Education and water conservation in Tucson, Arizona: towards an educational model for Saudi Arabia

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Education and water conservation in Tucson, Arizona: Towards an educational model for Saudi Arabia

by

Mohammad Sh. AL-Shayaa

A dissertation submitted to the graduate faculty in partial fulfillment of the requirements for the degree of DOCTOR OF PHILOSOPHY

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Iowa State University
Ames, Iowa
2004

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For the Major Program
# TABLE OF CONTENT

## LIST OF TABLES  

<table>
<thead>
<tr>
<th>List</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>iv</td>
<td>v</td>
</tr>
</tbody>
</table>

## LIST OF FIGURES  

<table>
<thead>
<tr>
<th>List</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>v</td>
<td>vi</td>
</tr>
</tbody>
</table>

## ABSTRACT  

<table>
<thead>
<tr>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>vi</td>
</tr>
</tbody>
</table>

## CHAPTER I. INTRODUCTION  

<table>
<thead>
<tr>
<th>Subsection</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Problem Background</td>
<td>1</td>
</tr>
<tr>
<td>Statement of the Problem</td>
<td>2</td>
</tr>
<tr>
<td>Accessible commodity</td>
<td>7</td>
</tr>
<tr>
<td>Use it or lose it principle</td>
<td>8</td>
</tr>
<tr>
<td>Government or state related problems</td>
<td>8</td>
</tr>
<tr>
<td>Water consumption and irrigation</td>
<td>9</td>
</tr>
<tr>
<td>Purpose and Objectives of the Study</td>
<td>10</td>
</tr>
<tr>
<td>Why Tucson, Arizona?</td>
<td>12</td>
</tr>
<tr>
<td>The Arizona Water Resources Research Center (WRRC)</td>
<td>13</td>
</tr>
<tr>
<td>Tucson Water Department</td>
<td>13</td>
</tr>
<tr>
<td>Why this applies in Saudi Arabia?</td>
<td>14</td>
</tr>
<tr>
<td>Need for the Study</td>
<td>15</td>
</tr>
<tr>
<td>Research Questions</td>
<td>16</td>
</tr>
<tr>
<td>Implications and Educational Significance</td>
<td>17</td>
</tr>
<tr>
<td>Operational Definitions</td>
<td>18</td>
</tr>
</tbody>
</table>

## CHAPTER II. LITERATURE REVIEW  

<table>
<thead>
<tr>
<th>Subsection</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Groundwater in Tucson and Saudi Arabia</td>
<td>21</td>
</tr>
<tr>
<td>Groundwater Recharge</td>
<td>21</td>
</tr>
<tr>
<td>Water Problems of Other Countries</td>
<td>25</td>
</tr>
<tr>
<td>The Cost of Water and the Resident User</td>
<td>25</td>
</tr>
<tr>
<td>The Cost of Water and Farmers</td>
<td>31</td>
</tr>
<tr>
<td>Water Leakage</td>
<td>32</td>
</tr>
<tr>
<td>Recycled Water</td>
<td>34</td>
</tr>
<tr>
<td>The Psychological and Moral Impact of Norms and Values on Conservation</td>
<td>34</td>
</tr>
<tr>
<td>A Different Approach</td>
<td>36</td>
</tr>
<tr>
<td>It Talks a Village</td>
<td>38</td>
</tr>
<tr>
<td>Education</td>
<td>39</td>
</tr>
<tr>
<td>Teacher Training Program</td>
<td>41</td>
</tr>
<tr>
<td>Curriculum</td>
<td>46</td>
</tr>
<tr>
<td>Educational Role of Agricultural Education</td>
<td>49</td>
</tr>
<tr>
<td>Family role in education</td>
<td>52</td>
</tr>
<tr>
<td>Religion’s Role in Education</td>
<td>54</td>
</tr>
<tr>
<td>Mass Media Education</td>
<td>56</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>APPENDIX I. MATERIAL AND PUBLICATION DESIGNED OR DISTRIBUTED BY PIMA COUNTY COOPERATIVE EXTENSION</td>
<td>177</td>
</tr>
<tr>
<td>REFERENCES</td>
<td>178</td>
</tr>
<tr>
<td>ACKNOLEDGMENTS</td>
<td>188</td>
</tr>
</tbody>
</table>
LIST OF TABLES

Table 1. Participants Perceptions on Who Should Assist in Solving Water Shortage Problems (N=293) 80

Table 2. Resources Utilized by Participants to Gain Information on Water Issues (N=293) 95

Table 3. Participants Knowledge of Water Issues (N=293) 96

Table 4. Rank Order for Household Water Usage (N=293) 97

Table 5. Participant Motivations and Learning Capability Concerning Water Conservations Issues (N=293) 98
<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Education seen as enveloped in a political-ecology setting</td>
<td>40</td>
</tr>
<tr>
<td>2</td>
<td>Age of Participants (N=293)</td>
<td>77</td>
</tr>
<tr>
<td>3</td>
<td>Participants’ level of education</td>
<td>78</td>
</tr>
<tr>
<td>4</td>
<td>Number of teachers per school level</td>
<td>78</td>
</tr>
<tr>
<td>5</td>
<td>Tucson house garden</td>
<td>100</td>
</tr>
<tr>
<td>6</td>
<td>Saudi Arabia Water Education Model</td>
<td>127</td>
</tr>
<tr>
<td>7</td>
<td>Tucson Water Education Model</td>
<td>128</td>
</tr>
</tbody>
</table>
CHAPTER I. INTRODUCTION

According to the Merriam-Webster's Dictionary (1999), "education is the act or process of imparting or acquiring general knowledge and of developing the powers of reasoning and judgment". Moreover, education is defined as developing the knowledge, skills, or character of students (Callaway, 1979, Brynin, 1993). Based on those definitions, it is clear that there is no specific institute responsible for educational action. However, society tends to always relate the educational process only with school. This misconception neglects the importance of other educational institutes in society such as family, faith, and the media. "Since schools are but one agency for the education of the public, it is very difficult to separate what public schools alone achieve. Family and faith, library and museum, the work place and leisure place, visual and print media, art and music, also the communities that we live in, each of these plays a role in our education" (Leinwand, 1992, p.32).

Each one of these educational institutes should realize its responsibilities towards the educational process. They should also be able to cooperate in educating individuals to meet their needs and deal with general societal problems (Leinwand, 1992).

Tucson has a water shortage problem. The educational process should not only make people more aware of this problem, it should also serve as a primary force in changing their water consumption behavior. The concept of "It Takes a Village" (Clinton, 1996) stresses the importance of collaboration among different educational institutes in modifying society's attitude towards different issues. The responsibility has to be on both formal and informal education, and also on public and private organizations. Because the family, school, faith and the media should all be part of the behavior-changing process, the objective of this research is to identify the effect each one of them has on water consumption behavior. The
main purpose of this study was to explore the roles of Tucson's formal and informal educational forums that address conservation behaviors toward the water problem, and to determine how to export the knowledge and experience gleaned from Tucson to areas with similar climates and water supply conditions but different cultural and educational systems like Saudi Arabia to meet the specific objectives of this study. These study objectives were to identify: 1) the roles of the formal educational process on students' water consumption behavior; this goal focused on: a) identifying the existing curricula of public schools in Tucson and b) identifying existing facilitators' roles in the public schools; 2) the roles of the city of Tucson, Arizona in water conservation; 3) the roles of parental direction on children's water consumption behavior; 4) the roles of faith teachings and religious practice on changing people's water consumption behavior; 5) the roles of the academic programs and extension services offered by the University of Arizona on the water consumption behavior of students, farmers and the whole community; this goal focused on: a) the role of the Arizona Water Resources Research Center (WRRC); b) the roles of the Agricultural Education Department in preparing teachers to be aware of future water problems; and c) the roles of Agricultural Extension to help farmers manage their water usage; 6) the roles of different media programs on citizens' water consumption behavior; and 7) to propose a new model for applying these programs in Saudi Arabia.

Introduction of water problems, study problems, objectives, and study questions are discussed in detail in the following part of this chapter.

**Water Problem Background**

Water plays a central role in all aspects of life, no matter where one lives. Both public and private water consumers -- from international organizations to individual
households -- impact the natural environment, economic system, food security, production of services and politics. It is very important to look at the ways in which people use water and what their behaviors and attitudes are regarding this precious commodity.

The first step in changing the way people treat the environment is educating them: informing them about future needs and the real problems they face. Formal and informal education may promote holistic development that takes health, social and emotional issues into account. Both types of education increase public awareness, introducing human values and concepts to help people solve their daily life problems (Taplin, 2003).

For a long time, Americans considered environmental values to be secondary (Goddard, 2003). However, the public's attitude towards water problems has been changing significantly over time. Goddard discussed five polls focusing on the environmental issue conducted in 2000; the findings indicated that Americans were most concerned about water. Goddard cited the Money Magazine poll that surveyed which factors influenced where Americans decide to live. Water was at the top of the list of priorities (Goddard, 2003).

Although these polls show that people are aware of the water problem, awareness of a problem doesn't necessarily mean that people will take action. What really motivates people to action is their intellectual understanding of the problem and their belief that they can contribute to a solution (Bobe et al, 1996).

Educational conservationists have been very successful in convincing people to deal with waste problems by recycling. Given the fact that people really understand that water is an important issue, the proposed solutions for the water problem could be as successful as recycling. Unlike global warming, which comes at the bottom of the list in the polls because people cannot understand it clearly, water is a comprehensible issue. In order to fully
address the issue, however, all of the aspects of the water problem need to be understood (Goddard, 2003).

Polls show that most Americans are aware of only one part of the water problem -- the quality problem. Not including those who live in certain arid states such as Arizona, Americans know little about the problem of water quantity (Goddard, 2003). While the world’s population has been increasing rapidly, water resources are deteriorating due to overuse and abuse. The entire world is facing a huge water problem because of human needs and demands. “Humans can live for about four minutes without air, four days without water, and four weeks without food” (Anthony, 1998, p.3). Environmental education is a means of making people aware of the problems they bring to the environment and what they can do to restore the environment to its former healthy state. Development and economics depend on natural resources and the way people manage and consume water. Understanding natural resources, managing education and training people are the best solutions to environmental problems (Anthony, 1992).

In 1997, Stockholm reported that by the year 2025, two-thirds of the world’s people would suffer from water shortages. He noted that the rate of fresh water usage is twice the rate of world population growth (Bartlett, 1997, p.3). The fact is that current water resources will be insufficient for future use if people do not change their water-usage behavior. With current water consumption rates, the world is facing a crisis, which will grow more severe since people have failed in lowering population growth (Bartlett, 1997). However, raising concerns about water problems now and planning for future needs will help meet the challenge of providing a continuous supply of water for everyone. Food and water have a strong relationship because food production depends on water (Bartlett, 1997). Water can
overcome hunger and disease. “Without water, crops and livestock wither and die. People go
hungry and become weak. Weakness allows disease to run its course and finally the ‘quiet

The population increase worldwide has resulted in the rapid consumption of natural
water resources. Secure access to water has been essential for social and economic stability
of cultures and civilizations throughout the millennia. Water in one river basin is irrelevant
to those who live in another area because people need sources of water close to home
(Sustaining Water, 2003).

Agriculture is the biggest drain on water supplies, followed by industry, energy, and
then domestic or household use, accounting for about 60 percent, 23 percent and 8 percent,
respectively (Vickers, 2001). These figures indicate that economic and social development
depends on water. Humans have been utilizing water on a massive scale and this heavy
usage has caused the problems we now face. Once the resource is gone, there is no way to
renew the supply (Vickers, 2001).

Water problems are local, national and international issues. According to Butts
(1997), “The next war in the Middle East will be over water, not politics” (p.1). Not only
population growth contributes to water demand, but also technology, conservation, trade,
industrial and agricultural policies. The problem is that not all the water on the earth is
usable by human beings. Of the three percent of the earth’s water that is fresh, two percent is
not available to satisfy human needs because it is in polar ice caps, glaciers, or deep
groundwater aquifers that cannot be reached (Butts, 1997).

Along with availability, other water problems relate to quality or quantity. For
instance, water quality is a major concern in the eastern portion of the United States while the
western portion of the country focuses on water quantity. Mexico has both quality and quantity problems with the water coming from the Colorado and Rio Grande Rivers. North China, like many other countries, has water scarcity problems because of water usage for agriculture. Furthermore, World Bank statistics identify more than 20 countries having water shortages, including Saudi Arabia, Jordan, Israel, Kuwait, Egypt, Kenya and Singapore (Butts, 1997).

An example of a typical regional water problem in the United States is located in the state of Texas, where a major problem has resulted from population growth, leading to an increase in the demand of high quality water. Texas, like every other area, is subject to the weather. Recurring fluctuations in rainfall and periodic droughts have created a feast-to-famine cycle in Texas. Another problem is unwise use of household water. For instance, a quarter of the water supply in urban Texas is used for high landscape and garden watering or it is simply used inefficiently (Welsh, Welch, and Duble, 2000).

Basic water conservation is one of the most profound challenges to human development. Billions of people lack access to safe drinking water and adequate sanitation systems. Listed below are the main water resources available (Vickers, 2001).

**Groundwater.** Water is stored underground in aquifers, which may contain both fresh and salty water. The quantity of water in the aquifer depends on the recharge of water into it. The use of aquifer water without good management can cause deficits in water supply. Most areas of the world depend on groundwater, some more than others (Walker, 1978).

**Lakes.** Lakes are natural water tanks, holding water from rain or snowfall. In the lake, water quality is altered by density modulations and wind generated currents (Walker,
Lakes have substantial quantities of iron and occasionally manganese, which are caused by leaves, algae, and dead fish, to develop on the bottom of the lake (Walker, 1978). Treatment of lake water takes time and is not cheap.

**Rivers.** Rivers, similar to lakes, are created from rain or snow. The quantity of water in a river depends on heavy rains or flash runoff from melting snows. Rivers have pollution problems, which can occur naturally or as a result of human development (Walker, 1978).

**Rainwater Tanks.** This is a method of water storage that people use, collecting water from roofs during rain so that it may be used in the dry season. The cistern is an important water source in Australia, where water conservation is not available and groundwater is brackish. This source produces a problem in water quality because the water often contains bird droppings, wind-blown bacteria and fungi, as well as airborne pollution (Goosen & Shayya, 1999).

**Desalination.** To solve the water shortage in arid areas such as deserts, engineers have developed the process of water desalination, whereby fresh drinking water is made from salty water. This process is very expensive. Saudi Arabia, for instance, has 30 desalination plants on both its west and east coasts that produce drinking water (Whipple, 1994).

**Statement of the Problem**

“Water shortages and water-quality issues are global, not simply local. Emergence of these issues is a matter of 'when', not 'if'. There is a need to both conserve and clean up the world’s water supplies. Solutions need to be based on site-specific determinants and have long-term considerations.” (Cathey, 3/15/2003, p. 3).

“Water may be the resource that defines the limits of sustainable development,” states a 2001 United Nations Population Fund report (Harvey, 2002, p. 1). These statements reflect
many water-related problems, whether defined by quantity or quality. This research focuses on four problems, which are related to water usage and human behavior. Ideally, the research would take place in Saudi Arabia, but, because of travel problems and the difficulty of gathering information there, the research has been confined to a more accessible location with many of the same problems. The area selected for study and date is Tucson, Arizona.

The four major similar water issues are:

1. Accessible commodity;
2. "Use or Lose It" principle;
3. Government or systems related problems; and
4. Water consumption and irrigation

1. **Accessible commodity.** Despite the fact that water sources are limited, water has long been considered an inexhaustible commodity (Vickers, 2001). The accessible commodity misconception comes from two wrong ideas. The first one is overestimation of water quantity. The second one is that many people think that water supply is going to be continuous for a very long time. These two misunderstandings about the nature of water resources lead many people to overuse water and consume more than they need in all aspects of life including household use, industrial use, and agricultural use. They do not consider the water needs of future generations. Overuse of water becomes more dangerous as the world's population and water pollution increases day after day.

2. **"Use it or lose it" principle.** There are two schools of thought regarding the "use it or lose it" principle. Some Americans believe that "water in a stream is a moving resource, water left unused by one person may be used by others" (Green, 2002 p.1). A common misconception among people is that water saved in reservoirs leaks out whether it is used or
not. Some people in Saudi Arabia believe that they can’t guard water when they read this Quran verse “we send the fecundating winds, then cause the rain to descend from the sky, therewith providing you with water (in abundance), though you are not the guardians of its stores” (Quran, 15:22). This principle is widely criticized because it is believed to encourage waste and inefficiency and inhibit environmental or stream flow protection.

3. Government or state related problems. Governments are responsible for providing consumers with their water needs either through governmental departments or through the private sector. On the other hand, governments are responsible for preserving water and its resources. However, this doesn’t mean that governments should always take the initiative regarding water preservation actions. Unfortunately, many people are misinformed about that and they think that if the government does not take any action then everything is running smoothly and there aren’t any problems. This misconception makes people careless about their water consumption habits and they always wait for the government to take some action. This misconception leads some to believe that any drought season, water shortage, or water pollution threat is a challenge for the government and not the people.

4. Water consumption and irrigation. Farmers use the largest amount of water for irrigation. Because the government often subsidizes farmers, they tend not to use water wisely since it is cheap for them (Vickers, 2001). Irrigation often takes up to 80 percent of all water used in an area, with industry and human consumption using the balance. This accounts for a great deal of lost or wasted water, which could be used for other purposes. Moreover, the public brings up the fact that irrigation makes up the bulk of water consumption when the focus turns to limiting urban water usage. They argue that the government should put more rules and regulations on the farmers’ usage.
Purpose and Objectives of the Study

The purpose of this study is to explore and determine how to export the knowledge and experience of the educational systems in the United States to Saudi Arabia, in order to address water quality and quantity issues there.

This research intended to focus on seven objectives, using existing information in the State of Arizona or the tools explained later in chapter three.

1. **Identify the roles of the formal educational process on students' water consumption behavior.**

   This goal has two sub-goals:

   A) *Identity existing curricula of public schools in Tucson, Arizona.* The researcher looked at the curricula of Tucson, Arizona schools to analyze the amount of water-related material covered.

   B) *Identify existing facilitators' roles in public schools.* Teachers help students to improve their knowledge and skills in the subject matter they teach. In this goal, the researcher wanted to determine the teachers' methodology and philosophy of teaching in public and private schools to influence their students' water consumption behavior. A good strategy on the part of the facilitator can make it easier for their students to understand the importance of water resources and how to preserve them. The facilitator is aware that he/she might be confronted by different ideas from the class that would be of high impact on the topic.

2. **Identify the roles of the city of Tucson, Arizona in water conservation.**

   Identify the roles of Department of Tucson Water extension activities on the water consumption behavior of the community members. The responsibility of the Department of
Tucson Water extension is not only to provide water service, but also to help in educating people regarding the water problem. This goal will try to clarify what kind of role this department plays. It will also try to find out how the Department of Tucson Water extension has implemented the water legislation. There are laws governing the way water should be used and consumed by farmers and local people, in general. A step forward should be taken in educating water consumers about their rights and their water consumption behaviors and responsibilities.

3. **Identify the roles of parental direction on the water consumption behavior of their children.** Family plays a major role in education. Families help their children to improve their knowledge and skills, which help them throughout their lives. To implement this goal, it was necessary to find out if it is a common thing for a family to educate their children on how to use water; for instance, while bathing, washing dishes or watering the garden.

4. **Identify the roles of faith teachings and religious practice on changing water consumption behavior.** Religion helps people to build their morals and values towards life issues. To reach this goal, it was necessary to determine if there are community standards that have improved the ideas of preserving water.

5. **Identify the roles of the University of Arizona's academic programs and extension services on the water consumption behavior of students, farmers and the whole community.** To reach this goal, it was necessary to determine the degree of cooperation that exists among the university departments and Tucson's public and private organizations, when it comes to increasing the public's awareness of the water shortage. This goal also has three sub-goals: A) to understand the role of the Arizona Water
Resources Research Center (WRRC); B) to understand the role of the Agricultural Education Department in raising awareness among teachers and preparing them dealing with future water problems; C) to understand the role of Agricultural Extension to help farmers to manage their water uses.

6. **Identify the roles of the different media programs on water consumption behavior of the public.** The media helps professional and specialists to achieve their goal(s) to increase people's awareness of and action toward the water shortage. The media has the greatest advantage of being able to carry the fastest messages to the people. Professionals can choose among the print, audio, and visual media, which are able to both massage and then carry the message to large audiences. In this research, professionals were defined as those who are engaged in knowledge, have specialized training, and or are experts in their fields especially in water education.

7. **Propose a new model for applying these programs in Saudi Arabia.** The final step is to conduct an analysis of the data that was collected from Tucson, Arizona and create a model that can be applied in the Kingdom of Saudi Arabia in an effort to solve the water problems there. Investigation of Tucson, Arizona's school curricula, agricultural extension agencies, teacher programs and meetings with teachers will help to build new ideas, models and programs that will guide the future curricula in Saudi Arabia schools.

