact that it is a physical working model which works in the same way as the process it parallels…" (Craik, 1943, p. 51). According to his hypothesis, through interacting with

external events and emphasizing the structural aspect of models, humans can develop their own internalized models.

Based on Craik's postulation, Johnson-Laird (1983) proposed that people hold mental models as a form of cognitive reasoning. His main idea is that mental models are simpler representations of a perceived situation. Mental models are constructed to connect the incoming information and people's previous knowledge. Norman (1983) discussed some characteristics of mental models. He believed that mental models are constantly interacting with the target system. Accordingly, mental models are characterized as incomplete (constrained by the user's background); not totally correct (unscientific); run with restrictions (people tend to know a limited set of elements in the model); and unstable (constantly evolving during time). Although mental models have those characteristics, mental models are still functional. When people are evaluating results or making decisions, mental models will direct their previous knowledge and experiences when they interact with new information.

Gentner and Stevens (1983) argued that when people are engaging in and manipulating a specific domain of knowledge, they will form mental models. People playing different roles, such as teachers, students, or researchers, can represent and manipulate their mental models in various levels of elaboration on the same concept. Each mental model is developed for a unique purpose. Therefore, different purposes will result in different models. Experts and lay people will explain the same phenomena according to dissimilar mental models. This is due to limitations in experience and is especially obvious when mental models are adopted in the comprehension of discourse.

In summary, while manipulating new information, humans translate external-world signals into understandable words, symbols, or numbers. After the translation process, those

understandable images can be retranslated into actions. Mental models are like a bridge for humans to grasp a concept or a design.

CHAPTER 2
REVIEW OF LITERATURE

Humans are social animals. Communication between each other is an important social activity. A well-designed environmental interpretative program is a combination of principles related to communication, learning, and behavior change. For the following sections, research relevant to those topics will be reviewed. Specifically, the focus will be on the principles of effective communication, informal learning, and water conservation behaviors. Moreover, current research about environmental interpretation evaluation and the mental models approach will be addressed.

Effective Communication

In order to achieve effective communication, attracting the receivers' attention is the first step. Moscardo, Woods, and Saltzer (2004) mentioned several points in terms of attracting attention. Things that can stimulate, such as a good smell, loud sound, or huge display, will bring attention. Additionally, things that surprise people as well as move will be noticed. Another important point is the relevance and novelty to the receivers. Program designers need to keep in mind that presenting relevant and new things to the audience is a strategy to enhance communication effectiveness.

Key to understanding effective communication is to look at principles that play a role in influencing people's behavior. Cialdini and Rhoads (2001) summarized the six following influence principles. Although these rules are based on the field of marketing, they are applicable for other persuasive communication as well. The first rule is *reciprocity*. It is more likely for people to give when they receive. This rule can be used in receiving concessions as well. They took one example from a company to ask people to take a one-hour survey. After saying no, more people would respond to a 15-minute survey request instead, compared to the control

group. *Scarcity* is another factor. This rule used to explain why "limited edition" items are usually more attractive. Influential sources which they explained as the idea of "*authority*" are also important. That is why inviting experts is a strategy used in persuading behavior change.

Consistency means that people try to not contradict their own words. On the basis of this rule, communication programs can prepare a commitment form with vivid language and relevant examples for participants to make a promise in terms of changing behavior (Jacobson, McDuff, & Monroe, 2006). People direct themselves to agree with those they like or are attracted to. This is the rule of *liking*. Therefore having celebrities represent a conservation event could be successful. The last rule in terms of influencing human behavior is *consensus*. It is common for people to take their friends' or family members' actions into consideration. For that reason, communication programs can inform people with messages that show what other people are doing.

Informal Learning

What is learning? Fazey and Marton (2002) evolved the view of learning from a more dynamic perspective. They considered learning as a changing relationship between a person and the world. Therefore based on their definition, learning will have individual differences. Unique experiences as well as people's perceptions of the world will influence learning. This view is especially critical for environmental studies. Heimlich (2007) addressed issues related to education for sustainable development. He emphasized that a person's beliefs, knowledge, and thoughts toward the environment are developed more by informal learning.

School is definitely an important place for learning. However, learning not only occurs in school. Learning takes place during leisure activities as well. That is sometimes called "informal education". Broadly defined by settings, any learning activity that happens outside of school is informal education. Places such as museums, zoos, aquariums, and parks are educational

institutions. Because of their non-compulsory character, “free-choice learning” is the value of informal education (Falk, 2005). Koran, Longino, and Shafer (1983) compared formal and informal learning settings. In their comparison, four attributes of informal learning are relevant to this study. During informal learning, each learner can decide how much time is spent; learners are across the age spectrum; learners have diverse backgrounds; and the communication and language used are casual and diverse.

Nature centers are suitable places to inspire and communicate environmental ideas. From visitors’ perspectives, having fun while learning is often a strong motivation to visit a nature center. However, research also suggests that people participate in free-choice learning to satisfy their personal sense of identity and to fulfill emotional needs (e.g. Roggenbuck, Loomis, & Dagostino, 1990).

The debate between entertainment and education occurring in leisure settings is an ongoing issue for discussion. Packer and Ballantyne (2004) collected information from visitors with three different methods in six educational leisure settings, using visitors’ self-ratings, questionnaires, and visitors’ in-depth interviews. They concluded that education and entertainment can be synergistic to each other and interpreters can play a unique role in providing learning and fun experiences for visitors. For natural resource managers or educators, park attendance can be an opportunity to promote conservation concepts.

Adult learning is another dimension. Historically, children are the focus of educational research. Nevertheless, free-choice learning is important for adults and lifelong learning is promoted. For informal education, there are no prescribed standards such as grades in evaluating learners’ learning outcomes. In addition, open spaces with a variety of stimuli can easily distract

visitors' attention. Therefore, understanding an audience and targeting their needs is key to enhancing their learning, as well as provoking them to take action (Tilden, 1957).

Water Conservation Behaviors

Research related to people's water conservation behaviors can be reviewed based on two levels: the problem of social dilemma and tactics related to best promoting environmental conservation behaviors. In particular, people's environmental sustainable behaviors can be viewed from structural and social-psychological aspects. At the problem level, promoting water conservation behaviors, like considering sustainability for many other natural resources, is a social dilemma. Dawes and Messick (2000) have defined social dilemmas as "situations in which each member of a group has a clear and unambiguous incentive to make a choice that – when made by all members – provides poorer outcomes for all than they would have received if none had made the choice" (p. 111). In order to promote environmental sustainability, water conservation behaviors, like many other social dilemmas, need to be encouraged towards the following tendencies: altruism, cooperation, and prosocial (Gouveia, 2002). Individual and structural solutions are discussed for people to confront those social dilemmas. Educational programs are good examples of individual solutions. They promote voluntary changes and emphasize an increase of personal awareness about the environment. A structural solution is different. Structural solutions want to target internal conflicts while people are making decisions related to social dilemmas. Examples such as financial incentive programs and legal restrictions development are structural solutions for social dilemmas (e.g. Thompson & Stoutemyer, 1991; Van Vugt, 2001).

Van Vugt and Samuelson (1999) emphasized the decision making of water conservation behaviors in field and scenario studies of a water crisis. They monitored the effects of metering related to people's water conservation behaviors. Adopting a meter for monitoring water usage is

considered as a structural solution. Based on their results, when participants perceived a water shortage, metering can produce greater positive conservation effects for people to commit themselves to sustainable behaviors in the future.

The financial incentive effect related to water consumption is another aspect that should be taken into consideration while trying to understand water conservation behaviors. Van Vugt (2001) argued about the combined effects of different tariff systems (fixed and variable tariffs) and community identification based on a social dilemma approach. His study supported the idea that during hard times such as a natural resource shortage, people's community identification becomes influential in preventing public resource overuse.

In line with the social dilemma concept, social psychologists discussed the role of local identity and individual differences for water consumption (Bonaiuto, Bilotta, Bonnes, Ceccarelli, Martorella, & Carrus, 2008). A questionnaire consisting of perceptions of the local authority's legitimacy, local identity, voluntary cooperation, structural cooperation, social value orientation, and demographics was administrated to participants. Their results indicated that prosocial people with high local identity had the highest levels of voluntary cooperation. On the other hand, proself people with low local identity had the lowest levels of voluntary cooperation.

Time is a critical concept for promoting sustainable development such as water conservation behaviors. Time can be considered as a psychological construct with three orientations: past-oriented, present-oriented, and future-oriented. Personal, social, and institutional factors play a role in modifying people's time perspectives (Zimbardo & Boyd, 1999). Corral-Verdugo, Fraijo-Sing, and Pinheiro (2006) incorporated psychological time constructs with water conservation behaviors. Their research showed that future orientation can positively and significantly influence pro-environmental behaviors. They suggested that when

developing educational programs related to pro-environmental behaviors, including time planning skills, together with social norms and values development would be an effective strategy to promote sustainable behaviors.

Moreover, understanding personal factors such as attitudes, intentions or experiences influencing people's water conservation behaviors is what scholars are eager to know. Personal normative beliefs, motivational variables, perceptional variables, and conservation skills are discussed as having effects on water conservation behaviors (Corral-Verdugo, Bechtel, & Fraijo-Sing, 2003; Corral-Verdugo, Fraijo-Sing, & Pinheiro, 2006; Corral-Verdugo & Frías-Armenta, 2006; Corral-Verdugo, Frías-Armenta, Pérez-Urias, Orduña-Cabrera, & Espinoza-Gallego, 2002). Tal, Hill, Figueredo, Frías-Armenta, and Corral-Verdugo (2006) applied the concept of K-Factor life history to explain people's water conservation behaviors. The K-Factor which refers to a multivariate construct (parental investment, social support, general altruism, and long term planning propensity) about behaviors was proposed as a combination of conservation behavior predictors. Why are some people more receptive than others to conservation efforts? From asking 186 Mexican families' about water usage behavior comparing K-Factors; they concluded that increased levels of the K-Factor can predict higher levels of personal water use.

Florida Residents' Water Conservation Studies

There are a few studies related to water use measures, Florida water quality assessment, and Florida residents' water use situations. For example, Haley, Dukes, and Miller (2007) took 30 months to document and investigate if the controller setting for a scheduled irrigation system and adjusting the range of the turf area watered can reduce residents' water use. This study was conducted in Central Florida. They found that about 64% of the total household water supply was used for irrigation. Moreover, a zone garden design for different plants according to their water needs could reduce water usage.

Lynne, Casey, Hodges, and Rachmani (1995) explored Florida strawberry farmers' water conservation decision making on the basis of the Theory of Planned Behavior. This study focused on perceived control in decision making. For the strawberry farmers, adopting water conservation strategies included both governmental controls and economic concerns. Their research not only confirmed the Theory of Planned Behavior but also the Theory of Derived Demand. People's perceived control toward a specific decision and their actual level of control are both critical in this case. According to this study, they suggested that policy makers emphasize both perceived and actual control in water conservation technology adoption for farmers which provided implications for promoting water conservation technologies to farmers.

In addition, issues related to public water consumption and attitudes towards conservation and the effect of water conservation education strategies have been studied in other areas (Billings, 1989; Campbell, Johnson, & Larson, 2004; Corral-Verdugo et al., 2003; Geller, Erickson, & Buttram, 1983; Nieswiadomy, 1991). These studies provide support for the importance of water conservation research and also indicate research directions for better understanding people's water conservation attitudes.

Environmental Interpretation

Generally speaking, there has been basic research on environmental interpretation strategies to encourage conservation actions. For example, Uzzell and Ballantyne (1998) integrated relevant topics about heritage and environmental interpretation to edit a book of issues. Ham (1992) also published a book on environmental interpretation. Research about visitors' meaningful experiences (Barrie, 2001), the effectiveness of different modes of environmental interpretation (Anderson et al., 2003; Ham, 1992), and the linkage between ecotourism and environmental interpretation (Orams, 1996) attracted attention among natural resource managers as well as within the recreation field. In the following section, literature about

the effectiveness of environmental interpretation programs related to visitor studies will be reviewed.

For ecotourism or nature-based tourism, environmental interpretation is viewed as a powerful educational and communicative tool for providing information to visitors and developing a positive attitude toward conservation (Moscardo, 1999, p.8; Moscardo, Woods, & Saltzer, 2004). There are many modes of environmental interpretation and each mode has both benefits and disadvantages in terms of communication with visitors. Take wildlife guided tours as an example. Moscardo, Woods, and Saltzer (2004) summarized the benefits as follows: on site interpreters can attract the attention of visitors, answer visitors' questions, provide social interactions, and offer prompt information about the animals. The cost for training guides in promoting effective interpretative experiences and low impact management is a problem for this mode of interpretation.

Traditionally, interpretation evaluation studies can be classified into three paradigms (Zube, Sell, & Taylor, 1982; Stewart & Kirby, 1998). Psycho-social paradigm studies are developed based on a stimulus-response model. Research in this paradigm tried to understand the effect of interpretive media (stimuli). The cognitive paradigm focused on the interaction between an interpretive medium and the user. The potential meaning of an interpretive program is illustrated by users' perceptions. The last one is the experiential paradigm. Studies based on this paradigm focused on users as well as their personal experiences. Interpretive programs are understood as part of the users' holistic leisure or learning experience.

Evaluating the effectiveness of interpretative programs is necessary to reveal if the invested time and money has resulted in visitor satisfaction with the programs (Jacobson, McDuff, & Monroe, 2006). Even though scholars agree on the importance of interpretive

program evaluation (e.g. Ham, 1992; Uzzell & Ballantyne, 1998), some studies have also revealed the difficulties in evaluating higher orders of interpretive objectives (Beckman, 1999). Some have adopted triangulation – applying a variety of data collection methods, to increase the validity of interpretive evaluation.

In an effort to understand the internal validity for interpretative program evaluation and compare different interpretive approaches in terms of outcomes, Munro, Morrison-Saunders, & Hughes (2008) reviewed 21 interpretation evaluation studies in natural areas. They set a large visitor sample size, use of both pre- and post testing, and use of a control group as the criteria for internal validity. Environmental interpretation is a complex management tool. Many factors can play a role in determining the effectiveness of programs. According to their research, most evaluation focused on visitors' knowledge gains and attitude changes. None of the reviewed research met the criteria they set regarding internal validity. This suggested a more dynamic and systematic evaluation approach is needed to meet the multidisciplinary nature and complexity of interrelationships between visitors, interpreters, and the environment.

We know that besides knowledge, attitudes and values towards conservation behaviors also affect visitors' decisions. Based on Petty, Wegner, and Fabrigar (1997), there are three components that form human attitudes: affect, cognition, and behavior. Many studies have aimed at people's affective and cognitive processes. Howard (1999) took an interpretive program in Australia as a case study to understand program influences about visitors' cognition and affective attitude components towards sea turtle conservation. Hammitt (1984) emphasized cognitive processes in environmental interpretation. His research focused on a familiarization dimension. Familiarization, in his definition, is the visitors' ability to recognize environmental information

and is a cognitive process. It also implied that to effectively communicate in informal education settings, interpreters need to improve the familiarization process as soon as possible.

Ryan and Dewar (1995) adopted a communication competency scale in evaluating the communication process between interpreters and visitors. They defined communication competency as the ability to interact well with others. Therefore, it included accuracy, clarity, comprehensibility, coherence, expertise, effectiveness, and appropriateness. Their test setting was a heritage tourism interpretative program. This research raised the issue of monitoring the effectiveness of the communication process between interpreters and visitors.