**Why Tucson, Arizona?**

The city of Tucson in the State of Arizona was selected as a comparison for this research because of the similarity of its hydrological, geographical and atmospheric conditions to those of Saudi Arabia. For instance, both places are surrounded by desert, their temperatures are comparable, and they rely on groundwater. Moreover, the city of Tucson
has the lowest average water use per person in the state of Arizona. The average household water usage in Tucson is 160 gallons per day (California Economic Case Study, 2001). Furthermore, the average residential customer usages (per day per gallon) in other various communities throughout Arizona for the year 2000 are: Sierra Vista 378, Sedona 360, Apache Junction 309, Phoenix 260, Rimrock 227, and Superior 220 (California Economic Case Study, 2001, Sedona Community Plan, 2002). The University of Arizona is located in Tucson, which has the College of Agriculture and the Department of Agricultural Education. In addition, the Tucson Water Department works to increase local awareness regarding water problems.

**The Arizona Water Resources Research Center (WRRC)**

Established in 1957, the mission of the WRRC is "to provide statewide outreach and education focused on critical water issues affecting Arizona and to provide expertise on state and regional water management and policy" (Water Resources Research Center, 2003). Located within the College of Agriculture and Life Sciences at the University of Arizona, the WRRC administers the Federal 104 grant program authorized by the Water Resources Research Act of 1964. Related missions are to communicate water-related research needs from research users to researchers, and to report research findings to potential users of that information. The WRRC works with public/private organizations and individuals to provide information and services through outreach, conferences and symposia, and a publications program that includes two newsletters (Water Resources Research Center, 2003).

**Tucson Water Department**

One of the major departments in the city of Tucson is Tucson Water Department, which offers utilities for serving both potable and non-potable water to a customer base of
approximately 675,000 people located in a 375-square-mile area within the Tucson, Arizona metropolitan area. The utility has a staff of more than 575 people (Tucson Water Department, 2003).

The role of Tucson Water is to provide a safe, reliable, and sustainable water source to customers while managing groundwater use to meet future demands. Tucson Water's mission is to ensure customer satisfaction by consistently delivering high quality water and service in a cost-efficient, environmentally responsible manner, today, and for the future (Tucson Water Department, 2003).

**Why this applies in Saudi Arabia?**

The growth rate of the population is very high in Saudi Arabia. It is 3.28% and the expected need of water to meet the population’s demands is very high. Water is one of the most crucial issues in the desert because there are droughts and less rain during the year in a country like Saudi Arabia. " Saudi Arabia now relies on groundwater to meet 75 percent of its water needs, moreover Saudi Arabia's ground water could run out early in the next century" (Mining Groundwater: Saudi Arabia and the United States, 2003, p. 1).

Unfortunately, Saudi Arabian authorities did not realize the significance of education as a tool to deal with the water shortage problem. Saudi Arabia will not start from zero, but will seek help from expert people and expert organizations like the ones in Tucson, Arizona. Saudi Arabia provides 576 million gallons of fresh water a day and on average uses 260 gallons of water a day per person. Tucson, on the other hand, uses 160 gallons a day per person. (Balharith, 1995, and The water Sector in the Kingdom of Saudi Arabia, 2003).

The other impetus for developing a model to apply the information in Saudi Arabia is
because the King Saud University, which supports the researcher financially, is looking for
the benefits from the scholarship that has been provided to the researcher during his study

**Need for the Study**

There is no life without water! Human health, food production, and economic
development all depend on water. "Today, nearly 40 percent of the world’s food supply is
grown under irrigation, and a large diversity of industrial processes depends on water"
(Sherbinin, 1997, p. 3). Scientists expect that population growth and urbanization in this
century, together with changes in production and consumption, will place unprecedented
demands on water resources. Already, humans use more than one-half of all accessible
surface water runoff. Moreover, more than one billion people today lack access to an
adequate supply of safe water for household use (Sherbinin, 1997). "In 30 years, as many as
5.5 billion people may live in areas suffering from moderate to severe pressure on water
resources, rendering the provision of safe water even more difficult "(Sherbinin, 997, p.1).
Educational planners have the responsibility to educate people about the future of water
resources and about how to solve the problems they face (Sherbinin, 1997).

Because Saudi Arabia is an important country in the Middle East, it could be a leader
in the development of water conservation in that part of the world. It is a desert country
where there are no rivers and very little rain during the year. The population growth rate is
3.28% with the current population at 22,023,506 people. Therefore, the people must be
reached about the need for water conservation. New technology is needed to help the
government achieve this goal (Royal Embassy of Saudi Arabia Washington D.C. (RESAW),
2003).
Although the people may be thinking about water problems, they do not translate this process into action. According to Goddard, people take action when they are aware of problems, understand the problems, and believe they can make a difference. As a result of that, educators and scientists have to work together to achieve a good plan for the future (Goddard, 2000).

**Research Questions**

To meet the research objectives, the following general questions guided the research:

1. What is the impact of education related to the water shortage in Tucson? This question focuses on:
   - Determining the benefits from public education
   - Identifying the significance of these curricula
   - Determining the family role as a guideline for children

2. What are the perceptions of the public towards (public education, curricula, media program, religion) the water shortage in Tucson?

3. Are there any similarities/differences in understanding the water issue between high school seniors who took agricultural courses and those who did not?

4. What are the perceptions of Tucson teachers regarding water shortage teaching methodology in school?

5. What roles does the University of Arizona have when it comes to increasing the public's awareness toward water usage and the water shortage problem in Arizona, in general, and in Tucson, specifically?
Implications and Educational Significance

This study has tremendous educational implications that support teaching learning processes, curricula development, program planning, evaluation of school impact, evaluation of institutional impact on environmental educational programs in general and the water shortage specifically. The study proposes that requiring agricultural and environmental education at the university level will help solve the water shortage problem in Tucson long term. This study findings shows that traditional teaching in schools is not effective in preparing students for such real life crises. Instead, hands-on application (i.e. in agricultural education) and applying theories in real life situations is a better solution for improving learning and practice. The study findings suggest that education should be focused on people’s needs and point to the impact of formal and informal education related to those needs. Teachers believe that the background in undergraduate courses has to be focused on what teachers want to teach. Findings suggest that offering courses in environmental and agricultural education would also help teachers in their career. Required courses in agricultural education that help people to improve their situations, teacher training, society’s involvement in school administrative decisions and program design are major concerns.

The study will benefit researchers in both agricultural and environmental education. The results show the need of cooperation and collaboration among public and private organizations.

The study relies heavily on the Ministries of (Public Education, Higher Education, Agriculture, and Water and Electricity) in Saudi Arabia. Moreover, its findings are important to the Agricultural Extension and Rural Sociology Department at King Saud University.
The conclusion offers the best method for solving water problems and encourages all of society to become part of the solution by employing both formal and non-formal education.

**Operational Definitions**

The following definitions were adapted from the Merriam-Webster's Dictionary and the American heritage dictionary of Science.

**Agricultural Extension Agency**: an administrative unit of government or private organization that specializes in helping farmers to and improving the production methods of food and raw materials by cultivating certain plants, managing their irrigation field, and raising domesticated animals.

**Aquifer**: a layer or section of earth or rock that contains groundwater.

**Church**: a building for public, especially Christian, worship.

**City Counsel**: a body that gives direction or advice as to a decision or course of action.

**Curriculum**: a course of academic studies or a set of courses constituting an area of specialization.

**Desalination**: production of fresh water by removing salt from seawater or brackish water through the application of energy, usually oil or other fossil fuels.

**Education**: the result of good upbringing (especially knowledge of correct social behavior) or the activities of educating or instructing or teaching; activities that impart knowledge or skill.

**Family**: primary social group: parents and children.

**Fresh Water**: describes any body of water that contains minimal salt, such as rivers and
lakes.

**Groundwater:** any water naturally stored underground in aquifers, or that flows through and saturates soil and rock, supplying springs and wells (Sustaining Water).

**House of Worship:** any building where congregations gather for prayer for example (church, mosque, synagogue, and temple)

**Islam:** Muslims collectively and their civilization; based on a monotheistic religion believing that Mohammed was the last and major prophet of God.

**Media:** transmissions that are disseminated widely to the public.

**Ministry of Education:** a government department under the direction of a minister who oversees the profession of teaching (especially at a school or college or university).

**Ministry of Water:** a government department under the direction of a minister that deals with water issues in Saudi Arabia, including getting water to each home, sending water bills and taking responsibility for public water in all Saudi Arabian regions.

**Mosque:** a worship space for an Islamic community.

**Non-renewable Water:** water in aquifers and other natural reservoirs that is not recharged, or is recharged so slowly that significant withdrawal will cause depletion (Sustaining Water).

**Population:** the total of individuals occupying an area or making up a whole.

**Professional:** who are engaged in knowledge, have specialized training, and or are experts in their fields especially in water education.

**Renewable Water:** water continuously renewed within reasonable time spans by the hydrologic cycle, such as that in streams, reservoirs or other sources that refill from precipitation or runoff. The renewability of a water source depends both on its natural rate of recharge and the rate at which the water is withdrawn for human ends. To the extent water is
withdrawn faster than its source is recharged, it cannot be considered renewable (Sustaining Water).

**Role**: normal or customary activity of a person in a particular social setting.

**Runoff**: water originating as rain or snow that runs off the land in streams, eventually reaching oceans, inland seas, or aquifers unless it evaporates first.

**School**: a public elementary, junior high or high school in the United States.

**State of Arizona**: A state in southwestern United States; site of the Grand Canyon

**Tucson**: A city of southeast Arizona south-southeast of Phoenix with population around 850,000

**Water Consumption**: use of water that allows evaporation or makes it unfit for any subsequent use.

**Water Scarcity**: a condition in which the annual availability of renewable fresh water is 1,000 cubic meters or less per person in the population.

**Water Shortage**: when the amount of water is less than expected or required.

**Water Stress**: condition in which the annual availability of renewable fresh water is less than 1,667 and greater than 1,000 cubic meters per person in the population (Sustaining Water).

**Water**: binary compound that occurs at room temperature as a clear, colorless, odorless, tasteless liquid.
CHAPTER II. LITERATURE REVIEW

In this chapter, the researcher presented a review of the water-related dilemma occurring in Saudi Arabia to provide a more realistic background of the problem. Also included in this chapter is a discussion of the positive aspects of educating students as a possible solution for overcoming this pending environmental disaster. The State of Arizona has been selected as a comparison in this research because of the similarity between its hydrological, geographical and atmospheric conditions to those of Saudi Arabia. For instance, both places are surrounded by desert, their temperatures are comparable, and they rely on groundwater. Because of these same natural conditions, both places suffer from similar types of water-shortage problems.

Groundwater in Tucson and Saudi Arabia

Tucson, Arizona, a city in an arid environment with an annual rainfall of 11 inches, is experiencing tremendous pressure on its water resources because of in-fill housing construction within the city proper, urbanization that is pushing the city’s boundaries further and further outward and the impact of economic growth. It is reported that fifty percent of the water used comes from groundwater (Jacobs, 1997). This has affected Tucson’s water policies. During 1997, water demand in Tucson was 345,400 acre-feet. Renewable supplies of natural groundwater replenishment, CAP water and effluent totaled only 194,500 acre-feet, leaving Tucson with a water deficit of 150,900 acre-feet of mined groundwater (Gelt et al., 1999). If CAP water had not been available to irrigate some agricultural land, groundwater would have been used instead. Even with the added CAP water, the result is that Tucson is pumping far more groundwater than is being replaced in the aquifer. This situation is not sustainable in the long run. The only options left for the Tucson area are to
make full use of CAP water, make greater use of reclaimed water, severely limit current and future water demand or some combination of these strategies (Gelt et al., 1999).

These issues are similar to those in Saudi Arabia, because both places rely on groundwater. The difference between the two can be found in that Arizona has additional surface water resources, utilizes reclaimed water, and receives supplementary water from the Colorado River through the Central Arizona Project (CAP). Saudi Arabia, on the other hand, has two different types of groundwater sources: alluvial aquifers and confined aquifers. Alluvials represent the renewable part of groundwater; the 27 confined aquifers are non-renewable and can be depleted through sustained usage. Saudi Arabia also has more desalination plants than any other country from which to draw its water supplies (Al-Sabby, Harris & Fox, 2002), and it has recently begun using reclaimed wastewater for agriculture and industry.

Saudi Arabia harvests less than 3.94 inches of rain per year out of its potential 78.74 inches. Fifty percent is lost in evaporation through water runoff in Wadis and 20% evaporates immediately. In the north, it is less than 3.54 inches and in the south it may be as high as 19.68 inches. Rainfall itself is not consistent. One year in Riyadh, it was 0.53 inches, and the next, it was 8.51 inches. There are no permanent rivers, but occasional runoff does occur during the rainy season in the coastal areas and in the highlands of the southwest. Furthermore, there are also 18 aquifer wells supplying groundwater. To recharge the aquifers, the government has constructed 200 dams of different types throughout the country, as well as storage capacities to utilize the runoff water. Nonetheless, aquifer recharge is inefficient, though possible, and would require many years to recoup pumping losses. Because of its limited water resources, Saudi Arabia depends upon desalinated water, so 30
desalination plants have been built, which have a maximum capacity of 890 million cubic meters of water (Water Industries Market in Saudi Arabia).

The statistics for breakdown of use are very confusing. Al-Sabby et al. (2002) states that Saudi Arabia’s water usage is split at 70% for irrigation, 25% for municipal use and 5% for industry. On the other hand, Bakir (2001) states that use is divided into 9% for domestic use, 1% for industry and 90% for agriculture. No matter how it is looked at, similar to Tucson, Saudi Arabia is pumping far more groundwater than is being replenished, and Saudi Arabia faces an additional dilemma in that it does not have any rivers or lakes from which water can be diverted while groundwater is being refurbished.

Another problem is that while the entire city of Tucson has a sewage system that adequately meets the needs of all of its residents, this cannot be said of Saudi Arabia. In fact, sewage systems are almost non-existent. Out of 106 municipal areas throughout the kingdom, only 22 areas have adequate systems. Many small rural towns have no sewage system at all. This has dire consequences for Saudi groundwater because of cross contamination of groundwater with sewage (Water Industries Market in Saudi Arabia, 2003).

Tucson has another advantage in that its city government has programs for water conservation, such as “Beat the Peak,” which uses conservation concepts to educate people regarding water usages, it has many different approaches to urge the public to restrict water use during peak hours (Gelt et al., 1999). Tucson’s citizens are very water conscious in that individual homeowners invest in water saving devices, such as 1.6-gallon flush toilets, reduced water-flow showerheads and spigots and xeriscape landscaping (Gelt et al., 1999). In the past, there had been no strong laws in either country to manage groundwater withdrawal until the State of Arizona passed the Groundwater Management Act in 1980, and
water conservation became an official state policy. This provided the state with three management tools to meet its water goals: (1) conservation methods, (2) the Assured Water Supply Program, and (3) an augmentation program to increase the water supply. The plan required a mandatory date be met to comply with the law (Gelt et al., 1999).

The conservation policy requires all water users to meet progressive conservation measures designed to achieve the safe-yield goal by 2025. The Assured Water Supply program requires that water providers must demonstrate a sufficient water supply to meet the needs of projected growth and development for the next 100 years. The augmentation program seeks to develop additional water supplies via artificial groundwater recharge, importation of water, and water storage. (Al-Subby et al., 2002, p. 120).

Unlike Tucson, Saudi Arabia has not actively involved its citizens in the water problem to the point where it has become an individual's personal responsibility to conserve water. Saudis use 260 gallons of water a day per person compared to Tucson's rate of 160 gallons, Turkey's 258.5 gallons and the Gulf Region's 260 gallons a day per person (Balharith, 1995). One of the greatest water problems encountered in Saudi Arabia is that the toilet flush boxes use about 15 to 20 liters or 4-5 gallons per flush compared to the American flush boxes, which by law must now be no larger than 6 liters or 1.6 gallons, and this accounts for 30 to 40 percent of Saudi household water consumption (The Water Sector in the Kingdom of Saudi Arabia).

Water in Saudi Arabia is a government responsibility and only recently, in the Seventh Development Plan (2000-2004), has it included private enterprise to help it meet the spiraling demand for water. A national Water Strategy Plan, which the Ministry hopes to carry out in the near future, will determine the available groundwater resources and, based on
findings, the long and medium term policies will be determined. While there is a water plan in effect that will cost the Saudi Arabian government $81 billion dollars to achieve by 2024 and involves development of more desalination plants and sewage plants, as of yet, there has been no implementation of citizen incentives to conserve water (Water Industries Market in Saudi Arabia, 2003).

**Groundwater Recharge**

The State of Arizona and Saudi Arabia have a problem regarding the role of aquifers in groundwater recharge. In spite of this huge dependency on groundwater sources, there is widespread ignorance about the nature of this essential water source among people, in general, and among farmers, in particular. Groundwater can be renewed, as shown in research by Palmer and others in 1997. Glaser, Evenson, and Wildermuth's work concluded that water injection, which recharges groundwater by injecting rainfall or treated wastewater to the aquifer, helps significantly in reducing the average rate of groundwater decline. The problem in Tucson is that the groundwater is being drawn down before it can be recharged and at the moment, Tucson, with the rest of the Southwest, is experiencing drought conditions. In Saudi Arabia, the aquifers are not being recharged because there is not enough rainfall (Palmer et al., 1997).

**Water Problems of Other Countries**

Serious water shortages exist in all countries. Although three-fourths of the earth’s surface is covered with water and humans consume only about one percent of the total, the problem is that water is often found in the wrong place at the wrong time. Usually, the shortage is resolved by mining underground water sources, which results in a drop in water
tables, i.e., the water tables around Phoenix, Arizona in the United States have dropped more than 400 feet in the past 50 years. In Tucson, Arizona, the Metro Water District measures the level of groundwater in its wells annually. The recent measurements showed that 15% of its wells have declined slightly more than five feet since 2001. Previously, Tucson had experienced three-foot drops for some wells, so the five-foot decline showed the Metro Water District that it had to accelerate its efforts to utilize renewable water (Val Little, Water Conservation Alliance of Southern Arizona at the University of Arizona, personal conversation, 7/10/03).

This over drafting would not be a problem if the water was replaced by recharge quickly enough to keep the aquifer from being depleted (Anderson & Wentworth, 1997). The lack of substantial natural recharge is the main factor in the decline in Tucson's groundwater levels. The past two dry winters of 2001 and 2002 in Tucson have substantially limited natural recharge and weather projections do not forecast the needed moisture for the foreseeable future. The increasing use of groundwater means less water moves down the watershed to Metro Water District's wells.

The Water District is attempting to be proactive in addressing its current and future water resource needs and so it has undertaken a substantial Capital Improvement Program to ensure the water system meets the city's needs. Although conservation is important, it is not enough to solve the city's water problems. "The decline in water levels clearly shows that significant replenishment of groundwater needs to take place" (Val Little, private conversation, 7/10/03). Tucson has the added problem of the reduction in groundwater continuing to erode the water storage system. Highways, railroads, buildings, aqueducts, irrigation systems, wells and sewage systems will be damaged as the land sinks depending on
geographic location and type of structure (Carpenter, 1991).

Water quality is also another serious problem. During the 1970’s, 25% of the world’s population had access to water resources that did not meet the drinking water quality standards. By 1980, this figure had risen to forty-three percent (Anderson & Wentworth, 1997). In Saudi Arabia, most of the groundwater is salty and has to be blended with desalinated water in some cities to be drinkable. The over-pumping of groundwater has worsened the groundwater quality. Part of this problem is due to poor quality of sanitary and drainage system and the use of inorganic fertilizers and pesticides (Water Resources of Saudi Arabia, 2003).

Egypt, like Saudi Arabia, is a country with very little annual rainfall. It ranges from 7.87 inches near the Mediterranean coasts to practically zero near Cairo. The Nile is a single flowing river until it enters Egypt where it divides into two branches. Development and increased demand have made it clear that Egypt needs other water resources and better management of the Nile. The balance between the available and required needs of water in Egypt is fragile. Egypt has two major conventional water resources: renewable (Nile water and groundwater in the Nile Delta and the Nile Valley) and nonrenewable (groundwater). The non-conventional resources consist of treated wastewater, desalinated water and recycled drainage water (Simonovic, Fahmy, & El-Shorbagy, 1997).

In Egypt, as in Saudi Arabia, the agricultural use of water is high at 85% of the total consumption. The remaining 15% is divided between domestic and industrial use. To date in Egypt, there has been enough water to meet population growth, industrial development and agricultural expansion. However, water sustainability shows an expected scarcity for the 21st century because environment and water quality planning were sometimes not taken as
seriously as they should have been (Simonovic, Fahmy, & El-Shorbagy, 1997).

Planners have not taken a continuous look at the future, although resource development and growth requirements usually vary with time. The reason for this was that previous policies for dealing with the future were subject to uncertainties, such as changes in technology, development preferences and institutional requirements so decisions were put aside. Nature itself is an uncertainty with its droughts and floods and these uncertainties also make it difficult to estimate future resource needs and no resource requirements or alternatives have been developed (Simonovic, Fahmy, & El-Shorbagy, 1997).

For its agricultural sector, Egypt has adopted a free cropping pattern, which existing system of versatile canal regulation to release timely deliveries due to flood and drought season, but the impact on water policies has yet to be defined. Nonetheless, any planning now or for the future is dependent on the economic development of its agricultural sector (Simonovic, Fahmy, & El-Shorbagy, 1997).