In terms of program effectiveness, Madin and Fenton (2004) used a self-administered visitor questionnaire to measure visitors' knowledge gain after participating in an interpretive program. They targeted four topic areas: reef knowledge, human impacts on the reef environment, reef health and reef tourism. In the first section of their questionnaire, the measurement of visitors' knowledge about the reef was developed based on reef ecosystem facts which the program interpreted.

In addition, evaluation should focus on audiences. Jacobson and Marynowski (1998) suggested an audience-centered model in designing effective interpretative programs. Their objective in building a model was to meet the needs of ecosystem management. They evaluated different media in transmitting ecosystem management information on military lands. According to their results, instead of site specific characteristics, an interpretive program focusing on audience attributes can better contribute to the effectiveness of interpretive programs.

Mental Models Approach

The theoretical overview in chapter one served to introduce the idea, the history and the initiation of applying human mental models towards many domains of life. In this section, literature about the mental models approach is reviewed. Where this approach has been applied,

as well as summarizing issues related to mental models research will be identified and addressed here.

Rouse and Morris (1986) summarized the objectives of human mental models as describing the purpose and forms to answer why and what questions; explaining function and mental states to reply to how and what questions; and predicting mental states to react to what questions. Those objectives are why research addressing issues related to people's perceptions are important and are applicable to adopting a mental models concept. Some applications of a mental model approach such as communication with the public, supervisory control, manual control, and computer programs' interface designs were described (Rouse & Morris, 1986).

Mental models research mainly targets human cognitive dimensions. For instance, cognitive neuroscience is critical in understanding memory abilities, language processing, speech reproduction, and word recognition. Johnson-Laird (1983) defended mental models theory on the basis of deductive reasoning, a critical concept in learning new ideas. The central idea is not only identifying the critical factors but also the working processes. Many works based on mental model theory have expanded their scope. The goal of environmental interpretation is to communicate a message or it can be thought of as translating a signal (Ham, 1992). Interpreters use appropriate facts to support environmental messages and translate connections between events to visitors. Interpretation is pleasurable, relevant, organized and has a theme (Ham, 1992). Thus, one goal of environmental interpretation would be to promote a concept (e.g., water conservation) and hope that the public makes decisions toward taking appropriate actions (e.g. recycling or supporting pro-conservation policies).

Mental models research is also relevant to understanding decision making processes. Kovacs, Fischhoff and Small (2001) conducted research in understanding perceptions of PCE

(perchloroethlene) use by dry cleaners and dry cleaning customers. PCE is classified by EPA as a possible-to-probable human carcinogen in the United States. In addition, the International Agency for Research on Cancer (IARC) also lists PCE as a probable human carcinogen. However, PCE is still commonly used by dry cleaners in the US. Kovacs et al. (2001) interviewed dry cleaners in Atlanta, GA and Pittsburgh, PA. Dry cleaning customers were recruited at Carnegie Mellon. For the dry cleaners, even though they knew the possible health risks in using PCE and they had alternatives, dry cleaners still used PCE and justified the use with some incomplete or incorrect assumptions. Interviews with dry cleaning customers revealed they had little knowledge or awareness about PCE. By comparing their mental models, a better communication strategy was designed.

Wagner (2007) conducted a study about natural hazards coping strategies. The main purpose of the study was to evaluate if the prepared materials for communicating with the public about flash floods and small landslides are too complex or too easy. The research targeted four communities in the Bavarian Alps area. The expert influence diagram was created based on scientific literature. Mental models of the lay people living in that area indicated that there are big differences between newcomers and residents with longer hazard experiences. The research suggested that personal experience and the visibility of processes are the two main factors in informing the public about natural hazards. Better communication strategies such as good examples, designed exhibitions representing the processes and computer models were recommended to promote better understanding of these two influencing factors.

Conflicts exist because different interest groups might view a particular management tool from different perspectives. This raises challenges for managers. Wildland fire management is an example. Decision makers effectively communicating the risks and benefits of prescribed burns

to local people is an increasingly important aspect of fire management. Zaksek and Arvai (2004) implemented a mental models approach in British Columbia communities to address the understanding of level of awareness of expert and nonexpert stakeholders regarding wildland fire management activities. They interviewed fire management professionals and local residents in the study area. Based on the comparison of wildland fire mental models, several significant gaps were revealed. For example, experts carried a better understanding in terms of environmental benefits of fire management while nonexperts had less knowledge of this aspect. This study played a role in triggering further concerns in that, more than half of the nonexperts mentioned the advantage of adopting education as an effective management tool while only one-third of the experts referred to this. Suggestions for better communication about fire management topics were identified based on this research.

Another example of mental models in action was to characterize people's understanding of climate change. Global climate change is an occurring dynamic phenomena and an exploratory mental models project (Bostrom, Morgan, Fischhoff, & Read, 1994) showed several basic misconceptions in the public's mental models. For instance, many of the 37 interviewees recruited during the annual Pittsburg automobile show were confused about the underlying mechanism of climate change. Also, concepts such as the greenhouse effect or ozone depletion were understood on the basis of both correct beliefs and misconceptions. Following an open-ended interview process, Read, Bostrom, Morgan, Fischhoff, and Smuts (1994) continued exploring these ideas using a questionnaire. Four parts: basic facts, causes, effects, and the effectiveness of diverse policy responses were included in the survey. These four parts were based on previous interview results. Results from the questionnaire provided a better understanding of the essential factors while communicating the critical concepts of climate

change. When designing communication materials on climate change, the role that carbon dioxide plays should be addressed and the effectiveness of communication can be improved.

How effective is the mental models approach in understanding communication gaps? Niewöhner, Cox, Gerrard, and Pidgeon (2004) adopted a mental models approach to examine communicative interventions for chemicals in the workplace. In their evaluation of this approach, they used questionnaires and semi-structured interviews to assess the content and relevance of communicative interventions (Niewöhner et al., 2004). They concluded that the mental models approach, as part of an iterative process, was successful in supporting the design of a better communications plan to educate the public about chemical risks.

Besides risk communication, mental models studies are also found in other domains. Lay beliefs of disease inheritance and genetic testing were analyzed. Three lay mental models were established (Henderson & Maguire, 2000). With these models, some suggestions and communication strategies can be provided to people facing a decision of whether to do genetic testing. Another research example was found in a communication study on pastoralists, researchers and management agencies about views toward rangeland resources. Because the fundamental purposes for rangeland development are different among these groups: pastoralists, researchers and land management agencies held different mental models. Abel, Ross, and Walker (1998) built mental models to examine information and facilitate communication and management for the different stakeholders interested in rangeland landscapes. They argued one advantage of building mental models is not only to identify the influential factors but also to learn reasoning processes.

A characteristic of the mental models approach is creating an environment for interviewees to talk about their beliefs openly, relevant to an issue. Researchers can elicit the primary factors

from a careful conversation. Byram, Fischhoff, Embrey, de Bruin, and Thorne (2001) wanted to acquire women's ideas about breast implants. In this study, the expert model was established based on scientific literature. After analyzing data based on interviews with women, they concluded several points that should be emphasized during communicating with women with breast cancer about potential implant treatments. Even though most women are able to review facts about local complications, improving the understanding of medical terms that are used for describing implants is critical. Also, information about detecting localized implant problems and the possible consequences to direct impacts need to be addressed. Based on the results, recommendations such as creating educational programs for self-monitoring skills, better targeting misconceptions when communicating with women, and other effective communication strategies were suggested to improve the quality of the decision making process.

Is there a general mental model for a target concept? According to Jungermann, Schütz, and Thüring (1991), they assumed that people hold a general mental model for drug effects. They applied the mental models approach to investigate people's understanding of prescription drugs. The information on patient package inserts, physicians' explanations, and pharmacists' suggestions helped form a general mental model of drug effects. However, Wagner (2007) argued against the existence of a general mental model. He targeted people's perceptions of landslides and flash floods. He found that they did not hold a general mental model in these situations.

Breakwell (2001) advocated the role that social influence processes play in individuals' development of mental models about hazards. According to his arguments, mental model development is a process of social construction. Factors such as subculture and social identity can be influential and important in constructing mental models.

Therefore, the study that Fischhoff, Riley, Kovacs, and Small presented in 1998 can be considered as a conclusion for what and which is the best way to provide efficient warning information to the public. They first identified the most critical information that needs to be understood; they assess the public's current beliefs; messages focused on the gaps were designed and evaluated; and an effective information delivery mechanism was developed to draw people's attention.

In this chapter, literature about the mental models approach was summarized. This approach will be used as the guiding framework. Concepts of water conservation behaviors and studies related to informal learning and environmental interpretation were also reviewed, since this study will evaluate an informal educational program targeting water conservation concepts.

CHAPTER 3
METHODOLOGY

The purpose of Chapter III is to describe the methodology used to explore and investigate the mental models Florida Yards and Neighborhoods (FYN) program interpreters (experts), non-FYN participants (Florida homeowners), and FYN homeowner participants possess regarding water conservation. First, a narrative about the FYN program is provided. Second, methods adopted to establish FYN interpreters' mental models are explained. Third, an index used to measure a sample of Florida homeowner's water conservation behaviors is developed. Fourth, Florida homeowners' mental models about water conservation are described. Last, an explanation about the establishment of FYN participants' mental models of water conservation is elucidated.

The present study is focused on understanding the mental models of water conservation beliefs as a means of evaluating the FYN program. A qualitative approach, as Gaskell (2000) mentioned, can explore a range of opinions and different representations of the issues. The particular research interests this study addresses is establishing the mental models of water conservation that experts and homeowners hold. To explore the range of views that people might have, an appropriate methodology should be employed.

Florida Yards and Neighborhoods Program

The Florida Yards and Neighborhoods (FYN) program is an educational program designed by partnerships between the University of Florida/Institute of Food and Agricultural Sciences (UF/IFAS), Florida's Water Management Districts, the Florida Department of Environmental Protection (FDEP), the National Estuary Program (NEP), the Florida Sea Grant College Program, concerned citizens, members of private industry and numerous other nongovernmental agencies. The objectives of this program are to help community residents reduce water pollution,

conserve water and enhance their environment through education and outreach activities that inform their abilities to improve home and landscape management.

In the early 1990s, research by the NEP revealed that decline in water quality (excess nitrogen) around the Tampa Bay area was a serious issue. Urban stormwater runoff was the main reason. Therefore, the Florida Yards Program started to create programs addressing water pollution, water shortage, and impacts on natural environments in the Tampa Bay area. In 1994, the programs were merged and named the Florida Yards and Neighborhoods (FYN) program. Currently, FYN is a statewide program expanding into 48 out of Florida's 67 counties.

Services such as workshops, yards evaluation, and publications are provided in this program. Demonstration gardens for most of the counties are designed as educational exhibits for the public to have first hand experiences in terms of creating water conserved and Florida friendly landscapes. Interpretive signs, guided tours and booklets are designed to enhance visitors' informal learning experiences.

Study Design

The research is a cross-sectional, multi-phase design and included the following stages: expert interviews; creation of the expert model; homeowners' instrument development; non-FYN participants homeowner interviews, creation of the non-FYN participants' mental model; FYN homeowner participant interviews, and the construction of FYN participants' mental model.

Sampling

The sampling strategy for the first stage of this study was purposive sampling. Specifically, Creswell (1998) labeled it "criterion sampling". Interpreters who developed the FYN interpretive program or are trained to lead interpretative tours were the sampling frame for the first stage. The interpreters' names were obtained through the FYN program office. From the list of FYN extension offices, ten offices with demonstration gardens were selected. First contact was made

by the FYN program director via e-mail. After the first contact, an e-mail invitation was sent to the interpreters (n=10). From those who responded, an appointment was made to visit each of them at a convenient time and place. As a result, nine FYN interpreters were interviewed.

For qualitative research, Creswell (1998) suggested between five and twenty-five interviews. Heterogeneity and research objectives are two criteria Kuzel (1992) used when he discussed the sample size needed for qualitative research. He recommended twelve to twenty participants for achieving the maximum variation. Maharik and Fischhoff (1993) tested a number of new concepts encountered in mental models interviews. They suggested that the first ten to fifteen interviews conducted can result in a rapid increase of new concepts. Around twenty to thirty interviews will likely approach a plateau in terms of generating new concepts (theme saturation). Limitations in funding and cooperative interpreters restricted the number of experts interviewed in this project to nine. For non-FYN participants Florida homeowners' interviews, convenience sampling based on a referral strategy was adapted. Several initial homeowners that were recommended by the researchers' graduate committee were interviewed and then asked to refer the researcher to other acquaintances who they felt might cooperate with an interview. Contacts were made to acquire their agreement with participating in the study. Before conducting face to face interviews, screening questions regarding whether they had any awareness of the FYN program and basic demographic information were asked. A face-to-face interview was conducted at a convenient time and place. Consequently, twenty homeowners were interviewed for this study.

The third group was FYN participants. Purposive sampling was applied to this group. A telephone list of FYN participants was obtained from the Citrus County extension office. A letter with Citrus County extension letterhead was mailed to those on the list. One week later, a phone

call was made to select individuals (n=46) on the list to acquire their agreement to participate in the research. As a result, ten face-to-face interviews were administrated at convenient times and places.

Stage 1: Creation of the Expert Model

Based on previous mental models research (e.g. Morgan et al., 2002), in order to clarify the major themes and causal factors influencing water conservation behaviors during an interpretive process, developing an expert model is the first step. Here the term "expert" refers to people who developed and are conducting the interpretive programs. It does not imply that experts' beliefs are perfect or greater than lay people (homeowners). To build the experts' mental model, a textual analysis focusing on water conservation concepts, the main factors influencing water conservation behaviors and the effects of taking water conservation actions were abstracted from a discussion held with each expert. The benefits of analyzing texts in research are addressed by Lincoln and Guba (1985): the stability of information, the contextual relevance, the richness of information, and the natural language of the setting. An open-ended interview question protocol (Appendix A) was established and approved by IRB. FYN educators were interviewed based on that interview protocol.

The expert model is represented as an influence diagram in chapter 4 (Howard & Matheson, 1981) (Figure 4-1). An influence diagram is a graph with arrows to connect related "nodes" to reveal interrelated holistic factors. There are two kinds of nodes: ovals represent factors that play a role in affecting water conservation behaviors; and rectangles represent suggested actions that can achieve water conservation goals. The node on the arrow tail side can have some influence on the node on the arrow head side.

Expert Participants

Table 3-1 is the interviewed FYN interpreters' list. As shown here, the participants were seven females and two males. They covered nine county extension offices in Florida. Those participants were given information about this research and the researcher's contact information. They could have withdrawn their participation if they chose to in compliance with IRB guidelines.

Table 3-1. List of Expert Participants

No.	Pseudo Name	Gender
1	Julie	Female
2	Mary	Female
3	Amy	Female
4	Robert	Male
5	Jennifer	Female
6	Cathy	Female
7	Alan	Male
8	Linda	Female
9	Barbara	Female

Stage 2: Instrument Development

A water conservation self-reported behavior index was developed using a Delphi method. The Delphi method is a systematic strategy for collecting information from a group of people (Clayton, 1997). Moore (1987, p 15 – 17) provides four reasons why using a group of people rather than an individual is more desirable in conducting social research: 1) it is logical that if you properly combine the judgments of a number of people, you have a better chance of getting closer to the truth; 2) it is desirable to use groups in order to understand social phenomena by obtaining the views of the actors; 3) it is often beneficial to use groups if you are concerned about the consequences of your research; and 4) complex, ill-defined problems often can be addressed only by pooled intelligence. The index was used as a weighting approach to categorize

participants into a high water conservation behavior group and a low water conservation behavior group.

In order to develop this index, an email was sent to the nine FYN experts asking "could you please name five concrete water conservation actions that you are taking?" Seven of them replied to the email and some of them listed more than five items. After this first round, forty water conservation action statements were listed from their emails.

Grouping and categorizing those forty items into an index was the next step. First, similar items were combined together. Next, if an item was mentioned three or more times, it was kept in the index. A new 11-item table (see table 3-2) was then prepared for the next round.

One week later, another email with the following question: "how important do you think the following water conservation behavior items are?" with a 7-point response scale (1=not at all and 7=extremely) was sent to the seven experts for them to weigh the items.

Another week later, all seven weighting tables were collected from the experts. The mode for each item was calculated (table 3-2). A clear mode is one reason to keep an item. Unlike a scale where similar scores are called "effect indicators"; in an index, a set of items with similar scores are called "cause indicators" that determine the level of a construct (DeVellis, 2003). If more than five experts rank an item with a higher score (5 to 7), the item should be kept. Moreover, Sommer and Sommer (2002, p.167) discussed the preferred number of items for a scale or index. Ten to twelve items seem preferable. Therefore, item six was deleted (there is no clear mode for this item) in creating the final index. A 10-item index was developed for measuring participants' water use behavior, based on the water conservation actions the interpreters reported that they considered as important actions.

Table 3-2. The 11-item Water Conservation Actions for Experts to Weigh and Mode.

	Not at all ←----------→ Extremely							Mode
Statement	1	2	3	4	5	6	7	
1. Shorten your showers		1			2	4		6
2. Run only full loads in the washing machine and dishwasher		1			1	1	4	7
3. Water plants only as needed						1	6	7
4. Fix leaky faucets and plumbing joints					1	1	5	7
5. Plant drought-tolerant plants				1	3	2	1	5
6. Use a rain barrel to collect rain water and use it to water plants		1	1	2	2	1		4, 5
7. Have a shut-off device on irrigation system					1	1	5	7
8. Wash car efficiently, park it on the grass and use a hose		1		1		4	1	6
9. Hand watering ornamental plants			1		3	2	1	5
10. Shut off tap water when not using it		1			1	1	4	7
11. Install water-saving shower heads or flow restrictors					2	2	3	7

This is a two-dimensional index. Each item in the index has a weight associated with the level of implementing that water conservation behavior. The index is measured by a 5-point Likert scale (see Appendix B). Since the weight of each item is calculated from a group of experts' opinions, a total score for each participant from non-FYN homeowners and FYN homeowner participants can be obtained. There is no statistical test of inter-item reliability for indexes. Face and construct validity is the basic quality measure for an index. Face validity is the extent to which a specific set of items reflects a content domain (Bryman, 2004; DeVellis, 2003). Construct validity is directly concerned with the theoretical relationship between two variables.

Before applying the index to non-FYN homeowners and FYN homeowner participants, a pilot test of the items was given to 83 college students. Cronbach's alpha determining whether

the items are related for combining into an index was calculated (Bryman, 2004). In terms of the internal consistency reliability of an index, an index should consistently reflect the construct it is measuring. Cronbach's alpha is the most common measure of scale reliability (DeVellis, 2003; Field, 2005). Cronbach's alpha is equivalent to the average of all possible split half correlations, though we would never actually calculate it that way. Cronbach's alpha is mathematically equivalent to the average of all possible split-half estimates. The widely-accepted social science cut-off is that alpha should be 0.70 or higher for a set of items to be considered a scale, but some use 0.75 or 0.80 (Santos, 1999). The pilot study revealed that the Cronbach's alpha for this index was 0.74.

An inter-item correlation was calculated for the ten items utilized during the initial pilot test. Three items (shorten my showers, run only full loads in the washing machine and dishwasher, and shut of tap water when not using it) had low inter-item correlations. However, the Cronbach's alpha would not be increased very much by deleting those three items, so they were retained.

Stage 3: Creation of Non-FYN Participant Homeowners' Mental Model

On the basis of the experts' mental model, an interview protocol targeting non-FYN participants (Florida homeowners) was established (Appendix C). The protocol was centered on the major themes abstracted from the expert model. Also, a checklist developed on the basis of the expert model was constructed. The first interview question was intentionally general and broad regarding water conservation variables (Willis, 2005). Follow-up questions were more and more specific based on their previous answers. Interviews were in a conversational style. Efforts were made to prompt participants to talk as much as possible related to water conservation variables. This is the basic strategy of a mental models approach (Morgan et al., 2002). All of the interview questions were asked in the same order. However, Willis (2005) discussed developing

verbal probes in conducting interviews. Verbal probing is an interview strategy. An advantage of verbal probing that Willis (2005) mentioned is that it assists the interviewer in keeping control of the interview. The interviewer maintains some level of flexibility regarding asking probing questions and in sustaining an interactive atmosphere. In addition, adopting a verbal probing strategy can help reveal relevant problems and the respondents can more easily understand and answer those questions (Willis, 2005, p.55). Each interview lasted about 30 minutes (Morgan et al., 2002).

Participants

Table 3-3 presents the non-FYN participant homeowners' list. As shown there, the participants were twelve females and eight males. Same as the FYN interpreters, these participants were given information about this research and the researcher's contact information. They were informed that they could have withdrawn their participation if they chose to.

Table 3-3. List of Non-Florida Yards and Neighborhoods (FYN) Participant Homeowners.

No.	Pseudo Name	Gender	Education	Years in Current Residence
1	Helen	Female	Completed graduate or advanced degree	20 years
2	Alice	Female	Some college or 2 year degree	5 years
3	Bill	Male	Attended business/technical school	12 years
4	Peter	Male	Completed 4 year college degree	6 years
5	Emily	Female	Completed 4 year college degree	11 years
6	Claudia	Female	High school diploma	4 years
7	Ryan	Male	Completed 4 year college degree	2 years
8	Lily	Female	Completed graduate or advanced degree	8 years
9	Sam	Male	Completed 4 year college degree	6 years
10	May	Female	Completed 4 year college degree	5 years
11	Gary	Male	Some college or 2 year degree	2 years
12	Sherry	Female	Attended business/technical school	2 years
13	Connie	Female	Completed graduate or advanced degree	6 years
14	Anna	Female	Completed graduate or advanced degree	1 year
15	Liz	Female	Completed graduate or advanced degree	6 years
16	Luke	Male	Completed graduate or advanced degree	6 years
17	Kevin	Male	Completed graduate or advanced degree	3 years
18	Gina	Female	Completed graduate or advanced degree	3 years
19	Alex	Male	Some graduate work	22 years
20	Fiona	Female	Completed graduate or advanced degree	15 years

Stage 4: FYN Participants' Mental Model

A list of FYN participants was provided by the Citrus County Extension office. Table 3-4 is a list of FYN participants for this study. The participants were seven females and three males. Those participants were given information about this research and the researcher's contact information. They were informed that they could have withdrawn their participation if they chose to.

Table 3-4. List of FYN Participants

No.	Pseudo Name	Gender	Education	Years in Current Residence
1	Pearl	Female	Some college or 2 year degree	39 years
2	Kate	Female	Completed 4 year college degree	1 year
3	Richard	Male	Completed graduate or advanced degree	11 years
4	Dan	Male	Attended business/technical school	1 year
5	Sally	Female	Some graduate work	15 years
6	Ruby	Female	Some college or 2 year degree	4 years
7	Nina	Female	High school diploma	9 years
8	Christine	Female	Completed 4 year college degree	33 years
9	Paul	Male	Some college or 2 year degree	5 years
10	Dolly	Female	Some college or 2 year degree	1 year

Interview Process

The experts' interviews roughly followed the interview protocol in Appendix A. The actual topic sequences of questions varied as the interviewee provided specific answers. For the non-FYN homeowner participants and FYN homeowner participants' interviews, a water use behavior index and some demographic questions (Appendix B) and the interview protocol (Appendix C) were applied in a more structured way. In order to overcome some possible initial responses such as "I have little idea about water conservation.", Kovacs et al. (2001) suggested that some might simply guess. To overcome this possible limitation, a short list of water conservation behaviors was administered (Appendix B), to "prime the pump" or to center the discussion on ideas that this research intended to focus on to trigger people's thoughts of the

target concept (in this study, water conservation). However, there is an issue related to implementing the questionnaire prior to the mental models interview. This will be discussed in chapter five, in the limitations section.

As shown in Appendix C, the first question for non-FYN participant homeowners and FYN participants was "When I say water conservation, what comes to your mind?" Interviewees were encouraged to talk as much as they could. According to the interview situation, interviewees were told not to worry about the correctness of their conversation. Some basic prompts utilized are listed in Appendix C. After this general question, depending on what kind of concerns or variables they mentioned, a more in depth discussion was encouraged. The order of interview questions was flexible to keep the flow of the conversation as natural as possible. If some variables listed (on the interview guide (appendix C))were not mentioned by the interviewee, further prompts such as "Have you heard of any other factors that might influence the water situation?" or "Can you remember anything else other than what we already discussed?" were used. The interview template also served as a checklist for the interviewer. If a specific variable was raised, a checkmark was marked on the interview script.

Data Analyses

Miller and Crabtree (1999) described the analysis process for qualitative research as like a dance between the investigator and the data. Five phases: describing, organizing, connecting, corroborating/legitimating, and representing are occurring repeatedly during the interpretative process. In this study, three data formats: the question template, the notes taken, and audio taping during the interview were used to facilitate analyzing and presenting the results. Moreover, the index developed for this study also served a role in triangulation. Patton (2002, p. 247) discussed the benefit of triangulation: "Triangulation strengthens a study by combining methods. This can mean using several kinds of methods or data, including using both quantitative and qualitative

approaches". Multiple data sources, methodological triangulation, and multiple investigators can be used to improve research creditability.

Interviews with experts, non-FYN participant homeowners, and FYN participants were audio taped and transcribed. In addition, note-taking and reviewing across interview results were applied to improve the quality of analyzing interview themes (Willis, 2005). Data collection and data analysis were concurrent to improve reliability and validity (Morse et al., 2002). For the interpreters' interviews, the transcripts were coded and categorized into main themes. In order to create an influence diagram, the assembly method was adopted (Morgan et al., 2002, p.44). In essence, this method means the preparation of a list of relevant factors (the main themes from the interpreters' interviews) and uncovering how they related to each other.

In terms of coding non-FYN participant homeowners' and FYN participants' interview transcripts; particular attention was paid to statements and issues related to the previously abstracted expert model. The expert model served as a coding template for coding visitors' interview results (Morgan et al., 2002). The frequency of any single topic that the public discussed was counted during the analysis phase. Each statement from non-FYN participant homeowners' and FYN participants' interviews was attempted to be connected to one node of the expert influence diagram by the researcher. Those statements which were difficult to associate with any expert model node probably reflect different routes that lay people use to understand water conservation concepts.

Another independent investigator was asked to transcribe one of the interviews. This is a form of investigator triangulation. A comparison between the transcripts of the two researchers added more rigor to this study. Fisher's exact tests were conducted to test for significant differences across each of the main themes between the non-FYN participant and FYN

participant samples. The interviewer was the only person categorizing responses onto the coding sheet in order to assure the reliability and consistency of data coding. The results of applying these methods are presented in the following chapter.

CHAPTER 4
FINDINGS

The purpose of this study is to explore mental model frameworks to better understand water conservation attitudes and behaviors. This study targets Florida Yards and Neighborhoods (FYN) program interpreters, Florida homeowners and FYN participants to decipher their water conservation mental models as well as reveal differences between these three groups. This study was conducted and the data analyzed using a qualitative methodological design. Face-to-face interviews were conducted with all three groups and a water use behavior index was developed and applied to both Florida homeowners and FYN participants groups. The following sections present results gathered from these instruments.

Expert Mental Models

As with previous mental model research efforts, this study began with the construction of an extensive mental model which attempts to explain key water conservation concepts on the basis of face-to-face interviews with nine FYN interpreters. The nine experts were based in the following nine Florida counties: Alachua, St. Johns, Putnam, Citrus, Brevard, Hillsborough, Sarasota, Charlotte and Lee. Five of these counties are located on the west coast of Florida, two of them are on the east coast, and the two are inland counties.

Figure 4-1 represents the comprehensive expert water conservation mental model. This model uncovered four water conservation education themes as reported by interpreters: 1) consequences, 2) resource aspects, 3) contributing factors, and 4) actions. Then, subthemes related to each theme were also identified.

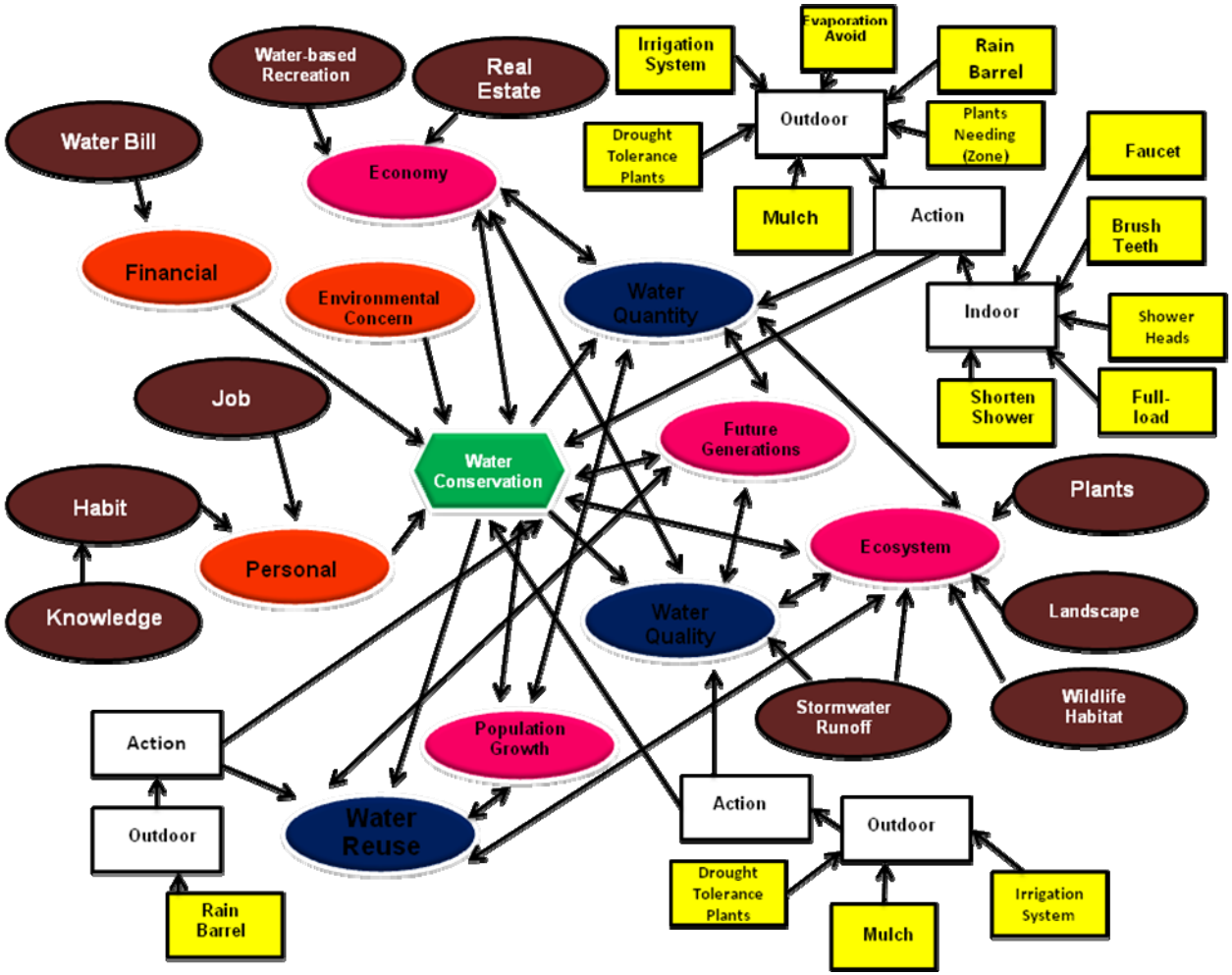

Figure 4-1. Comprehensive Expert Mental Model of Water Conservation.