Saudi Arabia has also experienced a similar situation. After the oil embargo of the 1970s, the Saudi government realized that it was vulnerable to a grain embargo. So Saudi Arabia initiated an agricultural plan to become self-sufficient in grain. The government subsidized land, equipment and water for the farmers and bought crops from them at prices above the world market to encourage farmers to devote their fields to wheat growing, while the farmers paid nothing for the water. Wheat is produced on 24-hour pivotal irrigation systems, which is responsible for the tremendous drain on groundwater. The wheat harvest grew from several tons in the 1970s to over 5 million tons in 1994. In that same year, water demand was 20 billion cubic meters, and 85% of it came from non-renewable groundwater. Barley was another crop that was heavily subsidized and caused a drain on groundwater.
The government realized that groundwater supplies would run out by 2030 and so they withdrew their price support for rice and wheat. Wheat production has fallen from 4.5 million metric tons in 1992 to 1.8 million metric tons in 1993. Similarly, barley production has dropped from 2.2 million metric tons to its current rate of 100,000 metric tons and Saudi Arabia is once again importing wheat (Earth’s Reserves of Groundwater Threatened, 2000). When the farmers saw their lands lying barren, they turned to forage production of alfalfa and Sudan grass to supply the dairy industry. These crops have the same 24-hour central pivot irrigation needs as wheat. While government research shows that these grains are as bad, if not worse, than wheat in water use and the government has been talking about banning forage production for two years now, so far no action has been taken (Mousa, 2002).

Jordan, another Middle Eastern country, is also threatened with a national water crisis in the 21st century. All of its known water sources have been exploited, even while the population is continuing to grow at the rate of 3.8% per year. This means demand will increase over time and Jordan is seeking ways to meet the needs of its citizens. At the current time, Jordanian households receive 66 liters or 17.16 gallons per capita per day and efficient consumption is the responsibility of all households. In an attempt to improve water retrieval, all new homes must be constructed with water storage tanks fed by runoff rainwater. However, Jordan feels regulation and municipal management alone cannot solve Jordan’s anticipated future water needs. They advocate education and communication strategies promoting water conservation (Middlestadt et al., 2001). Because of the impact of education on water conservation, it is discussed in a later section under “Curriculum.”

Another example of a country experiencing the same problems as Saudi Arabia is Malta, in the Mediterranean region. Rising water demands have forced an increase in the
amount of production. Groundwater has been used over and above a sustainable yield and has resulted in shortages of high quality water. The high saline levels in ground and tap water are injurious to human health, and in some cases, dangerous to industry and agriculture. One of the biggest problems occurs from the use of agricultural chemicals. Nitrate compound concentrations have deteriorated groundwater to unacceptable levels (Birdi, 1997).

To curb excessive use of groundwater and poor quality tap water, Malta has built desalination plants, which use reverse osmosis. This is the same system employed by Saudi Arabia in 24 of its desalination plants. This has not settled the problem in Malta because of the inequality in the distribution system. Some areas receive little or no water or water of questionable quality, while others receive a large share of good quality water. Severe water rationing has been necessary because of water shortages in most settlements, particularly in times of low rainfall (Birdi, 1997).

This same situation is occurring in Saudi Arabia where urban and environmental factors have put pressures on certain areas. For instance, because some cities are divided into zones and water is distributed on a shift program, some districts can go up to 4 days without water. When the holy seasons of Hajj and Ramadan occur, seven million people visit Mecca. To meet the demand, water is transferred from Jeddah’s desalination plant to Mecca. Other areas that suffer from water diverted to Mecca are the districts within mountainous topography, resulting in some areas not receiving water for 12 days straight (Services, Utilities and Development Committee, 1995).

Another situation in Malta is the increase in the production of drinking water to meet rising demands. These demands stem from the domestic sector, which is experiencing better
living conditions, housing availability, and a rejection of old values of water conservation. As the standard of living increases, the population has been acquiring water consumptive appliances, which are not designed for the type of weather that occurs in Malta. The people actually believe that the desalination plants can supply a bottomless amount of water and because the price was lowered when desalinated water came on line, all incentives to use it efficiently gave way to overuse in many households (Birdi, 1997).

The Cost of Water and the Resident User

The cost of water to the general public in Saudi Arabia is very low. This price structure in Saudi Arabia has had the same effect as that in Malta and, in fact, all countries throughout the world. Low prices cause harm to the environment and decrease the availability of water to large groups of people because there is no incentive for people to use water wisely and so they waste it. When talk turns to raising prices to reflect the true cost of supplying water, the population accuses the government of depriving people of the water that they need (Anderson & Wentworth, 1997).

The low price structure is a result of subsidized use of water in which water projects are created and built by national governments and is typical throughout the world. Although the largest share of inexpensive or free water goes to farmers, it is also a low-priced commodity available to the general public. While it is then used to provide food, cleanliness and drinking water to everyone, the low prices harm the environment because people have no incentive to use the resource wisely (Anderson & Wentworth, 1997).

In the past, Tucson, like Saudi Arabia, had reached a point where water use was greater than the capacity of the system and expensive upgrades seemed like the only alternative. What the Tucson governmental authorities did was approve an expensive rate
use structure and instituted conservation programs during peak season use. The citizens of Tucson soon realized that they were dependent on a finite source and it was going to cost them a lot more money for water. The price increase made water a pocketbook issue, which many consider the major factor in Tucsonans' present water use, i.e., reducing use to 27% from 1977 (Anderson & Wentworth, 1997).

The World Commission water specialists believe that a catastrophe is in the making because so far appropriate measures have not been taken to avoid the impending problem of lack of potable drinking water. The first step that needs to be taken is to value water properly, thus raising prices. In some places, water will have to rise high enough to reflect the full cost of production and delivery. Ismail Serageldin, Chairman of the World Commission on Water for the 21st Century and World Bank Vice President for Special Programs, states that the "situation has already reached crisis thresholds and may be economically irreversible." The Commission believes that the most important reform in water is to set a realistic price policy. Serageldin recommends "that pricing be adjusted to sustainable cost-recovery levels. Farmers, industry and consumers have become used to free or subsidized water in both rich and poor nations, which has skewed water use and led to over use and misuse of groundwater" (cited in Earth's Reserves of Groundwater Threatened, 2000).

The Cost of Water and Farmers

The United States, as well as Saudi Arabia and most other countries of the world, subsidizes water for farmers. As mentioned, Saudi farmers pay nothing while the typical farmer in the United States pays about one-fifth the true cost of irrigation from federal projects. This is a typical situation throughout the world. As a result, revenue collected from
farmers for water use covers about 10 to 20 percent of the construction and operating costs to supply water to them. This is instrumental in its overuse. Typically irrigation projects are less than 50% efficient and so much of the water used for crops runs off, taking with it the chemicals, such as herbicides and pesticides the farmer uses to increase his crop productivity, along with soil nutrients. Some farmers use water logging as a method of irrigation because water is cheap, but this too is wasteful. They also concentrate on high-valued, water intensive crops such as sugarcane, alfalfa and fruits (Anderson & Wentworth, 1997). As mentioned above, when Saudi Arabia withdrew its price supports for wheat, the farmers turned to alfalfa, another water intensive crop.

Research evidence indicates that the agricultural sector, which is responsible for about 80 to 90 percent of all water use, is also price-responsive (Vickers, 2001). For instance, in a study in California, a 10 percent price increase brought about a 6.5 percent decrease in water use. The findings show that when farmers pay more for water, they use less on a crop or they shift to a different irrigation technology and they change the way they plant their fields. If farmers could be motivated to cut their water use by higher prices, this would free up water for domestic use. It has been found that transferring just 5 percent of agricultural water to municipal uses would meet the needs of urban areas of the western United States for the next 25 years (Anderson & Wentworth, 1997). There is every reason to believe that savings like these would occur in Saudi Arabia or any other place in which water price increase is instituted. Anderson and Wentworth also suggest that privatization is a means of getting the government out of water production and that this would relieve the burden on the public treasury. In fact, Saudi Arabia is already considered taking this step with its June 2002 and November 2002 Council of Minister Resolution to privatize the water
and wastewater sector. Measures for private sector participation in the water sector are currently under consideration. So far about $1.5 billion dollars has been awarded to build water and sewer networks in various cities. Saudi Arabia has also provided an incentive award of 1 million pounds to scientists and scholars who provide solutions to a wide range of water problems (Water Industries Market in Saudi Arabia).

**Water Leakage**

Another problem that contributes to the amount of water wasted is water leakage. Every country suffers from this problem in one degree or another. For instance, the leakage rate in Saudi Arabia is estimated to be as high as 60 percent of the water produced by desalination plants because of inefficient use (The Water Sector in the Kingdom of Saudi Arabia). Additionally, the water distribution system contributes to the problem. Many houses that receive piped water do not have meters and, therefore, are charged at a flat rate. Also inefficient design, poor installation and inadequate maintenance of the system cause significant leakage (Water Resources of Saudi Arabia). In Malta, about 20 percent of the water is lost in leakages, but, then, they also suffer from water meter under-registration, billing errors and water theft, all amounts that can be considered water leakage because they do not get recorded or billed (Birdi 1997). In Buenos Aires, more than half of the city's water used to leak out of the pipes and shortages occurred every summer. When the state transferred the system to a private consortium, not only did the leakages improve, but the system began showing a profit, while also lowering prices for consumers (Anderson & Wentworth, 1997).

**Recycled Water**

Wastewater usage is not as large as it could be, though it is still an important source
of water for both farm irrigation and industrial use. Although the Ministry of Agriculture has had a program since 1982 to utilize treatment sewage effluent from Riyadh Sewage Treatment Plant for the Ministry's farms and the farms of King Saud University, the fact is that wastewater treatment is a relatively new practice for use by individuals in Saudi Arabia (Water Industries Market in Saudi Arabia). Currently, recycled water use is expanding and is expected to provide 5% of the needed water resources by 2010.

In 1997, Saudi Arabia changed its building ordinance so that owners of new buildings, such as hotels and commercial centers, now must include a water recycling system in the design of the building when applying for a permit. The majority of treated water is used for flush toilets and irrigation. Big cities such as Riyadh and Jeddah are major users of recycled water. Riyadh has wastewater treatment stations that supply 464,000 cubic meters of water and expects to expand to 584,000 by 2005. Jeddah is also expanding its wastewater and sewage system and has approved $2.213 million dollars for projects related to its sewage system (The Water Sector in the Kingdom of Saudi Arabia).

In the United States, Florida ranks first and California second in overall use of recycled water (Solley, Pierce, & Perlman, 1998). As for Tucson, it too has one of the largest reclaimed water systems in the United States. In 2001, Tucson Water delivered about 3.2 billion gallons of reclaimed water and it added new customers and made progress on converting Tucson Electric Power's cooling towers to reclaimed water. In 2003, there were about 600 sites which include 14 golf courses, 32 parks, 40 schools (including the University of Arizona and Pima Community College) and more than 300 single family homes. In the process, Tucson Water saved 3.4 billion gallons of groundwater for drinking, enough for 31,000 families for a year (The Water Connection, 2003).
The Psychological and Moral Impact of Norms and Values on Conservation

Young people have impressionable minds. In youth, they can be taught social responsibility. Because individual students may have different experiences, some types of educational experiences may be more important to them than others.

It has been shown that education can have a positive impact on the development of an environmental philosophy and moral code. The earlier a subject, such as water conservation, is presented to students, the more entrenched it will remain in their psyches, even into adulthood, although to what degree has not been established. In fact, some research has shown that compared to young people's development rate, adult development rates diminish as an adult advances in age (Armon & Dawson, 1997). This condition is thought to be influenced by "genetic history, lifestyle, individual interests and activity, competence, access to resources, specific life events and general health" (Armon & Dansor, 1997, p. 447).

This, then, is a very important reason to begin teaching about environmental issues to young children and continuing the subject for as many years as an individual remains in school, even up to and including college.

In Brazil, most children, have an awareness, interest in, and moral commitment toward the environment (Howe, Kahn, & Freidman, 1996). But how long will these sensitivities last when children grow older and are subjected to economic and social pressures? They may have to make a decision between economic benefits and environmentally destructive behavior (Howe, Kahn, & Freidman, 1996). This is where a personal moral dilemma arises.

Since very young people usually do not experience conflict that comes with awareness of moral or social dilemmas, they are more accepting of problem-solving ideas
that are espoused during an educational experience about environmental problems, whether it pertains to pollution, energy use or water conservation. What students' need is to be taught skills that sensitize them to the dilemma. This kind of education is seldom provided (Howe, Kahn, & Freidman, 1996).

A sense of belonging is important in many cultures. In the United States, individualism is encouraged, but in places like the Middle East or where Islam is practiced, group cohesiveness is more important than the individual. Initiatives that influence social norms are not made on behalf of individuals, but are used to influence the norms of the community. The ultimate decision for taking action is highly dependent on the outcome of social values and social virtues established by the community. For the researcher, the concept of community social norms must also include the value of emotions, symbols, and humor in attempting to find a way to change behavior based on culturally determined values (Strategies for Awareness Raising, 2003).

Changing people's habits is difficult to do unless social norms and values, which influence actions, are taken into consideration. This is why it is important to educate the young students with healthy norms and values about water use before inappropriate behavior becomes a habit. It is easier to alter behavior before it becomes ingrained. Research also shows that the older, and more prosperous a person becomes, the less attention is paid to social problems. This is another reason to reach out to young people before their behavior becomes so entrenched that even if they have an attitude change, they do not change their behavior (Strategies for Awareness Raising, 2003).

For instance, involving children in water conservation projects has become a popular approach. Educating the next generation on healthy attitudes about water can meet time
requirements of imparting knowledge and changing behavior and at the same time, be
effective in reaching the entire community.

Downs (2000) believes a community can work together to change norms and values
via social and spiritual constructs. These involve three enabling dimensions:
(1) positive social interaction to identify and address priority needs; (2) knowledge sharing
and integration to find solutions supported by all social groups in collaboration: (3) an ethical
code of practice that values the needs of different human social groups and the needs of other
species sharing the ecological system, and guides social interaction and how knowledge is
used.

Where community norms and values are the guiding principles, public participation
offers an opportunity to exchange ideas, broaden awareness and involve more people in
deciding on group actions that must be taken to solve a problem. “In the past two decades,
both ‘typical’ development projects in the developing world and governmental policy makers
in the west have passionately advocated public participation” (Strategies for Awareness
Raising). This coming together can reset the norms and values in a community, providing
psychological glue for new moral guidelines in the culture.

A Different Approach

While it has been shown that there is a serious water problem, and that there are ways
to tackle this problem (i.e., possible rationing, price increases, reduction of leakages, use of
wastewater, and privatization), there is another untapped source that can be used in Saudi
Arabia and that is education, which involves individuals as part of the solution to the water
problem. While education about water in the United States, the city of Tucson, and the State
of Arizona is a reality, it does not exist in Saudi Arabia. A review of the benefits of
education on the school age population, the psychological impact of the moral issues, suggestions for a teacher-training program, and a curriculum that is currently in use in Tucson, Arizona is offered as a guideline for implementing a program for water conservation for children in Saudi Arabia.

**It Talks a Village**

The public believes that education takes place in schools where there are principles, teachers, curricula, and a formal setup. "A majority of people do not see the education process as very complex. The average person believes that education involves little more than a teacher standing up in a classroom and telling the students what he or she knows about subject" (Bowsher, 1989, p.13). In reality, this is not true because education is a process of learning that can take place anywhere. Learning happens in all aspects of life (Bowsher, 1989).

In society, public and private organizations have to be involved with education to improve awareness that groups of people, as well as individuals, can make a difference. Each member of society has a right and a responsibility to talk about their needs. Everyone who belongs to a society has concerns over important issues that they share with the other members of that society such security, housing, food, water, etc. Clinton (1996) used the concept of "It Takes a Village" in describing the best way of raising children. This study uses the same concept to investigate one of the important problems people face and how education can be used to deal with it. Water security is involved with people's needs, their daily lives, society's development, economics, and many other issues. No one can solve the water shortage in the world except through life education (family, society, and private and public organization) (Bowsher, 1989).
Thomas (1983) had a good discussion to see the symbiotic relationship between *politics* and *education*. He explained that each one influences the outcome of the other. His idea was used in this study to support the theoretical framework. Figure 1 shows the relationship and how each factor influences education and also how the directions of education did.

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<td>Groups: their interpretation of the laws</td>
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**EDUCATION**
- Formal and Non-formal Programs
- Philosophy: Goals; objectives, Administration
- Curricula: Teaching methods & materials
- Evaluation methods
- Certificates, diplomas
- Students and Staff

**Directions of influence:**

Figure 1. Education seen as enveloped in a political-ecology setting (Thomas, 1983, p.5)
Education

Education plays a major role in shaping human behavior. However, behavior depends on people's beliefs. Once people's beliefs are shaped, they can discuss to try to influence other people about their ideas. In the same context, Fishbin and Ajzen (1975) stated that "a person's beliefs serve as the information base that ultimately determines his attitudes, intentions, and behavior" (p. 14). Education helps in developing individuals who behave in desirable ways and allows or helps them to assume responsible citizenship. In United States, the education system goes beyond basic education in a traditional sense and has fostered the development of many environmental programs. Their goals are to develop student knowledge, skills, positive attitudes and motivation to take action to prevent and resolve environmental problems. But research has shown that there is a drawback in that knowledge of the environment by itself is not good enough. "Knowledge of environmental issues, issue skill analysis, and attitudes and values related to taking action are also necessary for the individual to take action and to act responsibly" (Howe & Disinger, 1988).

Knowledge of environmental issues involves an understanding of the problem. The ability to understand the issues prompts responsible environmental behavior. Values refer to the relative worth placed on environmental issues and values do influence how an individual will act on these issues (Ramsey, 1993). Ramsey believed that education not only develops responsible environmental behavior, it also develops psychological and sociological traits that are connected to this behavior. Further, studies show that students believe that individual actions are not as effective as group actions and that social interaction influences environmental problem solving to a greater degree (Ramsey, 1993).

As for Arizona's environmental program, it has not survived the scrutiny of political
interests. The passage of the Environmental Education Act in 1990 was considered a milestone, but one that did not last. In 1995, legislative action repealed the 1990 mandate and placed restrictions on environmental education. So, environmental education is no longer a required topic and if it is provided, it must follow current scientific data and address economic issues and social implications of environmental action. Nonetheless, water issues have not been ignored and remain an important part of a child’s education (Gelt et al., 1999).

Fortunately, cities such as Tucson, have developed water curriculum guides that involve the student from the earliest grades, continuing right on through to high school. The programs support concepts, attitudes and skills, which are put in place over time in a hierarchical manner. They involve cognitive and affective awareness. They require students to acquire the skills to analyze the issues, and the school provides experiences in a group situation in which individuals feel their efforts and actions make a difference. The educators and curriculum specialists have continued developing materials to help students recognize the important contribution they make when they adopt responsible environmental behavior (Home & Disinger, 1988).

In a first to sixth grade guide, water curriculum development has been designed to provide an emphasis on conservation over time so that when the student reaches the sixth grade, the concepts of conservation are fairly well embedded and as a result, conservation practices are carried over to the home (Home & Disinger, 1988).

Other researchers, such as Hungerford et al., (1988) have developed curriculum that involve four activities: 1) concepts which help the student make ecologically sound decisions; 2) awareness of how individual and collective behavior influences the quality of both life and the environment; 3) issue investigation to evaluate ways for correcting
problems; 4) environmental action skills to teach students how to take positive action to improve the environment.

All four activities are necessary to change behavior. These concepts can be taught to students from fourth grade to junior high and with some adaptation, even to high school and college students. Two important claims are that the longer the students study the subject, the better the outcome, and that working on real issues has proven more successful than those in which the students have not had such experiences.

In 1990, Hungerford and Volk cited the objectives of environmental education that promise responsible citizenship behavior as a result of the “Tbilisi Intergovernmental Conference on Environmental Education,” published in 1978. These objectives, which can be applied to water issues, are: awareness, fostering sensitivity to the environment and problems or issues that are encountered; sensitivity, in which an individual experiences and acquires a basic understanding of the environment; attitudes, which provide a set of values and concern for the environment; skills, for identifying and solving environmental problems; and participation, by being involved and working toward solutions.

Research now shows that for positive environmental involvement to occur, behavior has to change and instruction must go beyond “an awareness or knowledge” of the issue to opportunity to develop ownership and empowerment and get involved in citizenship responsibility. “The research is very clear on the matter. Citizenship behavior can be developed through environmental education. The strategies are known. The tools are available. The challenge lies in a willingness to do things differently than we have in the past” (Hungerford & Volk, 1990, p. 17).

So, while a great deal is understood about the psychological conditioning that
education is capable of formulating, there is still much to be learned. For instance, the question that has been on the minds of researchers is how to make environmental education, in particular water conservation, a viable learning experience. They seek an answer to: "What kind of educational experience produces a commitment to an active and engaged environmental philosophy: behavior or attitude?"

In response to this question, Leeming, et al., (1993) reviewed 34 articles on the effects of environmental education on knowledge, attitude and behavior. Leeming, et al., (1997) narrowed these completed studies on younger children down to six, concluded that only five of the six studies measured change in environmentally related behavior, and used these findings for a basis for their own research. Various types of environmentally relevant activities were examined for the effects on the children as a result of participation. In these reviews, it was found that one group of six graders, who were involved in unspecified environmental activities for two weeks, showed a more positive attitude toward the environment than those who were not involved. Other studies also showed positive results, including a study about water conservation attitudes. Previous studies also suggested active involvement in environmental projects has a positive effect on a child’s attitude, knowledge, or both. Leeming et al. (1997) believe that although changes in attitude are important, the ultimate test for affecting the quality of the environment is behavioral.