Consequences

Consequences is the first theme that emerged from the expert interviews. The four subthemes of consequences are: 1) *population growth*, 2) *economic concerns*, 3) *future generations*, and 4) *environmental concerns*. Here is an example of the *population growth* subtheme:

> As it relates to Florida, water conservation is perhaps the most important natural resource issue that we face right now. As the state has grown over the last twenty years, the population has increased 50%. (Robert)

> We don't have much water now, as much as we had thousands of years ago. But we have many more people using it, so we need to be aware of conserving it. Water is so valued you cannot live without for 3 days, so we need to take care of the water supply; for many reasons the supply is the most important. (Cathy)

Population growth was mentioned as the major consequence as the importance of water conservation was discussed with the educators. Since Florida has had a very high and growing population, all the experts interviewed about this issue believed that providing sufficient drinking water will be a problem in meeting the needs for future Florida populations.

Experts also reported considering the *economic* situation in Florida. They discussed issues such as water-based recreational activities and real estate development.

People's recreational needs are mentioned:

> People travel here [Florida] and move here for fishing, boating, and swimming. These recreational activities that are here ought to be good. (Jennifer)

Given the fact that tourism is a major contributor to Florida's economy, water-based recreational activities are considered to be related to the economic consequences of water conservation.

Real estate development is another concern. Experts discussed that developers should be required to take water conservation into consideration when they build new houses in Florida.

> If developers present a plan for a given residential community in Florida, they have to demonstrate where they are going to get the water from. If the water is not available, they cannot develop the community…. He is going to have to have an estimated amount of water to support his plan. (Robert)

The educators believed a water conservation plan can be important for home developers to consider. The real estate industry will be affected by potential future water shortages.

The concern for *future generations*' water needs was also mentioned by educational experts.

> Water conservation is good. The water is going to be there for future generations. For a long time, we also have better quality of water as a result. (Linda)

> I will say we need water for our future generations. (Amy)

Water conservation also elicited experts' discussions about *environmental concerns*.

> As far as the eco-system and for keeping the eco-system functioning, the water needs to always be there. If we can keep those natural systems and keep those areas in a sustainable status, it is really important. (Linda)

> Saving [water] is very good not only for people themselves but for the environment. (Alan)

When considering ecosystems, four major factors were mentioned by experts: plants, wildlife habitats, landscape planning and stormwater runoff.

> There is no reason we should over-water our plants. If you over-water our plants, there will be some root diseases and other diseases related to over-watering. (Alan)

> If you do water conservation properly, like in our program, there is a principle talking about attracting wildlife. You can actually protect the environment and wildlife habitats…. There is a need to preserve our environment. (Barbara)

> My specific thinking (about water conservation) is about stormwater runoff and using collected rain water on the landscape when it is possible also on the landscape itself. (Jennifer)

Resource Aspects

Resource aspects is the second theme abstracted from experts' interviews. These interviews were intended to understand how people perceive the concept of water conservation and what they know about water conservation. From the experts' interviews, water conservation

was viewed within three subthemes: *water quantity*, *water quality*, and *water re-use*. The idea of *water quantity* was mentioned by all experts. Here is an example:

> Well, first thing comes to my mind is, it is everybody's issue and it is a major issue for inside and outside the house. It is an issue that has to be learned. You cannot take it for granted any more. People should learn how and they should save water. (Alan)

The second subtheme elicited from experts' interviews was *water quality*. The quality of our drinking water was discussed related to water pollution, over-fertilization, and stormwater runoff which are all related to water quality. Barbara talked about water quality:

> You may probably have heard about runoff. The more water you use for irrigating plant systems, the more likely it is that pollutants somewhere get kicked away by the runoff into the waterway eventually and cause all kinds of problems.... So here we have some kind of algae problem in the bay which may be not caused by the runoff but the runoff contributes to it. So for the preservation of natural resources that's the demand thing. (Barbara)

Barbara is concerned about the relationship between irrigating landscapes properly and water pollution. There are some related problems such as algae which can cause serious water quality problems. Julie also commented that over-watering can cause water pollution problems:

> A lot of times I just see wasting going on. It is just people don't know that their system is not working or leaking. Then also watering can make pollution stronger. So that the excess water can carry pollutants like fertilizers and pesticides, et cetera. (Julie)

The last subtheme about water conservation dimensions is *water reuse*.

> You know we talk about utility water that comes straight for use. The second one is well water. The third source is reclaimed water. So that is really basic water that went through the process. That is still not good enough to drink, but it is good enough to use for irrigation. Reclaimed water should be used for irrigation only, not for indoor water use. (Barbara)

Reclaimed water is one source of water. The idea behind this description is people can take the biggest advantage of reusing water, since water is a renewable resource. Such use also encourages taking the water cycle into consideration while using it.

Contributing Factors

The third theme that emerged from the experts' interviews is contributing factors. These contributing factors determine or are related to their water conservation behaviors.

Thinking from a *financial* perspective, water conservation behavior is related to water bills and can save money. Jennifer talked about financial aspects related to her water use behavior.

> I think my personal behavior that will save water to a certain extent is based on the financial aspect. Part of common sense is that water conservation can save you money. I have all drought tolerant plants, so I don't need to water them at all. My water bill saves a lot and that make sense for me. (Jennifer)

Another perspective is *environmental concern*. They value environmental issues and care about that topic.

> I think environmental conservation is always a value of mine. (Linda)

> I am concerned for the environment in general. I think that is basically the main thing. (Barbara)

> Doing the right thing for the environment is number one. Modeling the right thing to my child and, I would think money as one thing. The financial consequences are pretty affordable. (Julie)

Julie's words include many aspects of contributing factors. *Personal reasons* can also add to experts' water use behaviors. They want to be a role model for other people since their career is actually related to promoting water conservation. Here are some examples:

> The main thing is that I have to practice what I teach. I have to tell people you need to do those things. (Amy)

> Caring about a basic necessity; I have water and that is my driving force. I like to do my part. Since I teach, I think it is important to practice while I teach. (Robert)

They also consider a habit of not wasting as an influencing factor about their water use behaviors. Moreover, they attribute this habit to their knowledge about water.

> Number 1 I think there will be no waste. Certain times, I see people take actions about their landscape just for personal satisfaction. Also, people are interested in and knowledgeable about the environment. They will be able to give help a little bit. Another

> thing is you can still have a beautiful landscape while doing this thing. That will also be good and let you be satisfied about a landscape you created. (Jennifer)

Actions

The last theme abstracted from experts' interviews is water conservation actions that people can take. Predictably, experts provided a lot of actions that people can implement at home. They talked about actions outside their homes and indoor actions as well. All of these actions are related to those three subthemes which were mentioned above: *water quantity*, *water quality*, and *water reuse*. Non-controlled irrigation systems which will waste a lot of water are a major concern for experts. They suggested grouping plants and separate zones for different plants depending on the plants' needs; with a special concern about irrigation systems; planting drought-tolerant plants (native plants in particular); watering plants in a specific time period to avoid evaporation; using mulch to cover soil and retaining soil moisture; and using rain barrels to collect rain water. Here are some examples:

> There are a lot of things people can do inside or outside the house to help reduce water use. I will say they can do a lot in landscaping. And as we try to demonstrate, they can still have mulch and beautiful landscape without using so much water through the program. We teach them the right plants in the right place, and we teach them using mulches that conserve water in the soil. You know "proper places for proper plants" is really critical. Again, that is the most sustainable solution. (Robert)

> I encourage people including myself to use organic matter to increase soil water capacity so you will not need to irrigate so much. I also encourage people and also myself to use the most efficient system available and make sure I am not watering the driveway or sidewalks. (Julie)

> Using collected rain water on the landscape when it is possible. Calculate the irrigation system to reduce wasted water. Use and choose plants wisely and use water carefully. (Jennifer)

> Outside if you have a garden, remember to use the shut-off, check the hose, have a rain barrel that you can collect the rain water in. Those are some things people can do. And plant dry-tolerant plants. They do not require so much water. (Cathy)

Besides those actions that experts suggest the public take to conserve water, they also mentioned some indoor tips. Most reported doing these behaviors at home as well.

> I try to limit using the toilet. I never let my water run while brushing my teeth or washing dishes. Those are the personal actions I am doing. (Robert)

> I turn off water when brushing my teeth. I might use hand wash instead of using dish washer when my dishes are not that many. I try to minimize my laundry use, but I take long showers. (Julie)

In terms of *water reuse*, one specific action that experts mentioned is using rain barrels to collect rain water and use that for gardening.

> Use rain barrel for collecting water, we tell people how to get water savings outdoors….that's probably one of the simple things that people can do. That is probably one of the easiest behaviors that people can do. They can look attractive and look like they are into the environment. (Alan)

These FYN educators stated the active idea of conserving water. From a landscape design perspective, they also promoted painting or designing rain barrels to decorate yards which can demonstrate the concept that having a rain barrel will not destroy a whole landscape design.

Non-FYN Participant Homeowners

On the basis of the FYN educators' water conservation mental model, an interview template was developed. Twenty Florida homeowners without any training from Florida Yards and Neighborhoods program were asked their perceptions about water conservation. An overview of what they said about water conservation is summarized in this section.

Variables presented in figure 4-1 were included in the interview process. If interviewees were not able to mention any single variable, verbal probes were used. While analyzing the interview results, each variable presented in figure 4-1 was counted if a discussion about a variable with an interviewee was raised. Some other variables mentioned by homeowners but not FYN educators were listed separately. Figure 4-2 presents non-FYN participant homeowners' aggregated mental model of water conservation. Each theme is presented in the same color

scheme. In interpreting Figures 4-2, 4-3 and 4-4, be aware that the size of the polygon and darkness of the color representing a concept; is an indication of the percent of respondents who mentioned that concept. Thus, the smallest ellipse and lightest colors, represents a concept mentioned by 1-25% of respondents, the next size ellipse and slightly darker shade of colors represents 26-50% of the respondents mentioning that concept; the next larger ellipse and next darker shade of colors represents 51-75% of respondents raising that concept and the largest ellipses and darkest colors represents 76-100% of the respondents mentioning that concept during the interview. Also, the resource aspects are represented in blue shades; the action aspects are represented in yellow shades; the consequences are represented in pink shades and the contributing factors are represented in orange shades.

Resource Aspects

Instead of talking about the consequences of water conservation, the first theme that emerged from non-FYN participant homeowners' interviews was "resource aspects". Specifically, "*water quantity*" is the subtheme they raised about water conservation. All participants first mentioned about saving water and using it only when you need it, when the term "water conservation" was mentioned. Later on, several of them talked about "*water quality*". They expressed concern about pollution of drinking water having medical effects.

> Saving water. And not wasting it. (Connie)
>
> Saving water and using water in an efficient way. (Sam)
>
> I guess when I think of conservation, I also think keeping pollutants out to keep as much clean water available as possible. So I think about the eutrophication, detergents, and clean products. (Fiona)
>
> I heard about one thing. Some women cannot have a baby. They cannot be pregnant because of water. Some other women took a lot of pills to not to be pregnant [birth control pills]. They took the pills and then pissed. The chemical will contaminate water. It is very much a shock to me. After women drink the polluted water, they cannot be pregnant [any more]. (Anna)

Also, a few non-FYN participants mentioned *water reuse*. Some verbal probes were attempted asking if they ordinarily store water. *Water reuse* was brought up by only one participant prior to being prompted. He stated that he uses buckets to collect rain water to water his yard. Another interviewee talked about *water reuse* after probing. She has some buckets near her sink and uses the collected water to water her plants as well.

> I sometimes keep a bucket in my sink. I use water from the bucket to water my plants. (Alice)

Consequences

The second theme discussed was consequences. Most non-FYN participants valued the importance of water conservation. Some of them expressed concern about *future generations* and the *ecosystem* as two main subthemes in terms of consequences. They mentioned landscapes, plants, wildlife habitats, and stormwater runoff. They hope to have the same river available that they used to have in their childhood.

> We don't want to waste because we want to keep it [water] for everybody. We keep it for our generations in the future. Why use it when you don't need it? (Lily)

> I have lived in Florida for a long time. I used to go down to Ichetucknee River near the 60's and still occasionally go once or twice a year. What I remember as a child or a young adult was the river had what they call bubble fields around the bottom. …There are so many places that the bubbles just came out. It is still an amazing place, but I can see the water pressure has decreased. Generally, the rivers are lower than they used to be. So I think human uses are hurting a lot of our underground waters and hurting our springs. (Alex)

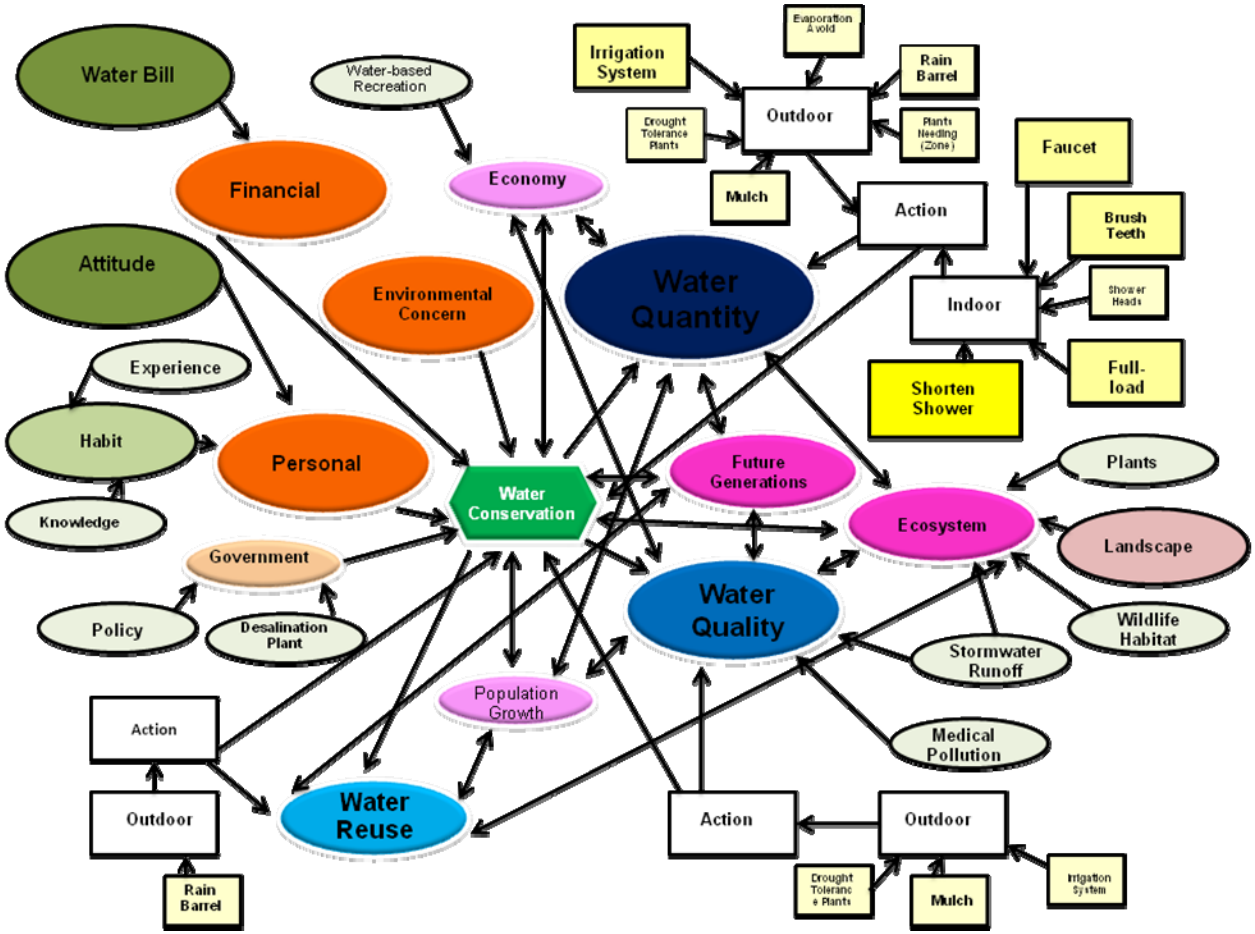

Figure 4-2. Non-FYN (Florida Yards and Neighborhoods) Participant Homeowners' Mental Model of Water Conservation

Surprisingly, people mentioned *economic* consequences less than *ecosystem* aspects. Only a few non-FYN participants discussed water-based recreation activities as a factor that related to Florida's economy. One interviewee did mention scenery and the beautiful green landscape that Florida has, as one important consequence, as it is the biggest thing that attracts visitors to Florida. She stated that tourism is a key industry for Florida. To keep the green landscape, water is critical. She expressed concern that water conservation might limit Florida's tourism business. Furthermore, another interviewee addressed tourism as a big water consumption industry. Hotels and golf courses require a lot of water to maintain their business. All these businesses contribute to Florida's economy. Moreover, one of the homeowners mentioned cattle and farming technologies as main factors related to Florida's water consumption. However, plant agriculture is also an essential industry for Florida's economy. No non-FYN participant homeowner raised real estate issues as related to water conservation.