In Leeming et al’s (1997) project, they provided students with definite environmental projects for long periods of time, encouraging the students to participate for a full school year. They also included a wider age range of children, beginning from first grade up to fifth grade. They also attempted to determine if children influenced their parents’ attitudes or behavior on the environment.
Their findings showed that students who engaged in specific projects had a more positive attitude toward the environment. They also discovered that students who had no interest in the environment failed to show a more positive attitude toward it as a result of participation in the project. Attitudes that developed were also affected by grade level. For instance, the children in the lowest grades experienced the greatest degree of increased positive attitude and behavior, although they offered no reason for this outcome. The students also had an effect on their parents' knowledge of the environment and their parents' behavior on behalf of the environment (Leeming et al., 1997).

Campbell, Waliczek, and Zajicek (1999) feel that attitude influences behavior and that since the young people of today will be responsible for fixing future problems, their attitude toward the environment is very important. As a follow-up to general education about the environment in grade school, they agree with Campbell et al. that it is crucial for this experience to continue in high school. In an attempt to determine if increased knowledge about the environment improved environmental attitudes, Campbell et al. evaluated 475 students on a 10-day environmental science course that included one-third lecture time and two-thirds hands-on activities. The results showed the course increased environmental knowledge, and attitudes were more positive after exposure. Their outcome, along with other researchers', indicates knowledge provides a strong positive attitude toward the environment, but they did not show that attitude affected behavior.

In an older study, Aird and Tomera (1977) looked at the effects of water conservation education on the values held by sixth graders. This experimental group of students also received lectures and hands-on activities, as Campbell's later group did. They were responsible for reporting on their own water use, producing oral reports on water use, and
getting involved in discussions of personal water use conservation. The major finding was that the experimental group differed positively in knowledge from their own pretest and from the post test scores of the control group.

In another older study, Birch and Schwaab (1983) assigned 843 children to either an experimental group or a control group. The experimental group received instructional units dealing with water conservation, which included a 30-page booklet, slide programs, a film and demonstration models. In addition, the experimental group's teachers received workshop training in water conservation. There was a significant difference between the groups, with the experimental group having greater knowledge and improved attitudes toward water conservation. Furthermore, Birch and Schwaab found a significant correlation between knowledge and attitude.

Other researchers believe that a fourfold answer to the environmental problem of water conservation must be based on awareness, knowledge, attitudes and behavior. If any one of these four factors is missing, the outcome will fall short of the desired goal (Birch & Schwaab, 1983). For instance, awareness raising is used to explore the conceptual ideas in relation to knowledge, attitudes and behavior and it needs to be interactive if it intends to influence behavior (Birch & Schwaab, 1983). Attitude describes the way a person thinks about behavior and how it can be used to achieve a result. The costs and benefits derived from behavior can be related to psychological, social or religious values. If the probable results of the behavior are positive, the attitude toward the behavior is likely to be positive also (Strategies for Awareness Raising, 2003).

**Teacher Training Program**

Because of the ever-changing condition of the environment, teachers need programs
to provide preparation, assistance, support, resources and in-service opportunities that address state and local as well as national and international issues. With an adequate background, teachers can provide effective environmental education to their students, regardless of which segment of the environment they are teaching. When designing in-service workshops, the developer needs to involve teachers in curriculum designs that foster teacher commitment and development of relevant materials (Wade, 1996).

Looking on the other side of the world at Saudi Arabia, it is appropriate to add here that since Saudi teachers are unfamiliar with teaching water conservation, they too will need training and support in preparation to carry out their tasks. It will also be a new experience for Saudi teachers when they ask students to think critically about water issues and creatively develop actions to be taken to overcome the pending water crisis.

The availability of skilled teachers is a necessity in transferring knowledge, especially since research has shown that knowledge affects both attitude and behavior (Wade, 1996). Since water conservation is the topic that children need to learn, teachers also need accurate information on locally important water issues, no matter where the impact is being felt. Training can be accomplished through seminars, workshops or specific on-the-job training. Teachers, if well informed, can empower students to increase their knowledge, investigate the environment and develop problem-solving abilities to meet the water problems being experienced in the student’s own community (Wade, 1996). Teachers can then foster knowledge that develops attitude change, which results in behavior change. Teachers have an important job to do. They need to be given the right tools to do it. Moreover, Middlestadt et al. (2001), DeYoung et al. (1993), and Newman, and Johnson
(1994), who all stated that workshop training helps teachers to feel competent in their teaching.

In the United States, there are many professional courses and workshops throughout the country that contain discussions, demonstrations and lectures to train teachers who are teaching environmental issues to students. The courses are developed to meet state standards for teaching certification and they are acceptable for teachers working toward advanced degrees. In addition, the courses provide field-tested, hands-on classroom activities.

At the present time, the U.S. Environmental Protection Agency (EPA) has prepared and provided a website (http://www.epa.gov/teachers/background_water.htm) covering 22 different topics to increase teachers’ knowledge of the water situation in the United States. These topics include the Wetlands Act, water conservation, acid rain, ground water primer, stream control, watershed and other different aspects of water science.

At the University of Arizona, The Water Resources Research Center, an interdisciplinary supplementary water education program through the Project WET, offers teachers a 16-hour workshop. WET’s mission is to assist teachers in integrating environmental education and encouraging awareness, appreciation, and knowledge of the water resources available within the State of Arizona. It also ties together water’s relationship to natural resources and the importance of water to all living things. The workshops presented are acceptable to the Department of Education for recertification. Most school districts recognize the WET course for professional growth credit. For teachers who cannot attend the workshop, classroom materials are available upon request. There are 11 material packs available to teachers for students from pre-kindergarten to adulthood (Project WET, 1998).
Every state in the U.S.A. offers conservation courses for teachers. For instance, in the state of Missouri, a place that is diverse and far from Tucson, the Department of Conservation offers 71 courses through its local state colleges, many of which provide college credit. They cover every aspect of the environment with a heavy emphasis on water. These courses are listed on a website called Workshops for Teachers (http://www.conservation.state.mo.us/teacher/workshops/workshops.html).

**Curriculum**

Not only do Tucson teachers benefit from the WET program for their own personal and professional growth and advancement, WET is the formal teaching program in the Tucson school districts. The philosophy of WET is that:

* Water is important for all water users (energy producers, farmers and ranchers, fish and wildlife, manufacturers, recreationists, and rural and urban dwellers).
* Wise water management is crucial for providing tomorrow’s children with social and economic stability in a healthy environment.
* Awareness of and respect for water resources encourages a personal, lifelong commitment of responsibility and positive community participation. (DeYonge, 2000, p. 22).

One of the greatest advantages of Project WET is that because students are exposed to the social and cultural aspects of water, it is a program that could be adapted to fit in with the Saudi norms and values of water as a community property. Additionally, the framework of the Project WET Curriculum and Activity Guide, while teaching the physical and chemical properties of water, also teaches students about the fundamental importance of water to humans, animals, wildlife, plants and
the conditions necessary for a healthy planet (DeYonge, 2000).

The program also helps students develop the skills of creative questioning, proposing investigations, summarizing conclusions, and assessing, exploiting and validating their findings. These studies cross all disciplines, providing the student with a broad educational background. The guidelines are coordinated to fit the individual water needs and problems of each state and they meet the individual state’s guidelines for educational standards (DeYonge, 2000).

In addition to Project WET, the Tucson Water Department also offers educational water programs, three of which have been created and are presently managed by The Environmental Education Exchange (EEE). These programs are for students in the first through the twelfth grades and are administered in several school districts in Tucson. The program aims to teach students about the cycle, resources and quality of water, so that they have an understanding of the water problems of the Arizona basin (EEE-What’s New?).

The first program developed in 1993 was Our Water, Our Future: Teach the Ways of Water. This program consists of five teacher-led activities and an interactive lecture by a Tucson water educator. It has been taught in over 700 classes and is still in use for fourth and fifth graders. It includes graphics, activities with a groundwater model, an overview of the water treatment process, ideas for water conservation and even free shower timers for students to take home and measure their family’s shower use (EEE-What’s New?). Materials for this program are available through the Zanjero Program Office, 6560 South Camino de Oeste, Tucson, Arizona, 85746. Telephone Number 520-791-4556.

In 1998, a program was created for first through third grade students, which is now known as Da Drops. “Talking water drops” take the students on a trip from clouds to the
kitchen sink. A video focuses on groundwater activities, showing how the use of water from wells changed over the years from hand drawn buckets to modern pumps. The idea behind this is to show how the Tucson population grew so quickly that the people had to develop a quicker way of obtaining water and as they did so, they also lowered the groundwater table. The aim is to teach the importance of everyone conserving water daily. When the program is over, the students receive activity booklets and buttons (EEE-What’s New?).

A middle school five-unit program Tucson Toolkit: Perspectives on Our Water was added in the year 2000. This is a program for science teachers to incorporate into their lesson plans. It has nine hands-on activities, which are led entirely by the science teachers. In the last activity, after the students have learned about the limited resources of water, they measure the water flow rate of their showers at home. Free water-saving showerheads are given to the students whose home water flow rate is high. These three programs are offered free to local teachers and students (Tucson WET, 1998).

The U.S. Environmental Protection Agency has developed a water curriculum resources website (http://www.epa.gov/teachers/curriculumwater.htm) for teaching environmental issues, especially water issues, to students from kindergarten through high school. This website deals with the same issues mentioned above such as water conservation, ground water, watershed, etc. It also deals with various aspects of water science and includes a collection of activities, ranging from a student’s first source book to data gathering and analysis of problems.

Returning to the situation in the Middle East, in what appears to be unprecedented action about water conservation. Since 2001, Jordan has been inviting Tucson’s Water Conservation Alliance of Southern Arizona (CASA) to monitor and provide advice on water
conservation in Jordan. This program, which would be of interest to Saudi Arabia, is the promotion of conservation in Jordanian schools in the Middle East. Like Tucson and Saudi Arabia, Jordan, as mentioned, faces a water shortage and has had to develop educational conservation programs.

The Jordan water conservation curriculum consists of six weekly sessions covering topics such as groundwater versus surface water, water conservation in domestic settings, house gardens and irrigation. The curriculum advocates personal, household and parental behaviors to conserve water. The courses were created to change behavior by instilling action skills, knowledge of action strategies, knowledge of environmental issues and other factors to influence action behavior. Research gathered on the effectiveness of Jordan’s water conservation program showed that “specific knowledge about how one can address an environmental problem is a crucial step in changing environmental behavior” (Middlestadt et al., 2001, p. 42).

**Educational Role of Agricultural Education**

Barrick (1989) defined agricultural education as "the scientific study of the principles and methods of teaching and learning as they pertain to the agricultural education" (p. 24). Both social and natural environmental change challenged agricultural education to play a major and critical role in both formal and non-formal education. These changes required decision makers in agricultural education to face the new needs of the society and the agricultural education institution. The curricula, teaching methods, and tools that used outdated because of the technological and social advances.

According to Trexler, Johnson, and Heinze (2000) agricultural teachers’ roles were to educate students about healthy nutritional choices but they "observed a lack of curriculum
material to teach students" (p.35). Moreover, teachers of pilot agri-science courses were more competent in teaching traditional units (animal, plant, soil, supervised agricultural experience, and leadership development) than nontraditional units (computers, biotechnology, and environmental science) (Newman, and Johnson, 1994).

It is important that agricultural teachers participate and teach in high school. High school principals are supportive of agricultural teachers because they believe that teachers help to meet higher educational needs. Furthermore, principals believe that high school students benefit from agricultural coursework (Trexler, Suvedi, 1998, Kalme, Dyer, 2000). Moreover, elementary school teachers agreed that it was important to integrate positive awareness of agricultural issues into elementary classes (Knobloch, Martin, 2000).

Peterson (1999) explained that agricultural education relates to real life and enhances the social, economic, scientific and technical connections to food, fiber, environment and natural resources. Also he added "agricultural education programs become an advocate for students and help them become engaged in their communities" (p. 3). Getting agricultural education experience makes students "become special kinds of citizens motivated to become all they can be" (Peterson, 1999, p. 4).

The conservation of water in Saudi Arabia is clearly a subject that the religion supports. With religion being a vital aspect of the educational system, it seems safe to assume that Saudi Arabia education includes agricultural education. Saudi Arabia has four high schools that focus only on agriculture. The institution of higher education has three colleges in agriculture and two-departments that focus on agricultural extension. The departments prepare specialist to work in the field to educate farmers. Agricultural extension uses a different method to carry their information to farmers including distributing brochures,
pamphlets, and relying on television, radio, and face to face contacts to educate the public. Surprisingly and inopportunely, Saudi Arabia does not emphasize this type of education in the public schools. In fact, there is no single course focusing on agriculture in Saudi public schools.

Even Saudi farmers receive some agricultural education. According to the Ministry of Agriculture in Riyadh (2003), agricultural education and mass information play major roles in encouraging farmers to adapt the new methods of farming. The Department of Agricultural Guidance and Services is the responsible agency that selects a team of agricultural specialists to deal with farmers' needs. The department produces agricultural education videos available for farmers to borrow and copy. The department also provides to farmers information about the agricultural season (Ministry of Agriculture, Riyadh, 2003).

**Family Role in Education**

Not only is education not dependent on specific places or times, it also isn't limited to specific teachers. Children start learning from their parents. Parents have a critical responsibility to educate and set a good example to their kids in any society (Drey, 2003). Moreover, "Parents are authoritarian as indicated by high involvement in their children's lives and strict regulation of their children's behavior." (Chun & Akutsu, 2003, p.100).

The important role of family in society leads the Center for Family Studies to focus on the family because it is within the family that "the child grows, develops an identity, is socialized, is hurt and healed, and struggles with powerful developmental issues. The family is a naturally occurring unit and the context in which most intense behavior-shaping experiences occur. The family can serve a protective and an insulating role or as the fertile ground in which severe problems take root "(Santisteban & Mitrani, 2003, p. 122).
One of the important keys in the future of any society is education. The role of family does not stop at the development of early childhood literacy, but continues to shape the child's behavior throughout life. Family plays a major role in children's lives by increasing the child’s access to information, improving their problem solving skills, helping them develop positive views of behavior, and providing cooperation and support to the society and school system (Ruma, Thompson, 1996). Furthermore, "parents have a powerful influence on their children. You can play a major role in helping them to succeed in areas such as education, reaching their goals, relationships, meeting life's changes, and avoiding problems such as alcohol and other drugs, gangs, etc." (Jackson, 1999, back cover).

Families are the first source of information for their children, but they aren't always very knowledgeable sources. Children usually follow what is modeled at home. Agricultural information and food system convenience takes precedence over nutrition in many families (Trexler, Johnson, Heinze, 2000).

The practice of Islam leads to the worship of only God; male and female alike are created to recognize His Lordship, follow the laws of Islam, including being “dutiful and good to parents, and to kindred, and to orphans, and the poor,” (Quran 2:83) and respecting what has been given to them “both apparent (i.e. Monotheism, and the lawful pleasures of this world…) and hidden [i.e. One's faith in Allah (of Islamic Monotheism) knowledge, wisdom, guidance for doing righteous deeds, and also the pleasures and delights of the Hereafter in Paradise]” (Quran 31:20).

The family is essential to Muslim society in Saudi Arabia and other Islamic countries. Thus, family members have responsibilities that correspond to acting as good Muslims. Parents are responsible for providing for their children (food, shelter, clothing, education,
etc.). In return, children are asked to treat their parents with humility and tenderness and say “Lord be merciful to them as they nursed me when I was an infant” Quran, 17:24). More specifically, the father is responsible for providing money for food, clothing, shelter, etc. for his family, and the mother has the responsibility of educating her children until age seven when the father must take over (Jomier, 1988). Taking over most times in Saudi Arabia may mean relying on the public school system for academic and religious knowledge.

Also fundamental to Islam is respect for the natural world in anticipation for the Hereafter. Islam mandates moderation and respect for the earth and its natural resources — “and walk not on the earth with conceit and arrogance” (Quran 17:37). The Quran reminds the Muslim that God made “from water every living thing” and His rain provides food for all living things (35:27, 28). Consequently, Muslims should make use of these resources without waste (Quran 21:30, 24:45, 25:54, 6:141,42 and 7:31).

Religion’s Role in Education

Religion is a significant aspect of any society in identity development. "To understand the significance of life with its conflicts and pain, we must think independently of any authority, including the authority of organized religion; but if in our desire to help the child we set before him authoritative examples, we shall only be encouraging fear, imitation and various forms of superstition" (Krishnamurti, 1953, p.36-37).

Furthermore, true religious education helps people to understand and think about their situation. Religion can bring awareness about the real meaning of life and can help people to link that awareness with all people, animals, the environment and the actions and behaviors that impact the environment. Justice has an important impact for religions, which deals with people, society, the entire environmental issue and hopes for a better world (Krishnamurti,
Community service and religiousness in America is important to youth and their identity process, politics, ethnicity, and culture. Moreover, religious involvement and identification with an ethnic group helps young people build strong relationships and enjoy social support (Markstrom, 1999, Youniss, McLellan, & Yates, 1999). "Perhaps the most fundamental aspect of ethnic identity is its strength and valence, or how strongly and positively individuals feel about their group membership" (Phinney, 2003, p.68).

In 1986, Tajfel & Turner defined social identity in terms of one's sense of belonging to a group and the attitudes and feelings that accompany a sense of group membership. People generally attribute value to the groups to which they belong and derive self-esteem from their sense of belonging.

Saudi Arabia is different than the United States in its religious practices. Contrary to the United States, where there is a separation of religion and state, Saudi Arabian public school system mandates the practice of religion. "The objectives of Saudi educational policy are to ensure that education becomes more efficient, to meet the religious, economic, and social needs of the country and to eradicate illiteracy among Saudi adults" (SAEW, general education, p.3, 2003). Islam is the universal religion in Saudi, and is the basis of the legal system and government (SAEW, 2003).

The rules of Islam envelop all aspects of life. Islam clarifies all the roles of worship, family, education, society, law, economy, and the rights of all people, animals, water, earth, and plants (Jomier, 1988, Farugui at all, 2001). Saudis focus on Islamic practices and worship in the mosques and emphasize applying what has been learned at the society level.
Mass Media Education

A media is defined as a "form of device or equipment, which is normally used to transmit information between people. Thus radio, television, newspaper, billboards, letters, handbills, books, teaching machines are all media devices by this definition" (Lifton, 1970). Now, we have to include the Internet, which is a great support to achieve media goals in education.

Education has different setups. Some are formal, and some are non-formal or informal. Media has been used for non-formal education because it plays a significant role in forming and influencing people's attitudes and values, behavior, and skills. Effective and well-designed media programs have clear goals. Television shows in the United States such as Mr. Rogers' Neighborhood offer powerful models for healthy care-giving behavior (Simpson, 1998). " almost two thirds (61%) of children now have a television set in their bedroom, 17% have their own PC- and own room access to such media technologies is linked to substantial changes in how kids use media" (Park, 2003, p.1).

Martinez and Scicchitano (1998) evaluated the effectiveness of the recycling media education program in 67 Florida counties. The result of the research showed that the television was the most active in public communication. Moreover, there was a positive relationship between the level of education and the media program. Media, in general, and television, specifically, is the primary source of information about food system (Trexler, Johnson & Heinze, 2000).

Media plays a major role in Saudi Arabia education for both adults and children. The culture or ways of life have been profoundly affected by media programming production in the Gulf area countries – Saudi Arabia among them (Amin, 2000). The Arab region
attributes radio and television as having paved the road for a healthy civil society (al- Hail, 2000). The media in the Gulf area usually focused on Islamic culture and history and used to teach people about their religion. Children cartoons also focus on Islamic principle and teach kids attitude and value (al- Hail, 2000).

Saudi Arabia television has established a farmer program in 1971 called Alardh Altaibah (Reach Soil) and in 1983 changed the name to Maa Almuzareen (With Farmers). The program focuses on farming issues and runs for 30 minutes. The program has three objectives:

1. Educating farmers and increasing their awareness related to agriculture.
2. Helping framers to adapt the new farming technology.
3. Calling farmers attention to all new subjects related to animals, plants, and water.

Shibah in 1992 reported that 94% of the Saudi farmers got their information from the television. In Tabooke (city in northern of Saudi Arabia), farmers ranked television as the second best source of information (Al-Fhigy, 1996).

In this section, the literature review has been presented to show the severity of the problem of water shortage. The topics that were covered are Groundwater in Tucson and Saudi Arabia, Groundwater Recharge, Water Problems of Other Countries, the Cost of Water and the Resident User and Farmers, Water Leakage, Recycled Water, The Psychological and Moral Impact of Norms and Values on Conservation, Education, Teacher Training Programs, and Curriculum.

In Chapter 3, the methodology for the research is explained. Chapter 4 presents the findings and Chapter 5 presents the discussion and the relationship with other researches done before. Chapter 6 discusses how Saudi Arabia can impart knowledge and change
attitudes, values and behaviors regarding the seriousness of the water shortage problems in the country through the education of its students. And chapter 7 will draw conclusions and recommendations related to future research. It is also expected that the information acquired from Tucson's experience can be utilized to reach the goal of developing environmental water awareness in Saudi Arabia for all citizens.
CHAPTER III. METHODS AND PROCEDURES

The purpose of this chapter is to describe the research methodologies that were used to gather and analyze data for this study. The main purpose of this study was to explore the roles of Tucson's formal and informal educational forums that address conservation behaviors toward the water problem, and to determine how to export the knowledge and experience gleaned from Tucson to areas with similar climates and water supply conditions but different cultural and educational systems. These study objectives were to identify: 1) the roles of the formal educational process on students' water consumption behavior; this goal focused on: a) identifying the existing curricula of public schools in Tucson and b) identifying existing facilitators' roles in the public schools; 2) the roles of the city of Tucson, Arizona in water conservation; 3) the roles of parental direction on children's water consumption behavior; 4) the roles of faith teachings and religious practice on changing people's water consumption behavior; 5) the roles of the academic programs and extension services offered by the University of Arizona on the water consumption behavior of students, farmers and the whole community; this goal focused on: a) the role of the Arizona Water Resources Research Center (WRRC); b) the roles of the Agricultural Education Department in preparing teachers to be aware of future water problems; and c) the roles of Agricultural Extension to help farmers manage their water usage; 6) the roles of different media programs on citizens' water consumption behavior; and 7) to propose a new model for applying these programs in Saudi Arabia.

Design

The research design used in this study was descriptive. According to Fraenkel, and Wallen,(1993) descriptive studies "describe a given state of affairs as fully and carefully as
possible" p. 11). The findings of this descriptive research study can help researchers and educators to understand how each one of the members of "it takes a village" play their roles. It takes a village members were: school, teachers, parents, religious, and government. The study was designed to see how the Tucson people acted related to serious water shortage problem. The research focused on the Tucson high school seniors, at the awareness of the general population; examining the role of the University of Arizona, the city of Tucson, places of worship, and families.

**Method of Selecting the Research Area**

As a person who was raised and lived in the desert, the researcher has always been in direct contact with water shortage problems and their economic, social and cultural consequences. Based on that background, the researcher became interested in using education as a tool to address this problem. Therefore, the water problem was the essence of the researcher proposed study towards his Ph.D. degree, which is supported by the researcher's program of study community. For the long range, this search will give the researcher the appropriate training and required experience to use education in dealing with water problems in the researcher's home country Saudi Arabia.

On April 21st, 2003, the Inaugural International Symposium, with the title "Rivers of Life: Water, People and Global Development" was held at the College of Liberal Arts and Sciences at Iowa State University. Through the different seminars and discussions, the researcher had the chance to learn a lot about water problems in the United States of America and the different approaches used to deal with each one. Although many parts of the United States suffer from water shortage problems, the Southwest has the most difficulty with water shortages. This gave an indication to the researcher about the best place to conduct his
This kind of research doesn’t end with sample collection and data analysis, instead, it will consider the application of these results in other places such as Saudi Arabia’s cities and towns, which on average have populations of 500,000 to 800,000 inhabitants (Saudi Arabia embassy, database, 2003). On the other hand, the Southwestern region of the United States has a wide variety of different population sizes, extending from small towns to large cities. But the researcher chose to study towns with a population of 500,000 to one million inhabitants so his research would have valuable results for the place where the research is conducted, and also be applicable in other places.

Tucson has the same regional location, climate and population properties as other Southwestern cities, but its average use of household user is 160 gallon/person/day, which is uniquely low in this part of United States (Sedona community plan, 2002, California economic case study, 2001). This low consumption could be explained by many factors and education is one of them. The researcher decided to choose Tucson to study how education has contributed to addressing the water shortage problem.

Another reason that Tucson was chosen is that Jordan, a neighboring country to Saudi Arabia in the Meddle East region, selected Tucson to exchange information. In May 2001 and in January 2002, Jordan invited Tucson’s Water Conservation Alliance of Southern Arizona (CASA) to travel there to provide advice on water conservation and plant material. The establishment of this relationship was pivotal in Tucson’s selection for this research (Water CASA, 2003).

**Population and Sample**

"Drawing conclusions about a population after studying a sample is never totally
satisfactory, since researchers can never be sure that their sample is perfectly representative of the population" (Fraenkel, Wallen, 1993, p. 90). The random selection method is one of the sufficient ways that researchers use to give them more confidence about the data that comes from the sample. There is no agreement among scholars regarding the sample size, but it should be relative to the information that researchers want from it. Also, "a random sample of 200 is better than a random sample of 100, but a random sample of 100 is better than a biased sample of 2,500,000" (Ary, Jacobs, Razavieh, 2002, p. 171).

The volunteer subjects who agree to answer a questionnaire or survey, interview or test are representative of the population and may lead to different conclusions (McMillan, Schumacher, 2001). The researcher intended to gather as much as possible from both qualitative and quantitative data. The data was gathered from the general public, teachers who attended the internship in Tucson Water and the workshop in the Water Research Center during summer 2003, high school students, extension workers in Tucson Water and agricultural extension workers in Pima County, water workshop designers in both the Water Research Center and Tucson Water Departments, and the head of the Agricultural Education Department.

Sample one:

As mentioned in Chapter 1, one of the objectives of the study was to apply the findings of the research to the Kingdom of Saudi Arabia. The researcher investigated the way that data may help Saudi Arabia. One of the major sources of data were the people who were members of places of worship in Tucson. All houses of worship listed in the Tucson phone book directory during the summer of 2003 were called and asked if they would provide a list of their members.
The researcher started during June 2003 with contact to the worship houses. Their information was listed in the Tucson phone directory. The researcher explained the goal during the initial call, and then they asked for help in providing the list of their members who owned or rented houses in Tucson, Arizona. From more than 165 worship houses, only 70 worship houses agreed to supply their lists. The 70 worship houses have 8,250 landlords or rental houses that pay water bills. In this type of descriptive study, the minimum number of needed subjects was estimated to be 100 (Fraenkel, Wallen, 1993). However this size is still not representative because it is less than 3% of the population (Fraenkel, Wallen, 1993). The researcher decided to sample about 5% of the population, which is equivalent to 420 subjects in order to collect all the data within a reasonable time. Systematic Sampling method was used to select the sample subjects from the total population (McMillan, Schumacher, 2001). Names of worship members were taken from worship houses lists and then a third party was asked to draw a number from a box containing numbered papers from one to ten. Based on that number the subjects of the sample were selected from the different worship house lists. Ten was then added to that number according to Systematic Sampling method guidelines. Focus groups need at least six to eight individuals per group and the 420-sample size allowed for 52 focus groups consisting of eight individuals (Krueger & Casey, 2000). Only 293 people completed the survey and attended the focus group.

By Sunday July 6th, every subject had been selected and had gotten his/her questionnaire. A cover letter on the first page of the questionnaire explained the nature of the study, the focus group meetings and the contact information of the researcher. Fifty-three focus groups were held in different worship houses every day, two times a day between 12 to 1 p.m. (except for Fridays), and 6 to 7 p.m. The subjects preferred that the focus group
discussion not be recorded, so the researcher asked one American lady named Heidi to help the researcher to write down the important points. Each focus group took 45 to 60 minutes and after each focus group meeting was done, Heidi and the researcher sat together and reviewed the information.

Justification of Sampling from the Public

The community of this study consists of the individuals who pay water bills in Tucson. The researcher had to exclude some people from the sample such as apartment residents, who either pay a flat rate or don't pay at all. In the case of people who rent houses, the researcher had to contact their landlords. It was extremely difficult to get a list of landlords in Tucson. The Tucson Water Department didn't provide the researcher with such a list because it would have cost a lot of time and money. So, the researcher followed a different method to draw the sample. Worship houses, regardless of their religion, provided very good places of gatherings of people from different socioeconomic classes. In addition, these houses could provide the researcher with a list of landlords in their flocks. A representative sample of landlords, who pay water bills, could then be drawn from such groups of people.

This sampling approach is based on a cluster sampling method, which is defined as "grouping individuals in a population into clusters or aggregates (usually based on physical proximity) rather than into strata (based on common class)" (Mason & Bramble, 1997, p.115-116). In this study, the landlords or owners who pay water bills are the population and the worship houses are the physical clusters where the samples were drawn from.

Sample two:

The researcher got permission from the Tucson Water Department to attend and
participate in a two-week teacher internship that trained them on water issues. There were 22 teachers from different schools in Tucson. Also, the researcher got a chance to attend a one-day workshop on water issues with the same teachers. All of the teachers answered the questionnaires.

Sample three:

Because of the difficulty of meeting with high school students during the summer when the researcher was in Tucson, the researcher asked for help from one of the graduate students at the University of Arizona's Agricultural Education Department, who was teaching during the summer 2003 at one of the high schools in Tucson. The researcher was able to observe the graduate student's class and explain the research. One of the sub-goals of the research was identify if there was any differences in student's information of water issues between students who took courses in biological sciences like agriculture and those who did not take such courses.

The class was made up of 25 students, 12 of them took biological sciences courses and 13 did not take them. The class was divided into two groups – the ones who took courses and the others – and then a random sample was drawn from each group. Six students from each were asked to participate in the study were asked to draw two concept maps (water cycle map, and Tucson water resources and usage map). There were only nine students who showed up, five of them did not take any agricultural courses and four of them took agricultural courses. These groups were compared to see if there was any significant difference in what they knew.
Methods of Data Collection

Three types of methods were used to gather information: questionnaires, focus group meetings, and interviews during the summer of 2003 from July 2nd until August 13th. The following details present the importance of this method related to the research goals, findings and application.

Questionnaire

Because the "questionnaire encompasses a variety of instruments in which the subject responds to written questions to elicit reactions, beliefs, and attitudes" (McMillan & Schumacher, 2001, p.40), the research used this method to draw out the attitudes, beliefs and behaviors surrounding the water problem. The two questionnaires used were directly administered questionnaires since the research needed a sample in a controlled environment (Ary, Jacobar & Razavieh, 2002, p.385). This research included two samples— the Tucson public and teachers. Both quantitative and qualitative questionnaires were used in this research. The quantitative questionnaire was designed for general population of Tucson, Arizona. There were 420 distributed and only 293 were collected. The qualitative questionnaire was designed for teachers. All of the qualitative questionnaires were returned. There were a total of 22 teachers. The researcher's rationale for choosing to use a questionnaire includes being able to collect a variety of information using one method (i.e. demographics, attitudes, beliefs, etc.). Also, the questionnaire is a commonly used tool in the discipline of agricultural education and studies for collecting information about participant perceptions.

1. Public questionnaire:

A questionnaire was developed based on the literature review and on the advice of
expert faculty members and staff at both Iowa State University and the University of Arizona. The questionnaire was designed to measure knowledge, attitudes, beliefs, social behavior, and household conservation behavior toward the water shortage problem in Tucson, Arizona.

The questionnaire had four parts. The first part had eleven questions. The first five questions asked for demographic information including age, gender, educational level, major, and career. Questions six to eleven asked about family size, home size, home gardening, plant types, water billing, course or workshop attendance, and information sources regarding water.

The second part covered water information on Tucson and water usage. This part solicited "Yes/No" responses and measured participants' knowledge regarding the water problem and usage.

The third part of the questionnaire requested participants' opinions regarding the current water problem in Tucson and attitudes regarding the water problem. It consisted of two sections, both using a five point Likert-type scale. The first one was as follows: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. The second scale used the following: 1 = strongly does not apply, 2 = somewhat does not apply, 3 = neutral, 4 = somewhat applies, 5 = strongly applies. The fourth part was designed to cover focus group interviews and discussed effective techniques for educating the public and solutions the water problem (see Appendix A). The entire public questionnaire was five pages long and contained 47 statements or questions.

2. Teachers questionnaire:

The second questionnaire was distributed at the end of a teacher internship held in the
Tucson Water Department during summer 2003. The questionnaires were returned soon after they were completed at one-day workshop held by the Water Research Center. The teachers were asked open-ended questions regarding their experiences of teaching about the water problem in Tucson high schools. Each teacher received a questionnaire, which was designed for teachers who attended both the two-week internship in the Tucson Water Department and the one-day workshop in the Arizona Water Research Center. Twenty-two teachers answered the open-ended questions about the effectiveness of teaching students about the water problem in the Tucson area (see Appendix B).

**Focus Group**

Another one of the methods used in the research was the focus group. Previously selected participants that had been identified through the selective sampling method were assigned to focus groups from the alphabetical list. Briefly, the first eight participants on the list were assigned to the first group; the second eight participants were assigned to the second group...etc. All the meeting information was written on the cover letter of the questionnaire. However, only five to six people attended each focus group. The focus group meeting was chosen so that the researcher could listen to the participants and gather information concerning the needs of the people of Tucson. Participation in the focus group involved getting the participants to express – in a community and social arena – their interests, feelings, and thoughts about the problem (Krueger & Casey, 2000). Moreover, since the focus group involved participants with some similarities (i.e. interests or characteristics), this method “provides clues and insights” for the researcher and helped identify and analyze particular trends and patterns. (Krueger & Casey, 2000, p.4). Focus groups are useful in new studying or when little information is available like in this research (Ary, Jacobar&
Razavieh, 2002). Because this is the first time that this subject of water conservation is studied in conjunction with religion, media, and other variables, using a focus group to collect information about the needs and attitudes of the participants ensures that the information will be controlled and more accurately recorded (See Appendix C).

**Interviews**

Interviewing was another method used in order to provide insight information that could be obtained through simple observation in this research (Mason & Bramble, 1997, p.314). Two interview processes took place – one for professionals and one for high school students. Open-ended questions were used to gain specific information from both professionals and students.

**Professional interviews**

Based on information provided to the researcher by the head of the department of Agricultural Education in the University of Arizona, it became apparent that some workers in the Tucson Water Department, the Water Resources Research Center, and the Pima County Agricultural Extension were involved in non-formal education about water in Tucson. These workers were professionals who had specialized training in water education and were experts in their fields. The professionals in the Tucson Water Department, the Water Resources Research Center, and the Pima County Agricultural Extension were currently involved in water education activities and roles. In order to gather information from these experts and “to obtain the present perceptions of activities, roles, feelings, motivations, concerns, and thoughts” the researcher used the interview strategy (McMillan & Schumacher, 2001, p. 444). In interviewing the head of the Agricultural Education Department, the researcher was prompted to inquire if the undergraduate program was preparing teachers on the subject of
With the professionals, the researcher wanted to know how they felt about the water phenomenon or problem (Ary, Jacobar & Razavieh, 2002). Six professionals, who had responsibilities in either designing the water workshop in Tucson, water extension, crops extension, disseminating Tucson water information, or heading the Agricultural Education Department, were selected for this process. Three interviews were with professionals who were experts in designing different water workshops aimed to train teachers and gardeners in Tucson, Arizona. The researcher designed questions surrounding the non-formal educational process. Questions were asked about the training materials and activities, about the trainees' selection, and about the training of teachers and their assistants. The last question dealt with the role of media in publicizing annual workshops.

The head of the Department of Agriculture Education at The University of Arizona was interviewed personally and contacted by e-mail on two separate occasions. He answered questions about the undergraduate program his department offers and courses specifically addressing water related programs.

Extension professionals are considered the link between water education programs and the public. Extension interviews focused on two professionals, the methods they used to communicate with the public and farmers, the procedures they used to evaluate their success, and the actions they took to develop the programs currently in use.

The researcher met with each interviewee individually for 30 minutes in his/her office. The researcher documented all the questions addressed in each interview (see Appendix D).
Students' interview

The interview with the nine high school seniors' contained questions about their knowledge and background on the water issue. The students were taking summer courses towards graduation in the fall of 2003. Their teachers, who were also graduate students in Agricultural Education Department at the University of Arizona, allowed the researcher to observe the class and explain the research goals to the students. The researcher then asked who was willing to participate. Nine students were interested and willing to help in this research study; five of them had not taken any agricultural courses and four of them had agricultural courses. The researcher, teacher, and nine students met in one of the Tucson restaurants during lunchtime on August 10th, 2003. The researcher used concept maps— a method used to symbolize rational diagramming in a hierarchical manner (Meischen, 2002) to get the students to illustrate their understanding about water cycle and water resources in Tucson.

Paper and pens were provided for the students, and they were given 15 minutes to draw their basic understanding of the water cycle. They were given an additional 45 minutes to draw their understanding of water resources and usage in Tucson. The researcher drank a glass of water as part of a demonstration for the students. The researcher then asked the students a series of questions including: “Where did this water come from?” “What uses do we have for water other than drinking and taking showers?” “How does Tucson water resources recharge or renew itself?” and “Where does Tucson’s water come from?” After the demonstration, lunch was provided and the researcher thanked the students and their teacher for their participation.

The Committee on the Use of Human Research at Iowa State University reviewed
and approved the data collection instrument (see Appendix E).

Data Analysis

Several methods of analyzing the data were used. The Statistical Package for the Social Sciences (SPSS) was selected for analysis. The open-ended questions and focus group discussions were organized by themes, and their input and significance to the study were assessed. The descriptive statistics consisting of percentages, means, standard deviations, and correlation matrices were used to describe the data. In order to achieve the research objectives, both quantitative and qualitative methods were used.

Limitations of the study

The researcher clarified that the following were the limitations of the study:

1. The population was limited to:
   
a. The landlords and rental property owners in Tucson Arizona, who pay the water bills and are members of worship houses.
   
b. Summer 2003 high school seniors, some with backgrounds in agricultural and some not.
   
c. Teachers who attended both the two-week internship at the Tucson Water Department and the one-day workshop in the Water Research Center.
   
d. The three designers of the workshop in Tucson, Arizona, who interviewed in the summer of 2003.
   
e. Extensions: water extension, crops extension, Tucson water information, head of the Agricultural Education Department at the University of Arizona,

2. The results of the study are limited to the studied population.
Assumptions

Education plays a major role in people's knowledge and behavior. Two assumptions were made: a) the data collected were honest and truthful responses of the participants, and b) the researcher designed the questionnaire and led the focus group with the application part to Saudi Arabia in his mind.
CHAPTER IV. FINDINGS

In this chapter, the analysis of the data and the findings will be presented. A restatement of the study's objectives and description of the participants' demographic characteristics will precede these findings.

The main purpose of this study was to explore the roles of formal and informal educational forums established in Tucson, Arizona to address conservation behaviors concerning the water problem, and to determine how to export the knowledge and experience gleaned from Tucson to meet specific objectives. These study objectives were to identify:

1) the roles of the formal educational process on students' water consumption behavior; this goal focused on: a) identifying the existing curricula of public schools in Tucson and b) identifying existing facilitators' roles in the public schools; 2) the roles of the city of Tucson, Arizona in water conservation; 3) the roles of parental direction on children's water consumption behavior; 4) the roles of faith teachings and religious practice on changing people's water consumption behavior; 5) the roles of the academic programs and extension services offered by the University of Arizona on the water consumption behavior of students, farmers and the whole community; this goal focused on: a) the role of the Arizona Water Resources Research Center (WRRC); b) the roles of the Agricultural Education Department in preparing teachers to be aware of future water problems; and c) the roles of Agricultural Extension to help farmers manage their water usage; 6) the roles of different media programs on citizens' water consumption behavior; and 7) to propose a new model for applying these programs in Saudi Arabia. The last objective will not be presented in this chapter, but will be discussed further in Chapter VI (under Application).
Demographic Characteristics of the Participants

The age distribution of the 293 people who participated in the study is reported in Figure 2. The percentages of the participant ages were as follows: ages 20 to 30 - 19.8%, ages 31 to 40 - 11.6%, 41-50 - 22.5%, 51-60 - 23.2%, and over age 61 - 22.9%. A majority (53.6%) of the participants were female and the remaining 46.4% were male.

![Age Distribution Chart](image)

Figure 2. Age of Participants

Figure 3 shows the participants' level of education. The education levels were: 0.7% had below a high school education, 30.7% had a high school education, 32.7% had a Bachelor's of Science degrees, 11.9% had Master of Science degrees, 5.8% had Doctor of Philosophy degrees, and 18.1% had other degrees (e.g., MBA, MA, etc...).

Figure 4 demonstrates the level of education of the teachers. There were 12
elementary school teachers, and 10 high school teachers: twelve teach science, four art and language, and there was one teacher representing each of these major areas: special education, exceptional education, chemistry, mathematics and biology.

Figure 3. Participants' level of education

Figure 4. Number of teachers per school level
The research was interpreted to show how the “it takes a village” concept could be used to address the water shortage in Tucson. In the following section the data was presented and categorized by the tools used to gather the information.

The Roles of Formal Schools

Focus group meetings

Fifty-two focus group meetings were held in different worship houses from July 6\textsuperscript{th} till August 10\textsuperscript{th}. Generally, participants from Tucson expressed favorable responses to the idea of educating people from kindergarten through college for long-term planning. Many participants suggested taking educational initiatives and addressing the issue in K-12 schools and in community and four-year colleges. This was a popular response. Some participants stated that teaching young people proper respect for their resources would help them to influence their parents and communities.

Participants believed that the schools play an important role in water education. Children, who get the right information from their teachers about water resources and water usage, have more confidence discussing the issue with their families.