> From the very beginning, people came to Florida because of the beauty of Florida. That is what our economic basis is. It is tourism. (May)
>
> We also have a lot of problems about farming technology. Farming techniques we are using are tending to increase runoff and not enabling water to seep back into the land. We also have the pesticide usage just growing which tends to waste water. In Florida, there are a lot of golf courses and recreation that use a lot of water. We have cattle in Florida, cattle use a lot of water. To raise any kind of meat, we use a lot of water. (Helen)

A few participants discussed *population growth* while talking about the importance of water conservation. Before probing, participants indicated that water is a precious resource and we might run out of water. After probing, few homeowners recognized that population growth was a major issue related to water conservation.

Contributing Factors

Predictably, *financial* aspects were mentioned by many non-FYN participants. They understood that saving water could also save on their water bill. One non-FYN participant took

the recent gasoline price increases as an example; he believed if Florida water prices increase one day, people will start to learn more tips to reduce household water use.

> Saving money, that is the first thing. (Liz)

> Money. Certainly, it costs money to use water. (Ryan)

Another contributing factor was *environmental concerns*. Several homeowners perceived this as a contributing factor to their water use behavior. They valued natural resources and some of them also thought about global warming. Here is an example:

> We cannot run out of water. Some of the species will die if we cannot have enough water. We have a lot people and we need to eat. I am not sure if the global warming thing will affect water, but I think about that as well. (Emily)

Even when the homeowner could not specify the effects of global warming to water issues, global warming still came up while discussing environmentally related topics.

One non-FYN participant did not consider water conservation as an important issue currently. From his perspective, he believed that it rains a lot in Florida especially during the hurricane season. For Florida in particular, water is sufficient from his perspective. However, upon considering financial aspects of using water, he still appreciated water saving behaviors and applied some water saving tips at home.

> I think in Florida it [water conservation] is not important. The importance is about the bill. Because it rains a lot conceptually we should not worry about water too much. We don't have any experience that we have to shut off the system. We don't have that worry. That is why it is not important. (Luke)

Not surprisingly, *job* related reasons were not mentioned by non-FYN participants while considering contributing factors in their water use behaviors. In terms of *personal* aspects, many homeowners regarded saving water as a *habit*. Few of them discussed their knowledge of not wasting water. They also talked about their previous experiences associated with droughts and sinkholes. Alice identified her previous sinkhole experience:

> Because I have a lot of experiences with sinkholes, I realize whenever you put something in the water; it goes down to the aquifer….The aquifer is not just under Citrus County. Whatever goes to the aquifer, it can go to the Gulf of Mexico and that will affect everybody. (Alice)

Another factor abstracted from homeowners' interviews related to *personal* aspects is *attitudes*. Many non-FYN participants mentioned that they hate waste. They also hate seeing other people's wasteful behaviors. Non-FYN participant homeowners described their observation of neighbors' outdoor water use behaviors. When their neighbors turn on their irrigation system without any time limitations, they dislike that and want more control over that kind of behavior.

> For example, across the street, they have a sprinkler system. They turn on the sprinklers and they run it for three hours a time, maybe four. The thing is to saturate [soil] and you turn off. They just constantly run it. (Claudia)

Therefore, *government* played a role in our conversations. Some non-FYN participants talked about water use policy. They thought the government should have more restrictions on companies related to waste water management. Moreover, some of them supported policies related to personal water use limitations. One interviewee mentioned the inconvenience of personal water regulation. She believes that the government should have better water use plans instead of limiting the public's personal water use behavior. She mentioned about reservoir or dam construction plans to store water. Desalinization plants were also raised by homeowners. In order to provide cleaner, drinkable water, they have heard about desalinization plants. They cannot specify any details about those plants, but this idea was mentioned by a few of them during the interviews.

> We can encourage through lots of policies that business will start to change their technology. (Helen)

> I think Florida has to be responsible for Florida. It has to start from the top [government]. They have to find a solution and they have not done that for years. (May)

> If everybody uses water more efficiently and with more concerns, we don't need to turn on the desalination plants. They cost money. It would be a shame to have to use them. We can use proper water conservation. (Lily)

Actions

Water conservation actions that people can take was the last theme discussed in the interview process. For most non-FYN participant homeowners, those indoor actions included "turn off your faucets while not using them", "turn off water while brushing your teeth", "wait for a full-load to operate the dish washer and washing machine", and "shorten your shower time" (also mentioned by experts, as previously noted), are currently being applied in their homes. Some of them changed their shower head to a water efficient version. Those actions related to the subtheme of "*water quantity*".

> I try not to turn on water fully. I try to wash my hands as quick as possible so I don't need to waste water. (Gina)

> I already changed my shower head. For my sink, I check any leak. (Kevin)

In addition, outdoor actions such as utilizing mulch to retain soil moisture was not described by most non-FYN participant homeowners. Some of the non-FYN participants described their irrigation systems, sprinklers, and their procedures in watering their yards. They follow weather forecasts to decide if they need to water their plants. Timers or sensors are used to facilitate determining their gardening behavior. Some even decided to not have an irrigation system but use a hose instead. For most of them, they report only watering their yards once a week. Some homeowners mentioned the variable of zoning for plants and the idea of avoiding high evaporation. These are some actions related to "water quantity" and "water quality" that were mentioned.

Consistent with the statement that only a few people talked about "*water reuse*", the action of using rain barrels to collect rain water was mentioned by only a few non-FYN participants. Some used the term "bucket" instead of rain barrel to explain their "*water reuse*" behavior.

For the *water quality* category, the idea of using mulch, and adjusting irrigation systems related to *water quality*, while the idea of planting drought-tolerance plants was not commonly mentioned in non-FYN participant homeowner interviewees.

FYN Participants' Mental Model

Ten FYN participants from Citrus County were interviewed to discuss their perceptions of water conservation. The interview template was the same as for the homeowners'. The following sections are a summary of the conversations. Figure 4-3 is a presentation of their aggregated mental model. As with the non-FYN participant homeowners' mental model, a similar color scheme and box size is used to present each variable based on the frequency. Same as figure 4-2, the size of the polygon and the darkness of the color representing a variable; is an indication of the percent of respondents who mentioned that variable. Thus, the smallest ellipse and lightest colors, represents a concept mentioned by 1-25% of respondents, the next size ellipse and slightly darker shade of colors represents 26-50% of the respondents mentioning that concept; the next larger ellipse and next darker shade of colors represents 51-75% of respondents raising that concept and the largest ellipses and darkest colors represents 76-100% of the respondents mentioning that concept during the interview. Also, the resource aspects are represented in blue shades; the action aspects are represented in yellow shades; the consequences are represented in pink shades and the contributing factors are represented in orange shades.

Resource Aspects

Similar to the non-FYN participant homeowner group, water conservation reminds the FYN participants about saving water. All of them consider using water only when they needed it.

Additionally, almost all of them talked about *water quality*. Some of them discussed stormwater runoff and non-controlled fertilizer use in yards impacting water. Some of them mentioned a video related to Florida's water system played in the FYN course. That video really made an impression on them. Concerns about Florida *water quality* were also influenced by the video.

Some of them also expressed their ideas about *water reuse*. They described the rain barrel classes in the FYN program. For those who talked about *water reuse*, no verbal probing was used in the conversation.

Actions

Most FYN participants were eager to talk about water conservation methods. Actions that people can take for water conservation came to their minds. They shared methods such as using their irrigation systems efficiently, their enthusiasm to plant Florida native plants, and how they designed their yards based on plants' watering needs. Recall of those outdoor water conservation behaviors was common for these FYN participants. Many of these methods as explained in the expert model are used for controlling both water quantity and quality. Surprisingly, only a few FYN participants discussed the "mulch use" variable as well as the idea of "avoiding evaporation" in the interviews.

Similar to homeowners, indoor water conservation actions were mentioned by FYN participants frequently. Turning off faucets when not using them; turning off water while brushing your teeth; waiting for full loads to run the washing machine and dish washer; changing the shower head; and shortening shower times are general ideas mentioned related to their indoor water use behaviors.

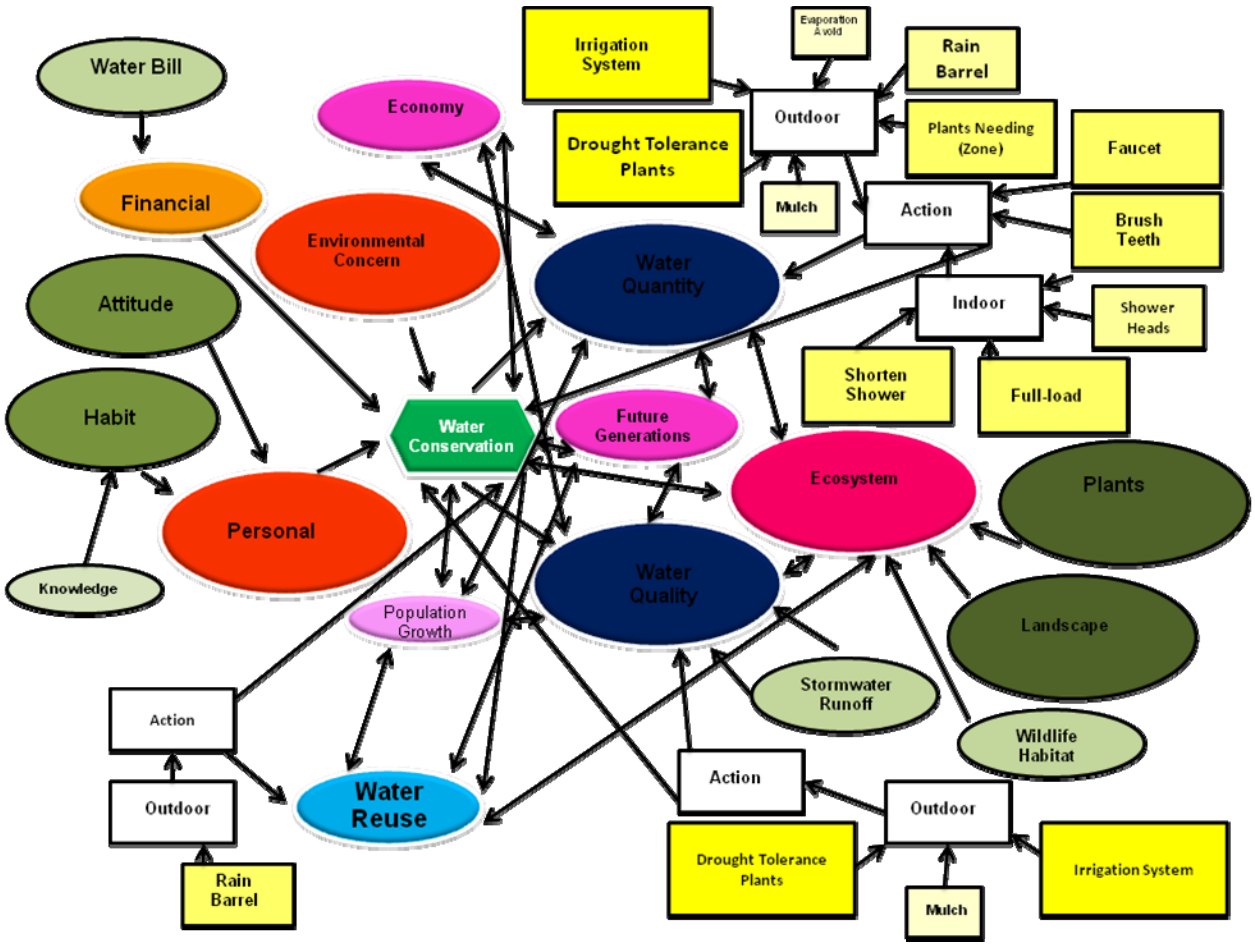

Figure 4-3. FYN Participants' Mental Model of Water Conservation

Consequences

The third theme is consequences. All FYN participants were concerned about the *ecosystem*. Factors such as plants and landscapes are especially prevalent in those interviews. They mentioned the ideas of maintaining beautiful landscapes and protecting ecosystems at the same time. They also discussed caring about plants. Since the main idea of the Florida Yards and Neighborhoods program is to promote Florida-friendly landscaping to conserve water, these factors are relevant for those interviewees. Wildlife habitat and stormwater runoff were mentioned by some participants, but not as many as plants and landscaping.

Some FYN participants think water conservation ideas will benefit *future generations*. They want their children and grandchildren to be able to have the same water conditions as they do. Moreover, some of them expressed a concern for the *economy*. Keeping grass green, commercial use and golf courses in Florida are the biggest three water use aspects from their perspective. They are also the basis for some of Florida's main economic industries. The successful key to water conservation could be strongly connected to these three aspects. However, none of the FYN participants thought of water-based recreation from an economic perspective.

Surprisingly, only one FYN participant brought up the *population growth* issue during the interviews. She thought because of population growth, more and more development would be needed. She thought it would be difficult to keep a balance between water demand and supply.

Contributing Factors

Almost all FYN participants expressed *environmental concerns* while discussing the factors might influence their water use behavior. They care about Florida springs, lakes, and rivers. Many of them value water as a precious natural resource. Therefore, all of them considered water conservation to be an important issue.

Similar to non-FYN participant homeowners, *personal habits* are a main factor playing a role in FYN participants' water use behavior. They reported a habit of not wasting anything. *Knowledge* is an attribute to developing this habit. As they obtained more knowledge about water and other natural resources, they appreciated their value. Also, their education on being a responsible citizen influenced their water use behaviors. Moreover, many of these FYN participants discussed their *attitude* of hating wasteful behavior. This is similar to the homeowner group. Observing other people's wasteful behaviors such as turning on their irrigation system all the time makes them feel uncomfortable. In contrast to the homeowner group, none of them mentioned about the government. This aspect is similar to the experts' perceptions of water conservation.

Between Group Comparisons

To assess the differences in variable discussion frequency between non-FYN participant homeowners (control group) and FYN participants (treatment group), 2 x 2 contingency tables were created and Fisher's exact tests (FET) conducted (Table 4-1). All concepts emerging in both groups were compared on their discussion frequency during interviews. All interviewees in both groups discussed *water quantity*. Ninety percent of FYN participants discussed *water quality*, compared with 60% of homeowners. There was no significant difference between FYN participants and homeowners in *water quality* (p=.204). Half of the FYN participants and 30% of the homeowners mentioned *water reuse*. There was no significant difference between FYN participants and homeowners in *water reuse* (p=.425).

In terms of consequences, 10% of FYN participants and 25% of non-FYN participant homeowners mentioned *population growth*. Therefore, there was no difference between FYN participants and non-FYN participants in mentioning *population growth* (p=0.633). *Economy* was the next subtheme. Thirty percent of FYN participants and 25% of non-FYN participants

talked about *economic aspects of conservation*. There was no significant difference between FYN participants and non-FYN participants in *economy issues* (p=1.000). Regarding *future generations*, 50% of FYN participants and 35% of non-FYN participants brought up this idea. There was no significant difference between FYN participants and non-FYN participants in *future generations issues* (p=.461). The next subtheme is *ecosystem*. All FYN participants and 45% of non-FYN participants raised the *ecosystem* while discussing water conservation. There was a significant difference between FYN participants and non-FYN participants in their mentioning of ecosystem ideas (p=0.004). FYN participants were more likely to mention the *ecosystem* during their interviews.

Several factors in the mental models related to *ecosystems*. Plants were the first factor. Ninety percent of FYN participants and 25% of non-FYN participants discussed this factor. As a result, there was a significant difference between FYN participants and non-FYN participants in raising plants as an issue (p=0.001). FYN participants were more likely to discuss plants as they expressed concern about ecosystems. The second factor was landscapes. One hundred percent of FYN participants and 40% of non-FYN participants expressed thoughts about landscapes. According to the FET, there was a significant difference between FYN participants and non-FYN participants in raising landscape issues (p=0.002), such that FYN participants were more likely to bring up landscapes while talking about water conservation.

Wildlife habitats were the third factor associated with ecosystems. Forty percent of FYN participants and 20% of non-FYN participants were concerned about wildlife habitats. There was no significant difference between FYN participants and non-FYN participants in mentions of wildlife habitats (p=.384). The last factor was stormwater runoff. Forty percent of FYN participants and 25% of non-FYN participants raised stormwater runoff. Therefore, there was no

significant difference between FYN participants and non-FYN participants in stormwater runoff being discussed as an issue (p=.431).

Among contributing factors, the first category was related to *personal* issues. Eighty percent of FYN participants and 60% of non-FYN participants attributed *personal* ideas to water conservation. There was no significant difference between FYN participants and non-FYN participants in raising *personal* ideas (p=.419) as an aspect of water conservation. *Financial* aspects were another contributing factor. Half of FYN participants and 70% of non-FYN participants discussed these aspects. Thus, there was no difference between FYN participants and non-FYN participants in perceiving f*inancial* aspects as related to water conservation (p=.425). The last perspective of contributing factors was *environmental concerns*. Ninety percent of FYN participants and 60% of non-FYN participants valued the environment as influencing their water use behavior. Accordingly, there was no significant difference between those two groups in environmental concerns (p=.204).

Habits and attitudes were two features of *personal* contributing factors. Seventy percent of FYN participants and 35% of non-FYN participants mentioned their habits of conserving water. Between these two groups, there was no difference in terms of personal habits when talking about water conservation (p=.122). Eighty percent of FYN participants and 55% of non-FYN participant interviewees referred to their attitudes towards opposing wasting water as a contributing factor to their water use behaviors. On the basis of FET, there was no significant difference between FYN participants and non-FYN participants on their personal attitudes (p=.246).

Interviewees shared the idea that their water bills played a role in determining their water use behaviors. Fifty percent of FYN participants and 70% of non-FYN participants raised this

idea. Therefore, there was no significant difference between FYN participants and non-FYN participants in awareness of their water bills related to water conservation (p=.425). As regards to their knowledge of water conservation, 20% of FYN participants and 10% of non-FYN participants mentioned their level of knowledge of water conservation. Consequently, there was no significant difference between FYN participants and non-FYN participants in mentioning their levels of personal knowledge on water conservation (p=.584).

There are actions that people can take outside their house to facilitate water quantity conservation. The first one was to control their *irrigation systems*. Ninety percent of FYN participants and 30% of non-FYN participants brought up this method. There was a difference between FYN participants and non-FYN participants in suggesting *irrigation system* control (p=0.005). Growing *drought-tolerant plants* was another one. Ninety percent of FYN participants and 25% of non-FYN participants suggested growing drought-tolerate plants in their yards. According to FET, FYN participants were more likely to be aware of the benefits of drought-tolerant plants than non-FYN participants (p=0.001).

Twenty percent of FYN participants and 5% of non-FYN participants thought of using *mulch* in terms of water conservation. There was no significant difference between FYN participants and non-FYN participants in suggesting *mulch* use (p=.251). Both groups were low. *Avoiding evaporation* was another approach to conserving water. Ten percent of FYN participants and 20% of non-FYN participants discussed this tip. Accordingly, there was no significant difference between FYN participants and non-FYN participants in suggesting *avoiding evaporation* (p=.64). For different types of plants, the water requirements are diverse. *Zoning plants* can have an effect on conserving water quantity. Seventy percent of FYN participants and 25% of non-FYN participants mentioned adopting *zoning* in the yard. There was

a significant difference between FYN participants and non-FYN participants in *zoning* (p=.045). The interviewees also recalled using *rain barrels* to collect rain water. Forty percent of FYN participants and 5% of non-FYN participants discussed this tip. There was a significant difference between FYN participants and non-FYN participants in awareness of *rain barrels* (p=.031).

As far as inside the house, 70% of FYN participants and 55% of non-FYN participants *shortened their showers* to conserve water. There was no significant difference between FYN participants and non-FYN participants in *shortening shower* times (p=.694). Moreover, running washing machines and dish washers only with *full-loads* is also a strategy in conserving water. Seventy percent of FYN participants and half of non-FYN participants discussed this. Therefore, there was no significant difference between FYN participants and non-FYN participants in running *fully-loaded* machines (p=.440).

Forty percent of FYN participants and 25% of non-FYN participants changed their *shower head(s)* to a water-efficient type. In changing *shower head(s)*, there was no significant difference between FYN participants and non-FYN participants (p=.431). *Turning off water while brushing your teeth* can conserve water. Seventy percent of FYN participants and 40% of non-FYN participants brought up this method. There was no significant difference between FYN participants and non-FYN participants in *turning off water while brushing their teeth* (p=.245). The last indoor water conservation tip was turning off *faucets* when not using them. Sixty percent of FYN participants and 40% of non-FYN participants thought of this method. Accordingly, there was no significant difference between FYN participants and non-FYN participants in turning off faucets (p=.442).

Some actions outside the house have a positive impact on water quality. *Growing drought-tolerate plants* was one. Eighty percent of FYN participants and 15% of non-FYN participants mentioned this action. FYN participants are more likely to mention *growing drought-tolerant plants* to conserve water quality (p=.001). Twenty percent of FYN participants and 5% of non-FYN participants understood using mulch to conserve water quality. There was no significant difference between FYN participants and non-FYN participants in using mulch for improving water quality (p=.251). *Irrigation system* use has an influence on water quality as well. Eighty percent of FYN participants and 15% of non-FYN participants discussed this. As a result, there was a significant difference between those participating FYN programs or not in adjusting *irrigation systems* for water quality (p=.001).

Forty percent of homeowners who received FYN training and 5% of non-FYN participants talked about using *rain barrels* for re-using water. According to the FET, there was a significant difference between FYN participants and non-FYN participants in using *rain barrels* to reuse rain water (p=.031).

Index Results

A developed index served a role of providing an alternative indicator of water conservation behaviors. The total score for this 2 dimensional index is 320. Among the 20 non-FYN participant homeowners, the minimum score was 158 and the maximum was 290. The mean score was 233. For the FYN participants, the minimum score was 242 and the maximum was 296. The mean score was 274.

Six interviewees' index scores were lower than 200 in the homeowner group. None of the FYN participants were lower than 200. Those 6 interviewees' results were aggregated. A mental model diagram was created for them in figure 4-4. The size of the polygon and darkness of the color representing a concept; is an indication of the percent of respondents who mentioned that

concept. Thus, the smallest ellipse and lightest colors, represents a concept mentioned by 1-25% of respondents, the next size ellipse and slightly darker shade of colors represents 26-50% of the respondents mentioning that concept; the next larger ellipse and next darker shade of colors represents 51-75% of respondents raising that concept and the largest ellipses and darkest colors represents 76-100% of the respondents mentioning that concept during the interview. Also, the resource aspects are represented in blue shades; the action aspects are represented in yellow shades; the consequences are represented in pink shades and the contributing factors are represented in orange shades. Implications and conclusions based on these results will be discussed in the next chapter.

Table 4-1. FYN Participation and Discussion Frequency Percentage and Comparison

	FYN participation	
	Yes (%)	No (%)
	Resource Aspects	
	Water Quantity	
Discussion frequency		
Yes	100	100
No	0	0
Fisher's exact test	--	
	Water Quality	
Discussion frequency		
Yes	90	60
No	10	40
Fisher's exact test	$p = 0.204$	
	Water Re-use	
Discussion frequency		
Yes	50	30
No	50	70
Fisher's exact test	$p = 0.425$	
	Consequences	
	Population Growth	
Discussion frequency		
Yes	10	25
No	90	75
Fisher's exact test	$p = 0.633$	
	Economy	
Discussion frequency		
Yes	30	25
No	70	75
Fisher's exact test	$p = 1.000$	
	Future Generations	
Discussion frequency		
Yes	50	35
No	50	65
Fisher's exact test	$p = 0.461$	
	Ecosystem	
Discussion frequency		
Yes	100	45
No	0	55
Fisher's exact test	$p = 0.004$**	
	Ecosystem – plants	
Discussion frequency		
Yes	90	25
No	10	75
Fisher's exact test	$p = 0.001$**	

Table 4-1. Continued.

	FYN participation	
	Yes (%)	No (%)
	Ecosystem – landscape	
Discussion frequency		
Yes	100	40
No	0	60
Fisher's exact test	$p = 0.002$**	
	Ecosystem – wildlife habitat	
Discussion frequency		
Yes	40	20
No	60	80
Fisher's exact test	$p = 0.384$	
	Ecosystem – stormwater runoff	
Discussion frequency		
Yes	40	25
No	60	75
Fisher's exact test	$p = 0.431$	
	Contributing factors	
	Personal	
Discussion frequency		
Yes	80	60
No	20	40
Fisher's exact test	$p = 0.419$	
	Financial	
Discussion frequency		
Yes	50	70
No	50	30
Fisher's exact test	$p = 0.425$	
	Environmental Concern	
Discussion frequency		
Yes	90	60
No	10	40
Fisher's exact test	$p = 0.204$	
	Personal – habit	
Discussion frequency		
Yes	70	35
No	30	65
Fisher's exact test	$p = 0.122$	
	Personal – attitude	
Discussion frequency		
Yes	80	55
No	20	45
Fisher's exact test	$p = 0.246$	

Table 4-1. Continued.

	FYN participation	
	Yes (%)	No (%)
	Financial – water bill	
Discussion frequency		
Yes	50	70
No	50	30
Fisher's exact test	$p = 0.425$	
	Personal – habitat (knowledge)	
Discussion frequency		
Yes	20	10
No	80	90
Fisher's exact test	$p = 0.584$	
	Actions – water quantity (outdoor)	
	Irrigation system	
Discussion frequency		
Yes	90	30
No	10	70
Fisher's exact test	$p = 0.005$**	
	Drought-tolerant plants	
Discussion frequency		
Yes	90	25
No	10	75
Fisher's exact test	$p = 0.001$**	
	Mulching	
Discussion frequency		
Yes	20	5
No	80	95
Fisher's exact test	$p = 0.251$	
	Evaporation avoid	
Discussion frequency		
Yes	10	20
No	90	80
Fisher's exact test	$p = 0.64$	
	Planting zones	
Discussion frequency		
Yes	70	25
No	30	75
Fisher's exact test	$p = 0.045$*	
	Rain barrels	
Discussion frequency		
Yes	40	5
No	60	95
Fisher's exact test	$p = 0.031$*	

Table 4-1. Continued.

	FYN participation	
	Yes (%)	No (%)
	Actions – water quantity (indoor)	
	Shorten showers	
Discussion frequency		
Yes	70	55
No	30	45
Fisher's exact test	$p = 0.694$	
	Full load	
Discussion frequency		
Yes	70	50
No	30	50
Fisher's exact test	$p = 0.440$	
	Shower heads	
Discussion frequency		
Yes	40	25
No	60	75
Fisher's exact test	$p = 0.431$	
	Brushing teeth	
Discussion frequency		
Yes	70	40
No	30	60
Fisher's exact test	$p = 0.245$	
	Faucets	
Discussion frequency		
Yes	60	40
No	40	60
Fisher's exact test	$p = 0.442$	
	Actions – water quality (outdoor)	
	Drought-tolerant plants	
Discussion frequency		
Yes	80	15
No	20	85
Fisher's exact test	$p = 0.001$**	
	Mulching	
Discussion frequency		
Yes	20	5
No	80	95
Fisher's exact test	$p = 0.251$	
	Irrigation systems	
Discussion frequency		
Yes	80	15
No	20	85
Fisher's exact test	$p = 0.001$**	

Table 4-1. Continued.

	FYN participation	
	Yes (%)	No (%)
	Actions – water reuse (outdoor)	
	Rain barrels	
Discussion frequency		
Yes	40	5
No	60	95
Fisher's exact test	$p = 0.031$*	

n=30.
*Significant at .05 level (2-tailed). **Significant at .01 level (2-tailed).