Questionnaire

Two different questionnaires were used, a quantitative one for the general public and qualitative one for teachers. The quantitative data is presented in Table 1, which indicates that the mean ratings and standard deviations from participants’ statements about whether or not the educational system can help solve the water problem. This method produced the highest rating with an average mean of 4.21 and standard deviation of 0.78 on a 5-point scale. On the other hand, it shows the lowest mean rating of 2.35 in response to the current school curricula relating to the water issue.
Table 1. Participant Perceptions on Who Should Assist in Solving Water Shortage Problems (N=293)

<table>
<thead>
<tr>
<th>Items</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public can help solve the problem</td>
<td>4.28</td>
<td>0.80</td>
</tr>
<tr>
<td>Education system helps solve the problem</td>
<td>4.20</td>
<td>0.78</td>
</tr>
<tr>
<td>Parents' direction helps solve the problem</td>
<td>4.19</td>
<td>0.76</td>
</tr>
<tr>
<td>Writing short stories about the problem helps solve it</td>
<td>3.62</td>
<td>0.87</td>
</tr>
<tr>
<td>Involvement of worshipping centers helps solve the problem</td>
<td>3.45</td>
<td>1.15</td>
</tr>
<tr>
<td>Current newspaper provides an insight into the problem</td>
<td>2.81</td>
<td>0.97</td>
</tr>
<tr>
<td>Current TV provides an insight into the problem</td>
<td>2.52</td>
<td>0.88</td>
</tr>
<tr>
<td>Current curricula helps solve the problem</td>
<td>2.35</td>
<td>1.52</td>
</tr>
<tr>
<td>Water shortage is a governmental problem only</td>
<td>1.66</td>
<td>0.95</td>
</tr>
</tbody>
</table>

Perception scale: 1 = Strongly disagree; 2 = Disagree; 3 = Natural; 4 = Agree; 5 = Strongly agree

Teachers stated that the current curricula have not been developed in a way that could help resolve the water problem. Furthermore, teachers believed that teaching about the water problem in Tucson schools depended upon the teachers' motivation and concern towards addressing the water shortage.

Teachers believed that their primary role was to educate students across the curricula about water quality and quantity choices. A majority of the participants surveyed felt that hands-on experience and teaching about water conservation were the best techniques. Popular suggestions included relating water issues to local problems, bringing speakers from the water company to the schools, and holding field trips for the students. Others suggested that students monitor their personal use of water at home. There were many more specific responses, which offered effective ways to teach students about the water problems. These
included giving people very practical and specific lists of ways that they can conserve water at home, emphasizing the consequences of long-term abuse of water resources, in-class presentations, discussions, and brainstorming sessions so that the students could bring in their own personal experiences.

Most teachers surveyed felt that in terms of curriculum design, the most effective strategy would be to include local issues in the discussions about water shortages. Many participants also mentioned Project Wet as a valuable resource, as well as, connecting the impact of personal usage to the water shortage. Other popular responses included taking different learning styles into consideration and not reinventing the wheel, asking the professionals and making the data accessible to students, and researching common trends that led to the current situation.

Teachers suggested creating effective guidelines for use across the curriculum. The guidelines should be developed while training teachers how to use them. They stated that teaching about the water problem would have to start in early elementary school. They suggested that teachers should link the water problem in all of their courses to everyday use. Teachers stressed that topics should connect water quality and quantity issues with lessons in science and social studies. For example, mathematics teachers would have to work with related measurement of water usage and groundwater reduction in the Tucson area. They would have to link the Tucson development to the current water situation.

The surveyed teachers considered that their evaluation of teaching methods regarding the water shortage might offer feedback about students' awareness of the problem. The evaluation should focus on students' behavior rather than their knowledge. It would be most effective if they looked at student interests in the topic, class participation, and future
questions. Many teachers mentioned other common methods of evaluation, such as exams, research projects, lab and class participation, presentations, questioning, and basic student-teacher interactions. Some teachers suggested evaluating the level to which the students incorporate new knowledge into their exams and projects.

**Interviews**

There were seven interviews with professionals—two of them who worked with the school system in Tucson. They agreed with the public and teachers that the issues surrounding the water problem and society should be taught in school. They mentioned that the school curricula did not cover the water problem, and there were no required courses related to the water issue. They pointed out that the curriculum has not been developed in a way that could help to solve the water problem. Furthermore, professionals stated that any current teaching in school came from the teachers' individual motivation and concern towards addressing the water shortage.

**Students' concept maps**

Students' concept maps about the water cycle, water resources and water usage explain the relationship between the curriculum and the students' knowledge (see Appendix F). There were no significant differences among their water cycle concept maps. Most of the students had similar understandings of the water cycle, which they learned during their time in school. There were strong differences, however, among the students' concept maps regarding water usage and water resources in Tucson. Students who took biology or agricultural courses did an excellent job in their concept maps. They explained the water usage in a good way. Moreover, students who had backgrounds in biology or agricultural courses not only explained the water resources and water usage, but also how Tucson's
ground water was renewable.

**The Roles of Parental Direction**

**Questionnaire**

Teachers surveyed felt like the students should start at home with water education. Many respondents stated that the students should become aware of their personal situations regarding water shortages by connecting the water shortage issues to their local communities. Furthermore, teachers pointed out that parents and families are good sources of information regarding the water shortage in Tucson. Children usually follow what is modeled at home and emulate what their parents say and do.

Participants from the public agreed with the teachers about the role that parents play in educating their children about the water shortage. Table 1 indicates the mean ratings (4.20) and standard deviations (0.76) of participant responses (on a 5-point scale) to the statements concerning parents' direction in helping their children solve the water problem.

**Focus group meetings**

Most of the participants from the focus group discussion were adamant about the idea of setting a good example and demonstrating water conservation in the home was the best way to influence children. A large number of participants also stressed the importance of teaching children from an early age. Participants continued that parents could influence awareness and understanding through conversation and hands-on activities for their children. A few participants suggested discussing resolutions with children and taking their ideas seriously. Another idea was to teach children to read the water bill or to discuss the cost of water with them and explain how it affects the whole family.

A large number of focus group participants pointed out simple and practical
conservation methods that children could participate in around the house. These included things like not allowing water to run while brushing teeth and taking shorter showers. Several participants suggested that positive reinforcement was important and that conservation could be made into a game, possibly with household contests to see who could use the least water.

**The Roles of Faith Teachings and Religious Practice**

**Questionnaire**

As indicated in Table 1, the mean ratings and standard deviations that participants gave to the statements regarding the involvement of worshipping centers in helping to solve the water problem was 3.45 on a 5-point scale with S.D. 1.10. Moreover, participant statements about how the public can help solve the problem resulted in high ratings, with a mean of 4.28 and standard deviation of 0.80.

**Focus groups meetings**

Participants from the public group believe that religion could help solve the water problem. Religion plays an important role in helping people realize good manners, attitudes, and behavior. Participants state that religion should not only focus on worshipping God, but should also convey the message that everything on the earth is entrusted to us from God and should therefore be used for good. During the focus group, participants talked in detail about attitudes. They suggested that following the good example of others, having an environmental conscience, spiritual and religious leaders, beliefs, fear, and believing that they themselves can make a difference are motivating factors for people. Participants agreed that a little help from faith could increase people’s desire to preserve water resources for future generations. Moreover, participants believe that certain morals and values have to
help people to share and conserve all the natural resources for future generations.

Americans often read to their children and short stories are a famous tradition that is sometimes linked to religious practice. Both the public and teachers agreed with the importance of reading stories to children about water; participants suggested designing the stories to help shape children's behavior regarding water problems in Tucson and other parts of the world. Participants believe that stories related to the water shortage affect both the reader and listener. The results of the quantitative data match those of the qualitative data as indicated in Table 1. On a 5-point scale, the mean and standard deviation that resulted from participants' statements concerning reading short stories to solve the water problem was 3.62 and 0.87, respectively.

Observation

The researcher was invited to three different churches to attend seminars that focused on the water shortage in Tucson. All three were attended. All of the seminars had good information and discussions regarding the water shortage. The attendees were people from various churches and congregations and their friends. There was a great opportunity to talk to some of them about the water shortage. They seemed aware of the water problem. They also felt as if they were a part of the problem and were motivated to get involved to find a solution.

Role of the City of Tucson

Interview

The responsibility for water management in Tucson falls under the Tucson Water Department. The department has different kinds of activities related to education (see Appendix G for programs and publications). The researcher interviewed the Conservation
Program Manager. He said the program goal is to protect and enhance water resources through conservation. He reported on the water conservation programming efforts sponsored by the Tucson Water Department. The efforts are as follows:

1 **General Public Information:** Responsible for designing and promoting water conservation through pamphlets and brochures. The department distributes water information and public service announcements at malls, neighborhood events, etc.

2 **Education and Training:** So far, responsible for designing three different types of educational programs: the Water Smart Landscape Workshops, SmartScape Landscaper Workshops, and Youth Education Programs. The *Water Smart Landscape Workshops* are two-hour workshops targeting residential customers and covering three topics—drip irrigation, plant selection and design, and irrigation scheduling and timer use. The workshop meets approximately 40 times a year on Saturdays in different locations in Tucson. The workshop is advertised on billing statement inserts. *SmartScape Landscaper Workshops* are a series of eight workshops designed to teach landscape professionals, property managers, and homeowner associations about water conservation practices in landscape management. It meets twice a year and each time attracts between 30-40 people. The *Youth Education Programs* focus on designing classroom material for different grade levels. Starting at Grade 3, “DaDrops” focuses on water cycle, groundwater, and water distribution. “Our Water Our Future” for Grade 5 focuses on water cycle, water supply, and water quality. The “Tucson Toolkit” for Grades 7-8 focuses on water cycle, water quality, and water conservation. The “High School Program” focuses on teachers and curriculum design, and a two-week paid internship is offered to schoolteachers.
Finally, “Education Outreach” focuses on providing classroom presentations, tours and support for other educational programs.

3 Direct Assistance Programs: Responsible for helping customers reduce their water use. This department has two kinds of initiatives, one that focuses on residential use and the other on commercial and industrial use. Six professionals from this department are responsible for visiting customers and assisting them in reducing their water bills. One professional who said he was responsible for dealing with residential customers in specific parts of Tucson was interviewed. He explained his work this way, "I search for customers with high water bills and call them to discuss their water bills with them. I go over to visit them and see if there are any leaks in their home's plumbing." In the visit, he explains to them how to test for water leaks in their home. He also added that he replaces showerheads and adjusts toilets. If customers have landscape areas, he assists them in obtaining the appropriate irrigation requirements. Each visit last about 20 to 30 minutes but proves very helpful in reducing their water bills.

4 Other Programs: Deal with plumbing codes and different designs of toilets and showerheads. This department trains commercial users and multiple family homeowners on plant requirements and irrigation.

Observation

The researcher had a chance to attend some of the 2nd session of the two-week Teachers' Summer Internship Program-2003, which was held July 7th to July 18th, 2003. Teachers in this program tour the Water Department facilities and hear presentations on related issues. At the end of the session, teachers are asked to develop a lesson plan and to
follow up by evaluating of the lesson's application during the full semester 2003.

**Questionnaire**

The findings from the qualitative analysis data (teachers' questionnaire) related to the benefits from the training program. Participants found the Tucson Water Department's internship program a most valuable resource. Teachers mentioned that they were planning to invite Tucson Water employees to present to their students. Also, teachers looked forward to using the materials provided in the internship program with their usual textbook. Teachers believed that professional development, field trips, material for the unit of study, and current and reliable information for the teachers are very important. Many participants felt that the teachers feel more comfortable teaching about water issues when they received proper training and instruction.

Also teachers recommended more programs like the Tucson Water sponsored internships, which integrated world water issues and educated the parents as well as the students. In addition, teachers mentioned that the neighborhood meetings, nature conservancy, and volunteer organizations led by Tucson water are helpful in solving the water problem.

**Focus group meeting**

At the focus group meeting with the public, participants mentioned that the *Beat the Peak* campaign raised awareness among the people of Tucson and suggested that this effort be brought back. Moreover, participants believe that the involvement of city officials and politicians was also popular. Specifically, they suggested that city officials be encouraged to include water shortage issues in meeting agendas and pressured by the public to include water conservation issues in political campaigns.
The University of Arizona plays a major role in solving water problems not only in Tucson, but also throughout the State of Arizona, the United States, and in South America and the Middle East. The Arizona Water Resources Research Center (WRRC) deals with research and educational programs that explore water issues. It cooperates and coordinates with the Tucson Water Department without duplicate or collapsed responsibility between them. Also, the Pima County Cooperative Extension performs unique tasks regarding the water problem in the Tucson area. The findings of the research related to the University of Arizona are presented in the following details.

The Role of the Arizona Water Resources Research Center (WRRC)

Interview

As mentioned earlier, the WRRC has a lot of publications on water issues in Tucson specifically and Arizona, in general (see Appendix H for all publications and programs). Two professional designers for an educational workshop, who were collecting and distributing materials related to water problems, were interviewed. Both of them were involved with various educational activities including seminars, workshops, and classroom instruction. They engage in these activities to promote awareness of the water shortage and to teach people about conservation methods. They are also in charge of Arizona’s Project Wet, which focuses on helping and preparing teachers in K through 12 schools by providing them with curriculum materials and guidelines. Middle school and high school workshops are coordinated by the WRRC and funded by the Tucson Water Department. They include the Wetland workshops, Drought and Fire workshops, and Classroom instruction by facilitators and University of Arizona students, Water Smart series for homeowners, Desert

One of the interviewees focused on formal education in the schools and the other dealt with informal education. The one who focused on formal education mentioned the way in which teachers are selected to run the workshops. The WRRC advertises the workshops to all teachers and non-classroom educators statewide. The interdisciplinary workshops are open to all. Teachers are organized according to their expertise in given topics. More preference is given to teachers who are personally recommended.

Those who assist in workshops have to be dynamic, have good communication and organizational skills, a high level of energy, focus, and knowledge of water resources in the state and water conservation ethics. The one who usually conducts and coordinates the formal education workshop and training has more than 14 years experience in water issues.

The other professional, who is responsible for dealing with informal education and training, works closely with the Tucson Water Department. She is responsible for designing the materials and getting media publicity for the department. She focuses on plants, landscaping, and irrigation issues.

Questionnaire

The teachers mentioned Project Wet and credited it as a valuable resource. They also connect the impact of personal water usage to the water shortage. Frequently teachers take different learning styles into consideration, to avoid "reinventing the wheel," they ask the professionals, to make data accessible to students, and investigate common trends that lead to the current situation.
The Role of the Agricultural Education Department

Interview

The Department of Agricultural Education's mission does not include a focus related to water issues in Tucson. The head of the department was interviewed about his perspective on the water shortage in Tucson. He professed the readiness and willingness of the department to offer advice and help related to teaching and learning methods for solving the water problem. The department does have a cooperative agreement to work and train extension employees who work in Pima County or belong to the University of Arizona in Tucson. One Agricultural Education professor used to work with the Global project and its focus on sentimental issues that deal with agricultural issues, but not any more. While the department does not require that students take any courses related to water management or water education, it encourages students to take electives in other disciplines related to these topics such as: ABE 250 (Water and Its Use), ABE 426 (Soil and Water Conservation Engineering), etc... Most of the students do have backgrounds in teaching and learning associated with agricultural courses, but none of the courses are specifically related to the water issue. At this time there was no future plan to bring the water subject to the department.

Pima County Cooperative Extension

Interview

The University of Arizona cooperative extension specialist in crops and farm extension said that the cooperative extension plays a unique role in providing practical information and education to both rural and urban people in the Tucson area. He was interviewed for a half an hour on August 5th, 2003 in the Pima County Cooperative Extension
office in Tucson, Arizona. The meeting focused on farmers and irrigation. He explained how he works with farmers as a facilitator and conducts three seminars a year regarding crops and irrigation. Tucson has around 12 farmers, who extension works with regarding irrigation systems. Along with the seminars, farmers receive weekly announcements regarding water information. The seminars focus on the best way of using an irrigation system, irrigation time, and the right amount of water for crops. Farmers learn how to minimize their water bills by using suitable irrigation for each crop. The specialist mentioned that farmers are aware of the water shortage and the importance of conserving water in the desert and drought season. He believes that the price of water is still too low and should be raised to force farmers to use water wisely. He continues that farmers should follow new methods for irrigation at no cost to them. He sends information by both e-mail and mail to farmers. He added that the Pima County Cooperative Extension has many programs and strong cooperatives that deal with water problems in urban areas. The WRRC and the Tucson Water Department are two of those cooperatives (see Appendix I).

Focus group meeting

The public agreed with raising the price of water for farmers in a desert area like Tucson. They believed water should service the needs of the urban public first. Also, they mentioned that the government and farmers should produce crops or vegetables that need less water. "Using more than 80% from Tucson water for farmers is not fair," argued more than one-third of the participants from the focus group.

The Roles of the Different Media Programs

The public participants, teachers, and interviewees agreed that the media is a primary source of water information. They added that the media plays a major role in capturing
people's attention and shaping attitudes around the water shortage in Tucson.

**Interview**

The Tucson Water Department spends, on average, $22,000 a month on local television programs to educate the public about water problems. This money is for 30-60 second ads in English and Spanish (a large majority of people speak Spanish in Tucson). Also, the water department uses radio and newspapers for advertisements to spread information among the public, and the water department keeps records of the articles and broadcasts that cover water issues.

**Focus group meetings**

Participants felt that increasing public awareness of the problem and of potential solutions was the best technique. Popular suggestions included talking about it more, in general, and utilizing the media (TV, radio, Internet, newspaper, flyers, billboards, mass mailings). Other respondents talked about the availability of information, suggesting that television and other forms of the media are influential, as well as, education, personal discussion and general knowledge about the water shortage. Moreover, programs aimed at increasing awareness could inspect the newspaper for current problems and link those problems to economic and developmental issues of future water usage.

One popular discussion was about the need for children to be encouraged to discover water shortage information by media programs so that they can better analyze the water situation in their own areas. Participants suggested that there should be video programs available in the Tucson public library for children that demonstrate the best water usage indoors and outdoors. Participants believed that children' attitudes influence them to discuss these issues with their parents. Participants suggested that the programs have to be
imaginative to attract people and that messages have to be focused.

**Questionnaire**

On the other hand, participants did not give positive responses to the current television programs. As indicated in Table 1, on a 5-point scale, the mean and standard deviations that resulted from participant responses to the statements asking whether current educational television provide insight into the water shortage problem for the public were 2.52 and 0.88, respectively. Also, similar rates were the result concerning newspaper articles dealing with the water problem. This response had a mean rating of 2.81 on a 5-point scale with a standard deviation of 0.97.

**Different Approaches**

This section contains information related to the participants’ knowledge towards behaviors and attitudes about the water problem. It is useful to link this information to the research objectives.

**Information regarding the water problem**

**Questionnaire**

Participants from the public had different sources of information regarding water problems and management in Tucson. As indicated in Table 2, the majority (85%) of the participants got their information from the water bill, 73% from the television, 69% from newspapers, 37% from friends, 28.7% from books and magazines, 23% from family, 23% from the Internet, 16% from lectures or speakers, 13.7% from the schools, and other sources made up 13%.
Table 2. Resources Utilized by Participants to Gain Information on Water Issues (N=293)

<table>
<thead>
<tr>
<th>Source of Information</th>
<th>Present %</th>
<th>Source of Information</th>
<th>Present %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Utility bill</td>
<td>85</td>
<td>Family</td>
<td>23</td>
</tr>
<tr>
<td>Television</td>
<td>73</td>
<td>Internet</td>
<td>23</td>
</tr>
<tr>
<td>Newspaper</td>
<td>69</td>
<td>Lectures/Speaker</td>
<td>16</td>
</tr>
<tr>
<td>Friend</td>
<td>37</td>
<td>School</td>
<td>13.7</td>
</tr>
<tr>
<td>Book/Magazine</td>
<td>28.7</td>
<td>Other</td>
<td>13</td>
</tr>
</tbody>
</table>

Relationship between Knowledge and Behavior

Questionnaire

The public participants had good background knowledge on Tucson’s water resources as indicated in Table 3. Almost all of them (93.2%) answered yes for “groundwater is a source of water in Tucson.” On the other hand, only 42.3% answered “yes” to the question asking whether or not “rivers are a source of water in Tucson.” A majority of them – 88.1%, 75.2%, 74.1% respectively – answered “no” to the following three statements: “All groundwater is fresh,” “groundwater is not affected by human use,” and “rainfall does not penetrate to the groundwater.” All were right answers.

A full 96% of the participants believe that water pollution is possible. And 79.5% of them believed that household water usage affects water levels. However, only 33.8% believed that gardening consumes most of the water in the average household.