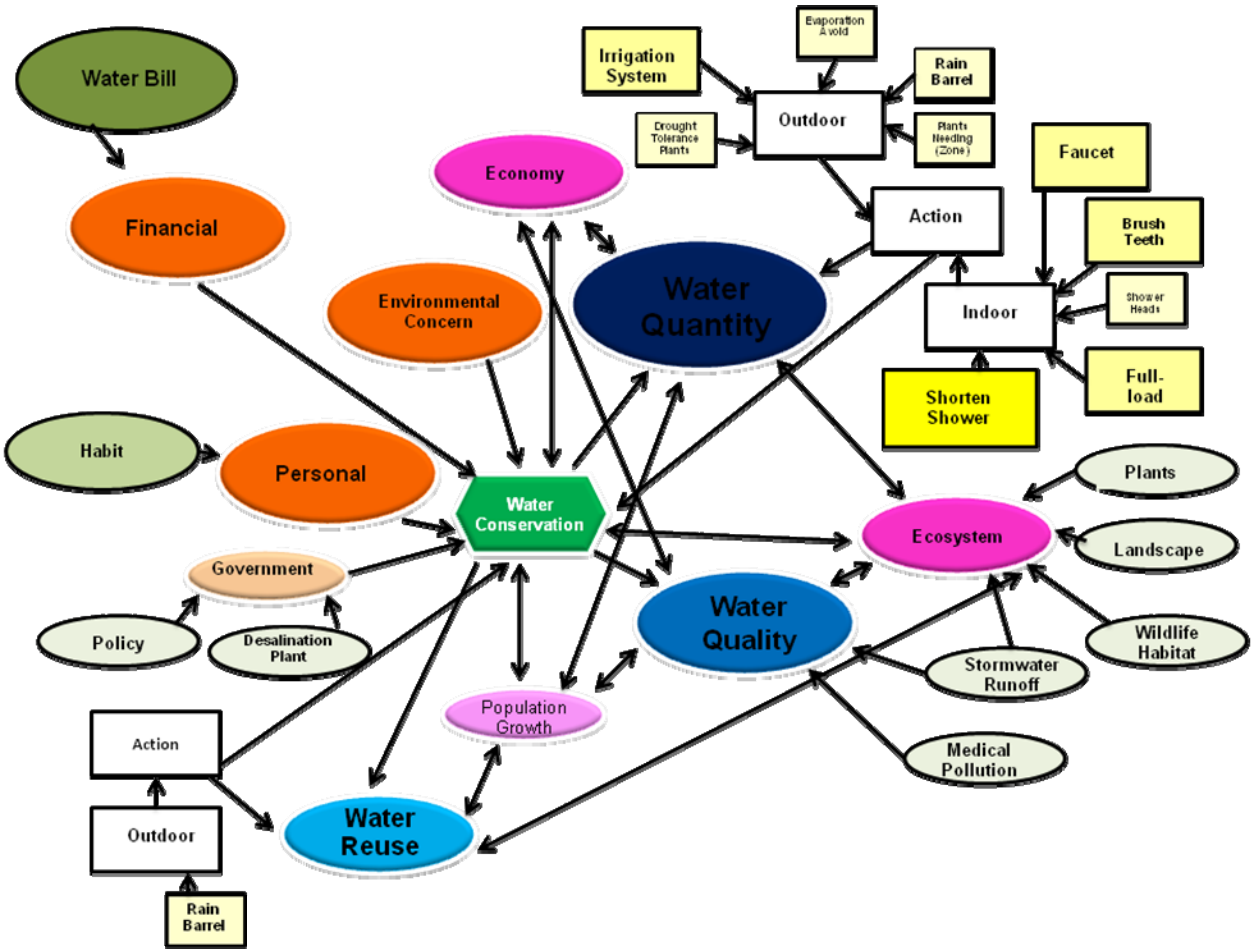

Figure 4-4. Low Index Non-FYN Participant Homeowners' Mental Model of Water Conservation

CHAPTER 5
CONCLUSIONS AND DISCUSSION

A discussion and conclusions of the major findings from Chapter 4 are presented in this section. The discussion is organized into the following sections: 1) mental models approach perspectives, 2) water conservation research framework, 3) informal learning aspects, and 4) Florida Yards and Neighborhoods program perspectives. Future research needs as well as recommendations for better communication strategies are provided.

Research Overview

This study investigated the Florida Yards and Neighborhoods (FYN) program interpreters', non-FYN participants' (Florida homeowners), and FYN homeowner participants' perceptions of water conservation concepts. Through face-to-face interviews, nine FYN interpreters (experts), 20 non-FYN participant homeowners, and ten FYN participants were interviewed between the end of May, 2008 and the middle of October, 2008. Semi-structured interviews were conducted in locations where participants felt comfortable. Each interview lasted about 30 minutes.

The purpose of this study was to understand if there are water conservation perception gaps between experts and Florida homeowners. On the basis of mental models theory, water conservation mental models for FYN interpreters, non-FYN participant homeowners, and FYN participants were created. Moreover, a non-FYN participant homeowners' and FYN participants' water conservation mental models comparison was done. This comparison was used as a tool to evaluate the program.

In the process of analyzing interview transcripts, several themes were abstracted as a result of coding and comparing the nine experts' transcripts. A diagram representing experts' mental model of water conservation was developed (Figure 4.1). The expert model was used to guide the interview template for both non-FYN participant homeowners and FYN participants.

Interviewing, coding, analyzing and comparing the 20 non-FYN participant homeowners' and 10 FYN participants' transcripts were done to understand possible gaps in the communication channels. As a result, discrepancies were identified.

Delimitations

This study was conducted in Florida. The sample population was homeowners in central and northern Florida. Given the unique fresh water conditions in Florida, the generalizability of this research is likely limited.

Limitations

Two limitations of this study were the way the respondent sample was selected and its small size. Volunteer respondents who were willing to participate in this research might have had a higher awareness or interest in water conservation issues. Some social desirability concerns might have affected interviewees' answers. Furthermore, attempting to estimate the general perceptions of water conservation from twenty Florida homeowners and ten FYN participants is subject to sampling error. However, the models presented here are an exploratory first step toward providing insights into the major water conservation themes held by the Florida public and limitations in funding restricted the sample size.

Moreover, the interview questions might have been too general. They may have limited the ability to abstract more specific relevant factors in terms of water conservation concepts; some open-ended questions might have been utilized to more fully reveal each mental model. As far as the interview administration procedure towards the non-FYN participant homeowners and the FYN participant homeowners, concerns such as possible recall problems or limited interviewees' thoughts about water conservation should be verified in a follow up study. In addition, the interviewer's interview conducting abilities probably evolved during the data collection process. This may have influenced the quality of the early interviews. Given the fact that the interviewer

is not a native English speaker, possible cultural and language background biases might have influenced the transcription and hence, research results.

Discussion and Interpretation of Findings

This section focuses on revisiting the literature about the mental models approach, water conservation behaviors, and informal learning. Integrating previous research and the results of this research, recommendations for future water conservation behavior research and the FYN program are also provided.

Mental Models Approach

As stated in Chapter two, the mental models approach is relevant to identifying communication gaps for a specific target concept (e.g. Byram et al., 2001; Kovacs et al., 2001; Wagner, 2007). In this study, the creation of an expert mental model was the first step to identifying what conservation educators think is important about water conservation. Given their specialized training and experience, the experts (FYN interpreters) expressed their thoughts of water conservation in a conversational manner. Rouse and Morris (1986) indicated that the purposes of mental models are to describe the target concept, explain the system, and predict the future of the system. It assumes while actually assessing people's mental models, the dynamic and working mental model will be presented (Rouse & Morris, 1986). Figure 4-1 details the main dimensions of water conservation; the potential consequences; the possible contributing factors; and the actions people can take. It is not only a presentation of knowledge but an active diagram of each concept. More detailed information about water conservation concepts from the expert mental model will be discussed in the next section.

Non-FYN participant homeowners in this study represented lay people as related to water conservation. This is a heterogeneous group in terms of their understandings of water conservation. Therefore, a water use behavior index was developed to facilitate categorizing

them. Meanwhile, this index also provided an alternative measurement to triangulate interview results. Figure 4-2 presents the non-FYN participant homeowners' water conservation mental model. In comparing figure 4-2 to figure 4-1; many additional variables were raised during the interview process by the non-FYN participant homeowners. Though some of these variables were only mentioned by few people, they revealed individual differences. Independent of the accuracy of their thoughts, these variables related to water conservation in their view and introduced directions that an educational program could focus on. The discrepancies also lead to a mental model theoretical issue – the nature of expertise.

As early as 1986, Rouse and Morris stressed a potential problem of mental model theory. They raised the popular belief that an expert will have a more elaborate mental model for a specific concept. However, researchers have argued this phenomenon from a methodological basis and provided explanations. Speelman (1997) summarized a number of explanations. Here are some possible explanations relevant to this study. The first one is the experts might not be familiar with the interview process. When they feel uneasy, it is possible their conversation would not cover all of their understandings on a specific topic. Also, they cannot verbalize as fast as they can reason. In addition, they might not mention those things that are "common sense" to them. Furthermore, the experts are FYN interpreters. Their discussion of water conservation might be limited to what they have decided to teach instead of covering a wider range of water conservation ideas. Rouse and Morris (1986) concluded one critical feature for being an expert is the ability to select the most useful elements toward solving the problem or making a decision. Therefore, those variables covered in the expert mental model would be the more concrete ideas associated with water conservation rather than the more elaborate ones.

Another theoretical issue that needs to be addressed is if there is a general mental model for water conservation. Some of the non-expert respondents did not seem to organize their thoughts around a general mental model of water conservation. One instance is the idea of water reuse. Even with verbal cues, many interviewees still failed to raise this variable. For those who have lower index scores (which indicated lower performance on mentioning water conservation concepts), some variables were missing in their model. However, in taking a closer look at the FYN participants' water conservation mental model, many variables are represented in darker colors and larger ellipses (i.e., more respondents mentioned that variable). Consequently, this indicates that they share a general mental model of water conservation. It showed that program training can modify people's mental model of a specific concept. Jungermann et al. (1991) discussed that people share a general mental model of a particular drug effect. They assumed that the general mental model was influenced by patient package inserts. These two studies indicated a similar research finding in understanding this theoretical issue.

In terms of homeowners and FYN participants expressing an attitude of disliking other people's wasteful behaviors, previous studies have viewed attitudes toward taking conservation behavior from two components: affective and cognitive. Research has defined this kind of disliking feeling as the affective component of attitudes (e.g. Breckler, 1989; French et al., 2005). However, this variable does not appear in the experts' model. There is a possible explanation for this. From a methodological perspective, research has shown that while conducting face-to-face, in-depth interviews, interviewees who are experts tend to discuss topics related to their profession instead of the "emotional" part (Anastas, 2004).

Generally, a mental models approach can be used to evaluate the effectiveness of an educational program for the following reasons (Fischhoff et al., 1998; Morgan et al., 2002):

- For most concepts, people have some basic knowledge or believe that they do. A mental models approach can be used to detect people's basic knowledge on a specific concept.
- By creating an expert model and a lay person's model, some possible discrepancies in associated concepts can be identified. The differences can be addressed during a communication process. Moreover, current knowledge that can be built upon can be revealed by the comparison.
- More in-depth information can be obtained with an open-ended, slightly guided response format compared to basic survey questions.
- Researchers have an opportunity to clarify responses during interviews with participants.
- The mental models approach can be employed as a preliminary study to develop issues for which questions can be written to be utilized in a later questionnaire.

From the comparison of the three targeted groups' water conservation metal models, some new directions for reinforcing people's awareness of water conservation concepts and communication gaps were revealed. This leads to a discussion on the content of the water conservation mental models via an examination of the scope of water conservation ideas expressed by the various segments.

Water Conservation Behavior Framework

Overall, what is water conservation for experts? They conceptualize water conservation along three themes: water quantity, water quality, and water reuse. Water conservation ideas and factors such as population growth, economic issues, the whole ecosystem and future generations influence each other mutually. Because of experts' concerns about the environment, their personal habits, job training, and their desire to save money; they are willing to take water conservation actions. Those are the variables that the experts think of while discussing water conservation. Some variables are either depreciated or added among Florida homeowners. In the following section, a close look at those variables within a water conservation behavior framework and the context of previous research is given.

First, is the idea of water reuse. As shown in table 4-1, only 30% of non-FYN participant homeowners discussed water reuse during their interviews. Since water reuse is an important resource aspect of water conservation for the experts, it should be communicated to the public in conjunction with other dimensions. In this study, residential irrigation gardening was considered as a water reuse action. Hartley (2006) studied how people perceived water reuse as well as their commitment to participate in water reuse actions. He presented five themes: managing information for all stakeholders; maintaining individual motivation and demonstrating organizational commitment; promoting communication and public dialog; ensuring a fair and sound decision-making process and outcome; and building and maintaining trust. These five themes cover governmental, industrial and personal water reuse strategies. He also listed some factors that might contribute to the degree of public acceptance of water reuse. Four of the factors are relevant to this study and are recommended for implementation to promote water reuse in Florida.

First, the protection of the environment is a clear benefit of reuse. According to this study, 60% of non-FYN participant homeowners think that environmental concern is an important contributing factor for water conservation. Studies have shown that water reuse can have environmental benefits. Anderson (2003) discussed the potential environmental benefits of water reuse. Protecting the natural resource and reducing the impacts on water quality were mentioned. Jeffrey (2002) indicated that people were more ready to reuse water from different sources for toilet flushing when they have undertaken some water conservation measures (such as using low-flow fittings) at home. The level of environmental concern has been shown to relate to their water reuse behaviors. From this point of view, clear benefits of water reuse being emphasized in water conservation messages is a good strategy to promote water reuse.

Secondly, promotion of water conservation is a clear benefit of reuse. As shown in figure 4-1, water reuse and conservation influence each other. In the interview process, most non-FYN participant homeowners considered water conservation as an important issue. Accordingly, providing water reuse benefits related to water conservation can reinforce the public's positive attitudes towards the importance of water reuse.

A third factor is the cost of technology. Money is a concern for most people. People expect to pay less for water bills if they implement water reuse skills. On the other hand, people generally do not expect to invest much for water reuse technology. It is a point to pay attention to in promoting water reuse strategies. While meeting with the experts, the researcher participated in a rain barrel workshop. The extension office partnered with a barrel recycling company. Reasonable prices for barrels and the teaching skills needed to make a quality rain barrel made the workshop successful. It also advocated the water reuse idea to the participants.

The last point, which is a critical one, is the awareness of water supply problems. People's awareness towards water reuse will likely increase when water shortage issues become critical. In1998, the Melbourne (Australia) water focus group described that water reuse is a last solution for the water needs problem when alternative strategies were presented (as cited in Po, Kaercher, & Nancarrow, 2003). A proactive approach would be to increase people's knowledge and awareness of water reuse during daily life before water shortages become acute.

Though studies have shown that Florida's population growth declined to a lower growth rate because of the 2008 economic recession, Florida still had about 18 million people in 2007 (Economic and Demographic Research, 2008). It was the seventh fastest growing state in the U.S. from April 2000 to July 2007 (EDR, 2008). Population growth is another variable that should be addressed. From the experts' understanding, water can become a limited natural

resource because of an expanding population. For Florida, the demand for water includes both Florida residents and tourists (which for some months of the year can add about one million people to the population). Without tourists, Florida's economic status would be impacted substantially. Moreover, water conservation also influences population growth in many aspects. Not many non-FYN participant homeowners mentioned population growth as an important driving force behind promoting water conservation ideas. For the FYN participant group, only 10% of them raised the population growth issue. This implies a concept that is not well understood and calls for information distribution, communication and education. Emphasizing the balance between water supply and population demand might be a good point to add to the FYN educational program.

The role which government is playing in water conservation was discussed by non-FYN participant homeowners. In particular, the government's water policy was addressed. Water policy in this case can be treated in two directions: financial policy and conservation policy. Rogers, de Silva, and Bhatia (2002) argued for water as an economic good and discussed issues related to using water prices to promote sustainability. They listed three well-known and three lesser known effects of price policy. A price policy can reduce demand; reallocate the resource efficiently; and increase the resource supply. Furthermore, a price policy can improve equity; improve managerial efficiency; and improve resource sustainability. Combined with people's concerns about their water bills, water pricing policies can play a role in promoting water conservation. However, given the fact that many Florida homeowners' water use is not metered, water price policy cannot be the only way to address water sustainability issues.