There were no significant correlations between participants’ knowledge and average household water usage. This result was in sync with the discussions that took place in the focus group meetings where participants said that they trusted the information they were given. Without faith or trust in the information and the source, knowledge does not influence
people's behavior

Table 3. Participants Knowledge of Water Issues (N=293)

<table>
<thead>
<tr>
<th>Statements</th>
<th>Yes%</th>
<th>No%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall represents a source of water in Tucson</td>
<td>81.2</td>
<td>18.8</td>
</tr>
<tr>
<td>Rivers are a source of water in Tucson</td>
<td>42.3</td>
<td>57.7</td>
</tr>
<tr>
<td>Groundwater is a source of water in Tucson</td>
<td>93.2</td>
<td>6.8</td>
</tr>
<tr>
<td>Tap water is a source of water in Tucson</td>
<td>49.1</td>
<td>50.9</td>
</tr>
<tr>
<td>Snowfall is a source of water in Tucson</td>
<td>52.6</td>
<td>47.4</td>
</tr>
<tr>
<td>Six percent of earth’s water is suitable for human consumption</td>
<td>60.1</td>
<td>35.2</td>
</tr>
<tr>
<td>Groundwater is not renewable</td>
<td>24.8</td>
<td>74.2</td>
</tr>
<tr>
<td>All groundwater is fresh</td>
<td>8.5</td>
<td>88.1</td>
</tr>
<tr>
<td>Groundwater is not affected by human usage</td>
<td>21.8</td>
<td>75.2</td>
</tr>
<tr>
<td>Rainfall does not penetrate to the groundwater</td>
<td>25.8</td>
<td>74.1</td>
</tr>
<tr>
<td>Pollution of the water resources is possible</td>
<td>96.2</td>
<td>3.8</td>
</tr>
<tr>
<td>Watering by drip irrigation is cheaper than by sprinkler</td>
<td>88.7</td>
<td>11.3</td>
</tr>
<tr>
<td>Watering in mid-day is less expensive than in morning</td>
<td>7.2</td>
<td>92.8</td>
</tr>
<tr>
<td>Gardening usage consumes most water in the average household</td>
<td>33.8</td>
<td>66.2</td>
</tr>
<tr>
<td>Water level in is affected by household water usage</td>
<td>79.5</td>
<td>20.5</td>
</tr>
</tbody>
</table>

**Household Water Usage**

**Questionnaire**

Only 5% of the participants chose the correct order (highest to lowest) of the amount of household water usage, which is gardening, bathroom, kitchen, and laundry. In fact, four different orders were given; 52.4% responded that water used in the kitchen accounted for the highest amount of usage, and laundry usage was 20.5% as the second highest water usage. Participants gave gardening and bathrooms the lowest water usage.
Table 4. Rank Order for Household Water Usage (N=293)

<table>
<thead>
<tr>
<th>Items</th>
<th>Correct order</th>
<th>%Order 1</th>
<th>%Order 2</th>
<th>%Order 3</th>
<th>%Order 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gardening usage</td>
<td>1</td>
<td>11.9</td>
<td>30.7</td>
<td>41.0</td>
<td>16.0</td>
</tr>
<tr>
<td>Bathroom usage</td>
<td>2</td>
<td>15.0</td>
<td>29.4</td>
<td>35.2</td>
<td>20.5</td>
</tr>
<tr>
<td>Kitchen usage</td>
<td>3</td>
<td>52.4</td>
<td>31.4</td>
<td>11.3</td>
<td>4.80</td>
</tr>
<tr>
<td>Laundry usage</td>
<td>4</td>
<td>20.5</td>
<td>8.20</td>
<td>13.3</td>
<td>58.0</td>
</tr>
</tbody>
</table>

Skills and Attitude

Questionnaire

Ten statements were given to public participants to rate on a 5-point scale. Data in Table 5 indicated that participants were capable of learning about the water problem in the Tucson area. The highest mean rating for learning capabilities and the water problem were given as 4.10, with 0.78 standard deviation. On the other hand, patience and motivation ranked the lowest rate, at 3.37 on a 5-point scale. Moreover, based on the indications given by mean 3.85 and 3.84, respondents believe that communication and reflection upon the water problem are both very important. Indicated by the mean rating of 3.80, and 3.74, participants were comfortable sharing knowledge and understanding the problem.

Also, to see if there was a relationship between peoples' skills and the water usage at home the result showed that there was not a significant correlation among average water usage and people's skills regarding the water problem.
Table 5. Participant Motivations and Learning Capability Concerning Water Conservation Issues (N=293)

<table>
<thead>
<tr>
<th>Items</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>I have the capabilities to learn the various aspects of the water problem and solutions in Tucson</td>
<td>4.10</td>
<td>0.78</td>
</tr>
<tr>
<td>I have the suitable communication skills for talking to other people about the best actions to prevent the waste of water</td>
<td>3.85</td>
<td>1.10</td>
</tr>
<tr>
<td>My current usage of water reflects my concern about the water problem in Tucson</td>
<td>3.84</td>
<td>1.03</td>
</tr>
<tr>
<td>I have enough knowledge about the problem</td>
<td>3.80</td>
<td>1.10</td>
</tr>
<tr>
<td>I have enough understanding of the problem</td>
<td>3.74</td>
<td>0.98</td>
</tr>
<tr>
<td>My current usage of water can set an example to my neighbors, friends, family and/or others</td>
<td>3.69</td>
<td>1.03</td>
</tr>
<tr>
<td>I can actively participate in the program by providing ideas</td>
<td>3.53</td>
<td>1.10</td>
</tr>
<tr>
<td>I have the time to participate in this program</td>
<td>3.48</td>
<td>1.17</td>
</tr>
<tr>
<td>I know a wide range of people who might be able to help in this program</td>
<td>3.48</td>
<td>1.13</td>
</tr>
<tr>
<td>I have the patience and the motivation to participate in this program</td>
<td>3.37</td>
<td>1.11</td>
</tr>
</tbody>
</table>

Perception scale: 1 = Strongly does not apply; 2 = does not apply; 3 = Neutral; 4 = Somewhat apply; 5 = Strongly apply.

Landscape and Tucson Attitude

Focus group meetings

The focus groups discussed the experience of dealing with the water shortage in Tucson. Participants told stories about residents of Tucson, who had moved there from other states. They offered that some usually started off by planting grass and shrubs in their gardens, but after while changed over to desert plants. The analysis of this result agrees with the quantitative results, in which showed a negative correlation between living in Tucson and the average water bill, which was (-0.503, P ≤ 0.01). To understand the relationship between
residency impact and other factors, the data analysis found out that there was negative correlation between living longevity, current curriculum, and short stories, which was (-0.118, p<.05, -0.170, p<0.01), on the other hand, a positive correlation with having enough knowledge about the problem, which was (0.139, p ≤ 0.05).

The participants believed that Tucson residents have certain intentions when they build and design their garden landscapes. Residents' attitudes toward water is obvious because the majority of people plant desert plants or use stone, sand or other materials that don't need water or need less water.

Nearly half of the participants (46%) have house gardens with plants, and 54% have landscapes without plants, but with stones and other materials designed creatively to make them attractive. The result of this observation agrees with the analysis of quantitative data, which found that there was no significant correlation between having house gardens and the average water bill. Figure 5 showed a typical Tucson house garden, which contains mostly desert trees and plants. The land is covered with dirt and stones instead of grass, and there was no irrigation system.

Of the 86% that did not attended water-related workshops, only 32% responded that they would be motivated to attend future workshops and 14% that attended workshops related to water or landscaping would recommend others to attend. The workshops are very beneficial and offer good information about managing household water usage.

Participants did not know until now that the city of Tucson has rules and regulations on water usage. But they suggested that the city of Tucson should put even more rules and regulations on water usage, specifically for new houses and construction. Participants agreed
Figure 5A. Landscape of house gardens in Tucson: desert trees, stones, dirt and no irrigation systems

Figure 5B. Some of the desert plants usually raised in house gardens in Tucson
that people should have two water meters on their houses—one for indoor use and the other for outdoor. These responses correlated with participants’ ranking of water usage of which only 15% knew that gardens consume most of the water in the average household.

Summary

The findings of this study from both the quantitative and qualitative analysis were organized to achieve the study’s objectives. There were 293 members of the public, 22 teachers, nine students, and seven professionals, who participated in this study. The participants agreed to address the water conservation issue with K-12, community colleges, and four-year colleges for long-term effectiveness. On the other hand, current schools and curricula did not do well related to water shortage.

Training teachers was a major concern, in addition to current problems and people’s needs. Providing information and curriculum guidelines were important issues for the teachers. Hands-on training, speakers, and field trips were the best methods for teaching water conservation.

Parents, religion, the media, schools, extension and universities play a major role in educating people about water conservation. Participants agreed that school alone cannot solve the water shortage problems in Tucson. Education should focus on people’s needs and apply water sustainability to solve the water shortage in Tucson.
CHAPTER V. DISCUSSION

Interviews, focus group meetings, and questionnaires were used to collect information in this study. Fishbin's and Ajzen's theoretical framework in chapter two discussed people's attitudes and beliefs. As the basis of this study, this theory supports the ideas of Clinton (1996) and Thomas' (1983) concerning a connection between politics, religion, education, and family and the responsibilities that these groups have shaping society. Clintons' idea from an old adage that "it takes a village" and Thomas' model that shows the synergistic relationship between politics, ethnicity, religion, parenting, community, education, etc. are interpreted in the framework. The majority of participants stated that families, religious institutions, schools, the media, the University of Arizona and the city of Tucson all have educational responsibility and impact when dealing with the Tucson water shortage. Participants believed that if all of the Tucson community would take responsibility, then they will not face water shortages in the future.

Schools and Curricula

Both teachers and the general public believed that education about water shortages should start from the earliest grade in school. Addressing the issue in K-12 schools and in community and four-year colleges were the popular responses and the topic of major discussions in the focus group meetings. The majority of participants agreed that teaching young people proper respect for the resource would help them to influence their parents and communities. Participants believed that schools can play an important role in water education. When children get the right information from teachers about water resources and water usage, they are able to be more confident in family discussions. These findings supported research conducted by Winkler (1982), which suggested that what the students
learn in school leads them to influence their families. Home and Disinger (1988) stated that involving students from the earliest grades, continuing right on through to high school, develops the students' knowledge, skills, positive attitudes and motivation to take action. They added that students carry out and practice what they learn in their home.

The findings of Leeming et al in 1997 showed that students who engaged in specific projects had a more positive attitude toward the environment. Tucson teachers agreed with this. The majority of them stated that hands-on experience and teaching about water conservation were the best techniques. Moreover, Trexler and Johnson, and Heinze (2000) supported Tucson teachers when they stated that schools play an important role in food system education. As one teacher noted, "children won't get information about how a cracker is made and gets to their table unless it comes from schools" (p. 34).

Participants agreed that the school curricula was weak when it came to teaching students about the Tucson water shortage. Participants gave the current school curricula the lowest mean rating. Moreover, teachers and other professionals at the University of Arizona agreed that the current curricula has not been developed in a way that could help to solve the water problem. Gelt (1990) supports this research; he states that environmental education is no longer a required topic. One study, conducted by Agbaje, Martin, and Williams (2001), found that teachers were rated "neutral as to the importance of sustainable agricultural in their own curriculum" (p.43).

Teachers believed their primary role was to educate students about water quality and quantity choice across curricula. Armon and Dawson (1997) described the impact of environmental education as approached in different subject groups "such as genetic history, lifestyle, individual interests and activity, competence, access to resources, specific life events and
Respondants in this study felt that hands-on experience and teaching about water conservation were the best techniques. They believed that teaching should include relating water issues to local problems, bringing speakers from the water company to the schools, and holding field trips for the students. Additionally, they suggested that students monitor their personal use of water at home. Teachers stated that effective ways to teach students about the water problems involved giving students very practical and specific lists of ways that they can conserve water at home, emphasizing the consequences of long-term abuse of the resource, in-class presentations, discussions, and brainstorming sessions, so the students could bring in their own personal experiences. This finding supported research conducted by Aird and Tomera (1977), in which they looked at the effects of water conservation education on the values held by sixth graders in a study where the experimental group of students received lectures and hands-on activities. Later on, Campbell, Waliczek, and Zajicek (1999) found the same result when they evaluated the effectiveness of science courses that included one-third lecture time and two-third hands-on activities. The results showed that these courses increased environmental knowledge and that attitudes were more positive after exposure.

Teachers stated that certified students in the university should have a strong background in water issues. Undergraduate courses should not be traditional, but instead focus on society needs. They added that building good guidelines across curriculum may help. The guidelines should involve teacher training. The Tucson Water Department and the Arizona Water Resources Research Center (WRRC) could serve as resources for this training. Thompson and Balschweid (1999) reported that teachers who integrated science
into the curriculum found that it increased their ability to teach students problem solving techniques (p.26). Newman and Johnson (1994) reported that teachers felt more competent in traditional areas like animal science and plant science, than in non-traditional areas like environmental science. They added that the undergraduate curriculum should be restructured to provide more preparation in non-traditional areas. They reported that teacher training workshops yield very positive results. Moreover, Peasley and Henderson reported that background knowledge and educational level are significant factors in the teaching of curricula.

The Agricultural Education Department at the University of Arizona does not offer or require courses in water management or water education. While the department does not require that students take any courses related to water management or water education, it encourages students to take electives in other disciplines related to these topics. The head of the department believes that training teachers and cooperates to help in both the Pima County and the Arizona Water Resource Research Center can support water shortage solutions. Williams (1991) stated that agricultural education can help with technology transfer activities and gave examples of ways in which agricultural education may make contributions, one of them being in regard to the water resource.

Teachers considered in their evaluation of teaching methods regarding water shortage, feedback about students' awareness regarding the problem a major issue. These evaluations should focus on the students' behavior rather than their knowledge. Also, teachers could ask students to bring their home water bill in at the beginning of the semester and compare at the end of the semester to see if instruction had any impact. It would be most effective if they also looked at student interest in the topic, class participation, and future
questions. Many teachers mentioned other common methods of evaluation, such as exams, research projects, lab and class participation, presentations, questioning, and basic student-teacher interactions. Some teachers suggested evaluating the level at which the students incorporate new knowledge into their exams and projects. These results matched with Geller’s (1981), Ramsey et al.’s (1981), and Horsley’s (1977) findings that evaluations should include student activities like comparing water bills, letters written by students to newspapers or students talking with neighborhood people about water conservation.

This research found a strong relationship between courses that students took and their knowledge. There were differences among the students' concept maps regarding water usage and water resources in Tucson. The majority of the students who took biology or agricultural courses did an excellent job in their concept map and explained water resources and usage in a good way. Moreover, students who had a background in biology or agricultural courses not only explained water resources and usage, but also explained how Tucson ground water could be renewed. In research carried out by Middlestadt et al. (2001) the impact of a water conservation curriculum that consisted of six weekly sessions and covered topics such as groundwater versus surface water, water conservation in domestic settings, house gardens and irrigation was evaluated. The curriculum advocated personal, household and parental behaviors to conserve water. The courses were created to change behavior by instilling action skills, knowledge of action strategies, knowledge of environmental issues and other factors to influence action behavior. They found that participation in the curriculum had a very strong impact on students' knowledge and behaviors (Middlestadt et al., p. 40, 2001). The same indication came from Kalme and Dyer (2000), who stated that students can benefit from agricultural coursework “no matter what their academic ability, location (technical
schools/centers, or high school), or geography (rural, urban, or suburban areas)” (p. 122).

**Parent's Direction**

Findings have indicated that children should start their education on water problems at home. Participants in this study believed that children should develop an awareness of their own personal situation regarding water shortages, something which can be accomplished by connecting water shortage issues to their local communities. Ruma and Thompson (1996) stated that families should not only support children, but also increase their children’s access to information, improve their problem solving skills, help them develop positive behavior, and provide cooperation and support to the society and school system.

Teachers pointed out that parents and families are useful sources of information regarding water shortage in Tucson. Children usually follow what is modeled at home and try to copy what their parents say and do. Dyer (2000) wrote that parents in any society have a critical responsibility to educate and set a good example to their kids. Trexler, Johnson and Heinze (2000) stated that families are the first source of information for their children, but they aren’t always very knowledgeable sources.

Children are the future of any nation, as a large number of people pointed out. There are many simple and practical conservation methods that children can participate in around the house. Participant suggestions included things like not letting water run while brushing teeth and taking shorter showers. Several people noted that positive reinforcement was important and that conservation could be made into a game, possibly with household contests to see who could use the least water.

Parents are adult learners, which means they are responsible for themselves. They are self-directing utilizing skills like, self-concept, motivation, self-evident, self-
oriented, and self-identity to achieve these goals. Parents may or may not have the
knowledge or behavior toward water conservation necessary to be good examples to their
kids. They are ready to learn what they need to learn (Knowles, 1984). The researcher
believes that the Pima County Cooperative Extension is the good place to train parents about
the water management and water conservation in their homes and community. The
Department of Agricultural Education at the University of Arizona could design a good
program to educate people in that way and there must to be an evaluation before and after the
program to come up with solutions for granted improvement.

Religion's Direction

Many participants indicated that religion could help to solve the water problem
because it deals with people’s manners, attitudes, and behaviors. They stated that religion
should not only focus on worshipping God but should also convey God’s message that
everything on the earth is trusted to us by God, so we have to use it conscientiously. During
the focus groups people talked about attitude, suggesting that environmental conscience,
spiritual and religious beliefs, fear, following the example of others or peer pressure,
believing that they themselves can make a difference or simply having an awareness that it is
in their own best interest to conserve water are all motivating factors for people. Participants
agreed that people’s faith has to lead people to preserve water resources for future
generations. Moreover, many believed that morals and values can help people to share and
conserve all the natural resources for future generations. Krishnamurti (1953), Austin,
(2003), and Oliver (2001) have all mentioned that true religious education helps people to
understand and think about their situation. Religion can bring awareness about the real
meaning of life and can help people to link that awareness to all people, animals, the
environment and the actions and behaviors that impact the environment.

Markstrom, Youniss, Mclellan and Yates (1999) agreed that community service and
religion in America are important to youth and their identity process, politics, ethnicity, and
culture. Moreover, Phinney (2003) stated that religious associations help to build strong
relationships among communities and allow people to enjoy social support. Religious
involvement can support community needs and create positive feelings among membership.
Participants in this study believed that morals and values, which come from religion, help
people to share and conserve all the natural resources. Participants gave a high rating to
statements that suggested that the involvement of centers of worship can help solve the water
problem.

Many religious people in Tucson understand their responsibility toward the water
problem, which lead them to get involved in helping to solve the problem. They had several
seminars in the summer of 2003, focusing on water shortage in Tucson. All the seminars had
good information and discussion regarding water shortage. Attendees were members of
churches congregations and their friends. Tajfel & Turner (1986) define social identity in
terms of one's sense of belonging to a group and the attitudes and feelings that accompany a
sense of group membership. People generally attribute value to the groups to which they
belong and derive self-esteem from their sense of belonging.

Religious authority and leaders need to be trained in water conservation to be
effective to their congregation. Also, the researcher believes that the Pima County
Cooperative Extension and the Department of Agricultural Education at the University of
Arizona could train and design a good program to educate religious leaders to help solve the water problem. The program should be evaluated continually to achieve better improvement.

**Media Education**

Participants from the general public, as well as teachers and interviewers, agreed that the media is a primary source of water information. They added that the media plays a major role in grabbing people’s attention and shaping their attitudes toward water shortage in Tucson. The Tucson Water Department is aware of the importance of the television. They have aired 30-60 second announcements, using both English and Spanish. Also, they have used radio and the newspapers to spread information among public. The department also has kept records of the articles dealing with water issues in Tucson.

Participants felt that public awareness could be increased by many methods. These included talking about water more in general and utilizing the media (TV, radio, internet, newspaper, flyers, billboards, mass mailings). Other respondents talked about the availability of information, suggesting that television and other forms of media are influential, as is education, personal discussion and general knowledge about water shortage. Participants also suggested inspecting current local problems in the newspaper, and linking them to economic and developmental issues in the future.

It is not only adults who are affected by media programs, discussions indicated that children should be encouraged to discover water shortage information by media programming, so that they can better analyze the water situation in their own areas. Participants suggested that there should be a movie program available at the Tucson public library for kids, demonstrating the best water usage indoors and outdoors. Participants also suggested that the programs should be focused and imaginative to attract people.
The results above support Simpson (1998) in his statement that the media has been used for non-formal education because it plays a significant role in forming and influencing people's attitudes and values, behavior, and skills. He added that United States television shows like *Mr. Rogers' Neighborhood* offer powerful models for healthy care-giving behavior. Further supporting the use of television, Martinez and Scicchitano (1998) evaluated the effectiveness of the recycling media education program in 67 Florida counties. The result of the research showed that the television was the most active in public communication. Additionally, Trexler, Johnson, and Heinze (2000) found that there was a positive relationship between the level of education and the media program. Media, in general, and television, specifically, are primary sources of information about food systems. The majority of children have great access to different kinds of media (Park, 2003), which could be helpful resource in reaching this particular age. Despite these considerations, the Tucson media has not thus far done a good job of helping to solve the water problem. Participants gave low ratings to the current television and newspaper programming related to water shortage in Tucson.

**Knowledge Towards Behavior**

There were 15 items on which participants were asked to measure their basic knowledge toward the water sources and water usage. The items had only Yes/No answers for participants to choose from. Participants often did not know that Tucson gets water from a river; only 42.3% answered, "Yes" for river is a source of water. This finding showed that there were no significant correlations among participants' knowledge and average water used at home. In the focus group meetings it was found that many people believed that information and knowledge do not lead people to change their behavior if they do not have
faith or believe. This result was supported by Fishbein and Ajzen (1975) when they stated, "a person's belief about an object was described as the perceived probabilistic relation between that object and some attribute... the formation of one belief may lead to the development of other inferential beliefs; that a person's attitude is determined by his salient beliefs about the attitude object; and that beliefs about a given behavior and about the expectations of relevant others vis-à-vis that behavior determine a person's intention to perform the behavior and thus also influence the overt behavior itself" (p. 388). Knowledge and awareness are not enough to change personal attitudes and behavior. As Solomon (1989) stated, "people do not always move from awareness to attitude change to behavioral change" (p. 96).