As far as the role of water conservation policy, mandatory restrictions on certain types of water use such as the time spent irrigating residential lawns was particularly mentioned during

non-FYN participant homeowner interviews. In Florida, due to previous, current and seasonal droughts, many counties have limited residential irrigation to two times per week. In the St. Johns River Water Management District, for example, residential irrigation is prohibited between the hours of 10 a.m. and 4 p.m., no matter the irrigation water source (i.e., wells, or public water supply). Lee and Warren (1981) studied the relationship between water consumption and water conservation policies. They concluded that mandatory policies with per capita restrictions were more effective than voluntary conservation campaigns.

Corral-Verdugo and Frías-Armenta (2006) reported that individuals' beliefs of environmental regulation inefficacy cannot be a predicator for their water conservation behaviors. In addition, more water wasteful behaviors can be observed in antisocial individuals than prosocial people. They suggested using water conservation programs which place an emphasis on environmental values and norms. In the current study, some interviewees (non-FYN participant homeowners) expressed the idea that promoting individuals' water conservation actions violates their rights of managing their own yards. They discussed that keeping their landscape green and beautiful, the way they want, is one of the benefits of living in Florida. This provides some indications of social desirability issues and how a pro-environmental educational program must cope with a social norm of maintaining green and neat yards by planting water consuming grasses.

One variable that did not appear in figure 4-4 (compared to the expert model) is a concern for future generations. While discussing water conservation issues with those who had lower scores for their water conservation behaviors, they did not mention water conservation as it relates to future generations. This raised an issue of people's ideas of sustainability. The definition of sustainability includes a time perspective component. Sustainable behaviors require

an inclination toward the future. It is possible that these respondents have a different time orientation. Corral-Verdugo et al. (2006) proposed a relationship between water conservation behaviors and time perspectives. They concluded that people with a present orientation, negatively affect water conservation behaviors. Conversely, people with future orientations, tended to report pro-environmental behaviors. This raises the question of how a pro-sustainability educational program can communicate the idea of time orientation successfully.

Informal Learning

Wherever people have the need, motivation, and opportunity for learning, informal education can take place. For the reasons that the mental model approach attempts to emphasize both on the scientific importance and individual realities of a specific concept; customized messages can bring concepts to people's attention fairly easily. Moreover, individual differences can play a role in people's approach to learning. This is especially important for adult learning. Marsick and Watkins (2001) proposed an informal and incidental learning model for adults. They believe that each daily experience can trigger challenges or problems that need to be solved or affect a vision of a future state. For adults, the way they interpret their experiences and diverse learning strategies make individual differences become more critical. The mental models were established on the basis of each individual's life experiences. In order to assess adults' perceptions of water conservation, establishing their mental models can inform the communication process.

During the interview process, many non-expert participants mentioned their memories of Florida springs and rivers in their childhood. For those interviewees who grew up outside Florida, they also recalled their childhood water experiences in their hometowns. This indicates the importance of triggering local community identity or sense of place. Sobel (1996) emphasized that when trying to teach kids environmental awareness, it is critical to explain

everything from a “local” viewpoint. For adult learners, it might be easier for them to view environmental issues from a global point of view. However, childhood memories still play a role in connecting mother nature with environmental issues. Therefore, this provides a reminder to assess the relationship between people’s “sense of place” and water conservation behaviors. In informal environmental education settings, how can interpreters or educators use sense of place to connect with target conservation behaviors (e.g. water conservation behaviors, water reuse behaviors)? Unfortunately, there is no literature addressing this aspect. There is a need to investigate this geographic connection issue more thoroughly.

Florida Yards and Neighborhoods Program Implications

This summative evaluation made several points and offers hints for future improvements of the FYN program. The FYN participants’ group in this study demonstrated better knowledge of several water conservation actions than the non-FYN participant homeowners’ group. From an FYN program training perspective, it showed that it is a successful educational program. The Florida Yards and Neighborhoods program is designed to teach people about protecting water systems and conservation in their own yards. There are nine principles emphasized in this program:

- Right plant, right place
- Water efficiently
- Fertilize appropriately
- Mulch
- Attract wildlife
- Manage yard pests responsibly
- Recycle
- Reduce stormwater runoff
- Protect the waterfront

Given the range of these principles, we can better understand how and why those participants were able to communicate water conservation actions fairly well. On the basis of the

comparison between non-FYN participant homeowners' and FYN participants' water conservation mental models, FYN participants showed better mental model awareness of concepts in many aspects of water conservation actions including irrigation systems, drought-tolerant plants, planting zones, and rain barrels than homeowners who did not attend the program. FYN participants perceived the importance of ecosystems, plants, and landscapes as having a water conservation role significantly more than homeowners. Moreover, many FYN participants were eager to show their Florida-friendly yards to the interviewer during the interviews. They designed and maintained their yards based on what they learned. Their own yards also potentially become excellent demonstration areas in local communities.

Also, FYN participants' water conservation index scores were aggregated at the higher end. Moreover, FYN participants' water conservation mental model presented in a similar way to the experts' mental model. The communication between experts and participants was shown to be accomplished, for the most part.

Based on these findings, the following suggestions can be made for the FYN program:

Many FYN participant respondents seem to have difficulty in connecting the idea of "mulch" to water conservation. In addition, the actions of preventing water quality deterioration were not usually mentioned by those represented in the low water conservation behavior scores mental model (Figure 4-4). These are two content areas that FYN should address. Different teaching styles or terms to explain the value of mulching might be a better way to inform participants of the benefits of mulching. Mulching can protect both water quantity and quality. However, people apparently lack knowledge of its contribution to water quality conservation.

Since previous personal experience plays a role for homeowners, another recommendation would be to share life experiences with homeowners. Sinkhole and drought experiences are good

examples. Experience sharing can be done in several ways. Storytelling, photographs, and video programs can impress people easily. In the interview process with FYN participants, many of them mentioned a video showing Florida's aquifer status with a scuba diver visiting Florida's underground caves as an impressive lesson. "Aquifers can be influenced by our daily life", is what they recalled learning. Therefore, information related to understanding Florida's water status and information about drought or other related experiences can help heighten people's awareness of water issues.

From the FYN nine principles (p.92), it is clear that the FYN program provides outdoor water conservation skills to their participants. Besides the water conservation skills, it is also critical to reduce the homeowners' worries about the water situation. In looking at figure 4-2, it is noted that the homeowners have some concerns about water issues. Since the awareness of water as an issue seems to be present, strategies to motivate people to participate in the FYN program will be key to providing them with knowledge to abate their concerns. Pro-environmental values can be emphasized while advertising this program. As in the previous discussions, the issue of water reuse, the possible consequences related to water conservation, water quality, and the responsibility of government are all intertwined. Providing information to instill these concepts needs to be an integral part of the program's message.

Awareness is the biggest challenge for this program. For most non-FYN participant homeowner interviewees, they had never heard of the FYN program. For the FYN participants in Citrus county, most of them learned about the program from the local newspaper. When asked where the homeowners obtained information about water conservation, most of them mentioned the local water utility company. It might be more successful for the FYN program to partner with local water utility companies. Booklets, brochures or stickers with FYN information could be

distributed to local homeowners along with their utility bills. Multiple communication approaches are encouraged to distribute conservation information to the public. Radio, newspapers, and internet advertisements can be mediums to more widely broadcast program information and awareness of the course.

Furthermore, building cooperation with local homeowner associations is critical. There are at least two benefits that should be realized. Local homeowner associations often play a role in suggesting individual homeowner's landscape planting selections and designs. Cooperating with them can promote program principles in advance of homeowners' landscaping decisions. That can save homeowners' money in terms of re-designing their landscapes and promote water conservation ideas at the same time. Furthermore, reinforcing local community benefits from implementing program strategies can strengthen people's local environmental awareness, and perhaps, establishing a 'sense of place' instilled with an idea of quality water use in a sustainable manner.

While visiting each FYN office and demonstration gardens, another problem observed was the lack of visitation. Demonstration gardens are located near extension offices. However, a lack of visitation underutilizes this valuable information. In line with the challenge of information distribution, increasing the awareness of FYN programs might be addressed by cooperating with local parks and recreation departments to promote demonstration gardens as well as planning and developing special events. Moreover, based on communication effectiveness studies from the marketing field, lining up celebrities to promote environmental conservation programs might be a good solution to attract the public (Cialdini & Rhoads, 2001). However, funding such events and gardens could be an issue, especially in the current economic downturn environment.

Future Research

Understanding people's perception of water conservation is the first step to understanding the public's awareness about this issue. Some insights about Florida homeowners' perceptions of water conservation themes were presented in this study. More questions were raised and more research needs were identified in the process. First, along with the mental models approach, a questionnaire designed around the basis of mental model diagrams is needed. A questionnaire can be easier to administer to a larger group of homeowners and a more generalizable result could be obtained based on the questionnaire being applied to a larger sample. It can also provide more information in terms of evaluating FYN programs.

Secondly, a lack of research regarding people's perceived difficulties in adopting water conservation behaviors is recognized. From the Florida Yards and Neighborhoods program perspective, there are diverse strategies such as workshops, lectures, demonstration gardens, videos and family-oriented tours adapted to demonstrate a Florida friendly (and water conserving) landscape concept. While this study focused on Florida, other effective educational strategies might exist in different states or different countries. Which educational approach is the most efficient method? How can these useful messages more effectively reach the public and prompt them to take conservation actions?

Furthermore, no literature was located that documented the relationship between "sense of place" and water conservation behaviors. How do people perceive water conservation behaviors when they have a strong attachment to a place?

Lastly, the study identified perception gaps between experts and Florida homeowners. Targeting those potential gaps in future message distribution is critical for improving informal educational program designs to enhance the public's understanding of sustainability issues.

APPENDIX A
EXPERT INTERVIEW TEMPLATE

This research is interested in how you think about water conservation. I am interested in everything you think about it and want you to say everything you think about water conservation.

1. Can you tell me all about the issue of water conservation?

   - ✓ Can you tell me more about _____?
   - ✓ Can you explain how (why) _____?
   - ✓ Can you explain to me what you mean by _____?
   - ✓ Does _____ bring anything else to mind?

2. Can you give me any idea how important water conservation is?

3. Can you tell me about the kinds of things that determine your water use behavior?

4. What might be bad about water conservation?

5. What might be good about water conservation?

6. What can be done about water conservation?

7. Have you ever done anything about water conservation?

8. What kind of information would you tell the public about your program (FYN)?

9. Have you heard about any other programs or agencies that dealing with water conservation?

10. If you were going to explain water conservation to someone else, is there anything you would say differently or add to what you have said?

Could you tell me a little about yourself (how long have you been working for UF extension? Who are your target audience?)?

APPENDIX B
INSTRUMENT FOR NON-FYN PARTICIPANT AND FYN PARTICIPANT HOMEOWNERS

The following statements refer to some water-conservation behaviors. Please answer according to your water use behavior. (Please ☒ only one response for each statement.)

Statements	**Never**	**Rarely**	**Sometimes**	**Very Often**	**Always**
Shorten my showers	❑	❑	❑	❑	❑
Run only full loads in the washing machine and dishwasher	❑	❑	❑	❑	❑
Water plants only as needed	❑	❑	❑	❑	❑
Fix leaky faucets and plumbing joints	❑	❑	❑	❑	❑
Plant drought-tolerant plants	❑	❑	❑	❑	❑
Have a shut-off device on irrigation system	❑	❑	❑	❑	❑
Wash car efficiently, park it on the grass and use a hose	❑	❑	❑	❑	❑
Hand watering ornamental plants	❑	❑	❑	❑	❑
Shut off tap water when not using it	❑	❑	❑	❑	❑
Install water-saving shower heads or flow restrictors	❑	❑	❑	❑	❑

Demographic Profile

1. What is your gender? ❑ Male ❑ Female

2. In which year were you born? _____

3. How many people are living in your household? _____

4. Is your water use metered?
   ❑ No
   ❑ One meter for indoor and outdoor use
   ❑ One meter for indoor use and a second meter for outdoor use

5. What is your permanent residence Zip Code? _____

6. How long have you lived at this location? _____ years _____ months

7. What is the highest educational level you have attained? (Check one)
   ❑ Less than high school
   ❑ High school diploma
   ❑ Attended business/technical school
   ❑ Some college or 2 year degree
   ❑ Completed 4 year college degree
   ❑ Some graduate work
   ❑ Completed graduate or advanced degree

APPENDIX C
INTERVIEW TEMPLATE FOR NON-FYN PARTICIPANT AND FYN PARTICIPANT HOMEOWNERS

Work sheet for guiding mental models interview about water conservation

What I'd like to ask you to do is just talk to me about water conservation: that is, tell me whatever you know about water conservation.

Basic Prompts:

1. Anything else?
2. Can you tell me more?
3. Anything else? Don't worry about whether it's right, just tell me what comes to mind.
4. Can you explain how (why) _____?

Draw a Blank (in order):

1. Have you heard (the word) _____? Can you remember anything at all about it?
2. Let me see if I can jog your memory a bit. (Describe a little about the term). Does that help?
3. Let me try a little bit more. (Describe more detail). Have you ever heard of such a thing?

When I say water conservation, what comes to your mind?

Water System

__|__ Water Source

__ Can you explain to me about the Florida water system?

The Importance of Water Conservation

__ Is water conservation really important to you or that is not all that important?

__ Can you tell me why?

__|__ Population (only if brought up)

__ You told me that _____ (e.g. population growth will influence water use), can you tell me more about that?

__|__ Economics (only if brought up)

__ You told me that _____ (e.g. economics will be influenced by water use), can you tell me more about that?

__|__ Consequence (only if brought up)

__ Can you give me any idea about the possible consequences if we do not conserve water now?

__ You told me that _____ (e.g. we will run out drinking water, storm water runoff), can you tell me more about that?

__|__ Natural Resource Sustainability (only if brought up)

__ You told me that _____ (e.g. sustainability), can you tell me more about that?

Water Conservation Behavior

__|__ Influential Factors

__ Can you tell me about the things that determine your water use behavior?

__ You told me that _____, can you tell me more about that?

__|__ Indoor Behavior

__ Can you tell me about the things that can be done at home about water conservation?

__ You told me that _____ (e.g. run only full loads in the washing machine and dishwasher), can you tell me more about that?

__|__ Outdoor Behavior

__ Can you tell me about the things that can be done outside your house about water conservation?

__ You told me that _____ (e.g. irrigation system, rain barrel, car wash), can you tell me more about that?

Water Conservation Promotion Programs

__|__ Information Delivery System

__ Where have you heard or read about water conservation messages?

__|__ Water Conservation Programs

__ Have you heard about any government or private programs to deal with water conservation?

__ Is there anyway someone can learn about water conservation?

__|__ Florida Yards and Neighborhoods Program (Only if brought up)

__ Can you tell me about FYN program?

__ You told me that _____ (e.g. landscape planning), can you tell me more about that?

At end

__ Is there anything else about water conservation that I haven't asked you that you would like to say?

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BIOGRAPHICAL SKETCH

Ting-Bing Wu was born in Taipei, Taiwan. In 1996, she received her Bachelor of Science degree in Agriculture from National Taiwan University, Taiwan. In 2000, she received her Master of Science degree in neuroscience from National Yang-Ming University, Taiwan. She was then employed in Academia Sinica until 2003. During her graduate education and her employment in Academia Sinica, she has gained experience in performing experimental design research, laboratory analyses, and report preparation.

She received her Doctor of Philosophy degree in health and human performance with a specialization in natural resource recreation and a concentration in wildlife ecology and conservation in May 2009 from the University of Florida. Her research interests include environmental education, people's conservation behaviors and educational program evaluation as well as sustainable tourism.