The average household water usage depended on many factors – not only the 15 items people were asked to respond about, but also the right information about water usage. Out of 293 people, only 5% chose the right order of household water usage in and out of doors. There was no significant relationship between the right ranking and the average water usage. This may be related to the fact that the majority of people plant desert plants and so do not need much water irrigation. Also, it could be that people did not practice and transfer their knowledge. McNeil (1996) stated that professional people must try to practice their knowledge and share their experience with others if they want to change society.

Skills and Attitude

Participants demonstrated a strong motivation to learn about water problems in the Tucson area. They believed that communication about and reflection upon the water problem are very important. People were also comfortable sharing their knowledge and understanding about the problem. There was no significant correlation among people's
average water usage and people’s attitudes. Downs (2000) supports the finding that a community can work together to change norms and values by three enabling dimensions: 1) identifying and addressing main concerns and needs; 2) sharing and integrating knowledge to find solutions supported by all social groups in collaboration; and 3) devising an ethical code of practice that values the needs of different human social groups and the needs of other species sharing the ecological system, and guides social interaction and how knowledge is used.

**The Tucson Government Agency:**

There are many water government allies' agencies, including the Tucson Water Department, the Arizona Water Resources Research Center (WRRC), and the Pima County Cooperative Extension. Each one of them has a responsibility to get involved, to help and to solve the water shortage in Tucson specifically, and in Arizona, the United States, and the world, in general. This research found that each one of these agencies had many educational programs. The Tucson Water Department offers water conservation programming such as General Public Information, Education and Training, Direct Assistance Programs, among others.

The teachers in the study stated that the two-week paid internship offered to school-teachers was very helpful. The program provided teachers with tours of facilities and presentations on related issues. Moreover, the program helped teachers to be familiar with water problems and gave them confidence to teach water topics in the school. It also helped them to find employees to be guest speakers in their classes. The materials provided, field trips, professional development, offered materials for the unit of study, and current, reliable information for the teachers were very important and usable in classroom teaching.
It was also found that the Beat the Peak campaign and the involvement of city officials and politicians in raising awareness among Tucson people were important. People also gave a credit to Direct Assistance Programs, which is responsible for helping and assisting customers in reducing their water use.

It was also found that the Arizona Water Resources Research Center (WRRC) has a major responsibility to deal with research and education in formal and non-formal setups. WRRC is cooperative: coordinators work with the Tucson Water Department without duplicate or collapsed responsibility between both of them. The educational activities held or supported by the WRRC include seminars, workshops, and classroom instruction, all of which aim to promote awareness of water shortage and conservation methods.

Goecker (1992) stated that teachers were trained to anticipate and deal with current social problem and are trained for that. Teacher participants in this study emphasized that the Arizona Project Wet, which focuses on helping and preparing teachers for teaching in schools, as well as providing curriculum materials and guidelines for teachers in Tucson K-12 schools, was the most supportive program for teaching about water issues. Teachers gave credit to Project Wet as a valuable resource, one that emphasized the impact of personal usage on water shortage. Other popular responses to the question of educational methods included taking different learning styles into consideration and not reinventing the wheel, asking the professionals and making the data accessible to students, and researching common trends that lead to the current situation. These findings are supported by Middlestadt et al. (2001), DeYoung et al. (1993), and Newman, and Johnson (1994), who all stated that workshop training helps teachers to feel competent in their teaching.
Pima County Cooperative Extension is responsible for helping farmers and urban people to manage their water irrigation by following the right methods. The general public is not happy with Tucson water rules regarding farmers. People agreed with the idea of raising water prices for farmers in a desert area like Tucson. They believed that water should serve urban people's needs first, not act primarily as an investment in agriculture. They also mentioned that the government and the farmers have to farm crops or vegetables that need less water, rather than crops like wheat or cotton. Over one hundred people who participated in the focus groups meeting discussed how it is not fair for farmers to use more than 80% of Tucson's water. The crop specialist in Pima County agreed with the public that the price of water is still cheap and it should be raised. These results are supported by Agbaje, Martin, and Williams (2001) when they stated, "the literature revealed that future agricultural system must become more environmentally friendly and socially acceptable along with being economically sound" (p. 43).

The findings showed that 85% of the participants got their information from their utility bills. The television came in second as a source of information, 73%. Then, in order: newspaper, friends, books/magazine, family, Internet, lectures/speaker, school, and other. The finding supported by Kaneen Advertising and Public Relations (2002): they carried out that Tucson people got their information from water bill, radio, television, website, newspapers, and verbally from family and friends. This is supported by similar results found by Riesenberg and Gor (1989): they found that farmers received their information from on-farm demonstrations, tours and field trips, group discussions, guest speakers, consultants, workshops, and practical short courses. Mass media, journals, bulletins,
computer assisted instruction, and home study (fact sheets and video cassettes) were also popular sources of information.

Finally, the research found that average person’s daily water usage was 152.45 gallons. This finding basically agreed with the statistics provided by the California Economic Case Study (2001), and Sedona community plan (2002), in which they state that the average water usage per person per day in Tucson Arizona was 160 gallons. Moreover, the data analysis showed that there was a negative correlation between the length of time living in Tucson and the average water bill, which was (-0.503, P = 0.01). This result showed that participants engage in self-directed lifelong learning. This finding is supported by Bolhuis (2003), who states that self-directed lifelong learning leads to democratic society, which "can only function according to its principles if people have equal possibilities to inform themselves, solve problems, make well-considered choices and generally take part in the social construction of reality" (p. 328).
CHAPTER VI. APPLICATION

This chapter focuses on the last research objective, which proposes a new model for applying these programs in Saudi Arabia. The researcher analyzed the data collected from Tucson, Arizona and created a model that can be applied in the Kingdom of Saudi Arabia to solve the water problems there. Investigation of Tucson's school curricula, agricultural extension agencies, teacher programs and meetings with teachers, the public, religious practices, professionals and experts in water issue helped to build upon new ideas, models and programs that will lead to a solution to the water problem in Saudi Arabia. But prior to this, there should be an assessment of the situation and evaluation of all groups relative to both formal and informal water education issues. Fishbin's and Ajzen's theoretical framework in chapter two discussed people's attitudes and beliefs. As the basis of this study, this theory supports the ideas of Clinton (1996) and Thomas' (1983) concerning a connection between politics, religion, education, and family and the responsibilities that these groups have shaping society. Clintons' idea from an old adage that "it takes a village" and Thomas' model that shows the synergistic relationship between politics, ethnicity, religion, parenting, community, education, etc. are interpreted in this study framework.

Introduction

As mentioned before, there are similarities and differences between Saudi Arabia and Tucson. The hydrological, geographical and atmospheric conditions in Tucson are similar to those of Saudi Arabia. Both places are surrounded by desert, have comparable temperatures, and rely on groundwater. Both places also suffer from similar types of water-shortage problems. The differences exist in average water usage – Tucson with 160 gallons/day/person and Saudi Arabia with 260 gallons/day/person. Saudi Arabia relies on
desalination, while Tucson relies on the CPA project, which comes from a river. Cultural differences are highly significant here and cannot be ignored because each society has its own unique culture (California Economic Case Study, 2001, Sedona Community Plan, 2002, Balharith, 1995, and The Water Sector in the Kingdom of Saudi Arabia, 2003).

The population of Saudi Arabia in 2001 was 22.1 million, and the growth rate was 3.28% (RESAW, 2003). The increasing population rate and the expected need of water to meet the population’s demands is exponential. In fact, in Saudi Arabia, with its droughts and little rain, water has become one of the highest critical issues in the desert. "Saudi Arabia now relies on groundwater to meet 75 percent of its water needs, moreover, Saudi Arabia's groundwater could run out early in the next century (Mining Groundwater: Saudi Arabia and the United States, 2003, p. 1).

**Schools and Curricula**

Basic assumptions about the educational practices in Tucson can be made. On the other hand, the Kingdom of Saudi Arabia established formal, primary education in 1930. By 1951, the country had 226 schools and 29,887 students. Now, there are more than 24,000 schools with more than five million students. General education focuses on arts and sciences. The Ministry of Education was established in 1954, and by 1957 the first university was instituted. For Saudi Arabia, the goal in education is "to become more efficient, to meet the religious, economic, and social needs (RESAW, 2003).

The Saudi educational system's teacher/student ratio is fifteen to one. There were more than 200,000 students enrolled in eight major universities and numerous smaller colleges and community colleges during the 2003-2004 academic year (RESAW, 2003).

The Ministry of Education the governing agency over education in Saudi Arabia
provides textbooks in each subject for both students and teachers. It also provides a
guideline textbook to each science teacher. The teaching curricula are controlled and
teachers cannot stray from the subject matter provided in the textbooks. The curricula focus
on "the importance of knowledge and its attainment" (RESAW, 2003). The academic school
year has two semesters. The achievements of the students in each grade are measured by two
major final exams at the end of each semester. In the final high school year, the Saudi
Arabia's Ministry of Education conducts the final comprehensive exam. Exams play a major
role in measuring what students have achieved, but application is not distinguished. Thus,
the main problem in Saudi education, in both general and higher education, is that the
teachers or professors focus on theoretical forms of teaching, leaving out application.
Moreover, the educational system focuses on basic knowledge in both arts and sciences.
What students study in elementary schools, they will repeat in high school at more
complicated or advanced levels. It is assumed that the educational system focuses less on
needs of people and society and more on preparing students for the job market.

In the educational system, there is not much emphasis on the water shortage. The
importance of water is mentioned three times in Saudi general education – in 5th grade, 11th
grade, and 12th grade (Altamime, 2003).

The findings and discussions of this research show the important role of education in
solving the water problem. Most of the research participants responded that addressing the
issue in K-12 schools and in community and four-year colleges was a good idea. The
research concluded that the educational system should focus on both awareness and action.
The Ministry of Education should direct its attention to local problems and give teachers
more freedom and responsibility in their courses providing teachers only with guidelines.
Findings linked to the authors' discussions indicate that training teachers and supplying them with the pertinent information makes teachers feel more comfortable teaching about the water shortage. In addition, hands-on experience and teaching about water conservation prove to be the best techniques in solving the problem.

Students' achievement and evaluation currently focused on short-term effectiveness — grades and points that students gain during the semester. Based on the research findings and discussions, Saudi Arabian schools should consider implementing long-term benefits from the courses; students' evaluation should include soliciting feedback about students' awareness and behaviors regarding the water problem. Teachers can measure student learning, for example, by asking students to bring in their water bills at the start of the semester and again at the end of the semester to see if there is any impact. This result matched with (Geller, 1981, Ramsey et al., 1981, Horsley, 1977) the finding that evaluations should include student-reported data like water bills, letters written by students to newspapers or talking with people in their neighborhoods. Fishbein & Ajzen (1975) stated that peoples' observations and knowledge influence their values and beliefs, which lead to attitudes, intentions and then behavioral change. People feel more comfortable discussing, conveying and accepting a message if they first believe it. The Saudi Arabian government, professionals and teachers should adopt this idea.

Parents' Direction

Research findings linked to the literature review and discussion indicated that children should start their education about water problems at home. Dyer (2000), Trexler, Johnson, Heinze (2000) agreed that parents play a critical role in their children's education. Since they are the first source of information for their children, parents have the opportunity
to set a good example for them.

Like in Tucson, Saudi Arabian families are expected to take responsibility for their children. With the majority of Saudi residents being Muslim, parents are bound by Islamic Law and the sayings of the Prophet Muhammad, "All of you are guardians and responsible for your wards and things under your care, the ruler is the guardian of his subjects and responsible for them and a man is guardian of his family and responsible for them, a woman is responsible for her husband's house, a servant is the guardian of his master's belongings and is responsible for them, all of you are guardians and responsible for your wards and the things under your care" (Al- Bukhari 2.18). Obeying the order and commands of God, parents take responsibility in feeding their children healthy foods, providing them with clean clothes, and raising them in the right manner. In return, children trust their parents. If children see how their parents care about water, then children will follow suit. For example, parents can use care when brushing their teeth by turning the tap water off and/or take showers using the minimum amount of water. Parents should be held accountable for sharing whatever information they have about water with their children and discourage waste.

**Religious Direction**

Research findings and literature also indicate the importance of religious practices in solving i.e. the water problem. Religion influences how people recognize, deal with, and manage natural resources such as water. In relation to Saudi Arabia as mentioned before, Islam rules and regulates the Saudi people's behavior. Muslims believe that water gives life to the earth and all life is made from water. The foundation of Islam is based on social justice; the Prophet Muhammad offers, "None of you will have faith till he wishes for his
brother what he/she likes for him/herself" (Muslim 1411). This saying is applied to every aspect of life including the use of water and is supported by several ideas: "People have a common share in three things: grass (pasture), water and fire (fuel)" (Abu-Dawood 3470). The sayings continue that there are "three people God will ignore on the Day of Judgment and one of them is a man who possessed superfluous water on a hot day and he/she withheld it from the travelers" (Al-Bukhari 3.838).

Islam maintains that Muslims use natural resources wisely: "O' Children of Adam, wear your beautiful apparel at every time and place of prayer: eat and drink: but waste not by excess for God loves not the waster" (Quran. 7:31). Muslims are asked to be economical with water even if they are taking that water from a fast flowing river (Al-Termithi 427).

For the Muslims of Saudi Arabia, Islam is a way of life. For prayers, sermons, and Islamic teachings, Muslims attend a place a called a mosque. A mosque can play a major role in promoting water conservation in Saudi Arabia. Muslims pray five times a day in the mosque. A mosque leader could address the water problem at least once a day after prayer, a time when mosque leaders usually offer advice, share the Prophet Muhammad's speeches, or discuss events related to religion. The Islamic Friday ceremony (like the Sunday church ceremony in Christianity), which usually focuses on this type of advice or societal needs, is a good venue for a water conservation speech.

Based on the research and findings, participants believed that water is a gift entrusted to us from God and should be made available to all living things (Khalid, 1996). Participants added that the needs of citizens should come first and then irrigation in places experiencing a water shortage. Muslims agree that the first right of the resources that come from God is for humankind, then for animals and then for irrigation (Faruqi, 2001).
Media Education

The findings stated that the media is a primary source of water information. The media played a major role in grabbing people's attention and shaping their attitudes towards the water shortage in Tucson. Public awareness could, however, be increased by many methods. In contrast, Saudi Arabia's media has not played a major role in the informal education of people concerning water shortage. With Saudi television and radio stations owned by the government, it should be easy to gain access to decision makers and use them as a tool to increase people's awareness toward the water problem. Newspapers are open to everyone that cares to write articles about any subject, and it is assumed that Saudi people are willing to read about the water shortage. While Billboards are not used in Tucson, they are popular media for advertising in Saudi Arabia. Billboard could be used to target the public with focused messages about water conservation.

The research findings indicate that media programs do affect children. Children can be encouraged to discover water shortage information through media programming. Media can encourage children to become better at analyzing the water situation in their own areas. Saudi's water extension should consider using the media effectively for creating children's programs that are culturally sensitive.

Agricultural Extension and Rural Sociology Department

The research did not find much involvement of the Tucson's Department of Agricultural Education with the water problem. On the other hand, Agricultural Extension and the Rural Sociology Department at King Saud University provided students with background experience to work in agricultural extension agencies. The department, however, does not provide for the teachers who work in the schools like agencies do in the
United States. The research did find that students who took agricultural or biology courses did better in displaying their knowledge of water issues than those who did not take these courses. The impact of the courses taught in schools is obvious according to Middlestadt et al., (2001), Kalme, Dyer (2000), who stated that the curriculum has a strong impact on students' knowledge and behavior no matter what their academic ability, location, or geography. So, the Agricultural Extension and Rural Sociology Department at King Saud University should be proactive in preparing teachers to incorporate strategies for learning about the water problem and environmental issues.

As indicated, one of the major issues in the findings was that the training teachers received from both the Department of Tucson water and WRRC was effective and beneficial. These findings are supported by Middlestadt et al. (2001), DeYoung et al. (1993), and Newman and Johnson (1994), who all stated that workshop training helps teachers to feel competent in their teaching. In essence, there have to be programs that train teachers in Saudi Arabia about a now crucial issue facing the nation – the water shortage. One of the suggestions is to implement programs at the College of Education and at all eight universities in Saudi Arabia.

**Ministry of Water and Electricity**

The findings of the research showed that the Department of Tucson Water is not only responsible for providing the people of Tucson with water, distributing water bills and fliers, training teachers, and supporting other programs dealing with increasing the public's awareness, but it also must recycle its waste water and reuse it in irrigation. Tucson Water delivered about 3.2 billion gallons of reclaimed water, added new customers and made progress in converting Tucson Electric Power's cooling towers to reclaimed water. In 2003,
there were about 600 sites, which included 14 golf courses, 40 parks, 42 schools (including the University of Arizona and Pima Community College) and more than 300 single family homes. In the process, Tucson Water saved 3.4 billion gallons of groundwater for drinking, enough for 31,000 families for a year (The Water Connection, 2003).

On the other hand, Saudi Arabia has wastewater treatment stations that supply 464,000 cubic meters of water, but less that 5% of it is used. In southern Riyadh, there is a small wastewater river that the Ministry of Water and Electricity has to deal with. The Ministry of Water and Electricity needs to cooperate and work with experts to educate and encourage people to use reclaimed water.

Ministry of Agriculture

The research found that people are aware of the water shortage problem and would consider raising the price of water to farmers. In Saudi Arabia, farmers do not pay money for using water for irrigation; whereas, Tucson farmers have to use crops or vegetables that do not use too much water for irrigation. The agricultural extension in Saudi Arabia should educate and train farmers to use the best methods of irrigation to manage their water supply.

The findings of this research showed that people in Tucson are concerned about water because the majority of them plant desert plants or use stone, sand or other materials while designing their gardens. These are materials that either don't need any water or don't need too much water. Nearly half of the participants (46%) have house gardens with plants, and 54% landscape with no plants, but use stones and other creative designs to make it looks good. On the other hand, Saudi people plant date palm trees in their home gardens. The problem with this is that the date palm needs to be watered at least two times a week to flourish. A date palm tree needs 30-40 gallons of water per time (Al-hudaib, 2001). So, it is
imperative that the Ministry of Agriculture cooperates with the Ministry of Water to educate people about water irrigation and conservation. While people are aware of the problem, they there should be rules and regulations that prohibit people from planting this kind of tree.

**Two Water Education Models**

The need for collaboration between public and private organizations is certain concerning the formal and informal education of citizens about water usage. The two very similar water education models described below are adapted from the Thomas (1983), which relates to political education with respect to Clinton's *it takes a village* (1996) concepts. Based on the literature review and findings related to the impact of water education, models that include evaluation methods were developed for both Tucson and Saudi Arabia (see Figures 6 and 7 – Saudi Arabia Water Education Model and Tucson Water Education Model, respectively).

Both models present strategies for incorporating formal and informal training and education in the subjects of water awareness, use, safety, management, conservation, irrigation, supply, pollution, and development. Both models illustrate transactions conducted between public and private sectors – federal and local government agencies and organizations and educational institutions. These groups influence each other distinctly.

The models differ in their government bodies or agencies (e.g. the Ministries of Saudi Arabia versus the Tucson Water Department). At the top of the models are the *Governing* or *Administering* bodies, which will have the reasonable authority for developing legislation, interpreting laws, implementing policies, managing funds, and encouraging other agencies' involvement in supporting institutional goals. In Tucson, select government agencies already work together in that direction. On the other hand, the Saudi Arabian government faces
Government: Ministries

- Water & Electricity
- Education
- Higher Education
- Agriculture
- Legislation, Laws, Interpretation, Polices,
- Funds, Agencies

Coordinated Training

Philosophy: Goals; Values; Needs; Rights
Sustainability: Socially; Environmentally; Economically.
Curriculum: Materials; Teaching methods;
Training; Evaluation Method; Certifications;
Diploma.

Formal
K-12, Colleges

Non-Formal
Extension

Mass media

Neighborhood council

Religious authority

Special-interest groups

Family groups

Outcome Evaluation
Impact Evaluation
Process Evaluation

Water Awareness,
Importance of Water,
Safe water, Water in
our life, Water
management,
Conservation,
Irrigation, Population,
pollution, Expanding
cities, Developing,
Experiential Skills
Development

Region groups

Mosque leaders

Tribe groups

Figure 6. Saudi Arabia Water Education Model
Government:

Tucson Water Department, Pima County Legislation, Laws, Interpretation, Polices, Funds, Agencies

Education

Philosophy: Goals; Values; Needs; Rights,
Sustainability: Socially; Environmentally; Economically.
Curriculum: Materials; Teaching methods; Training; Evaluation Method; Certifications; Diploma.

Figure 7. Tucson Water Education Model
difficulty in engaging decision makers in educational matters. Assembling an *Agricultural Education Council*, co-chaired by representatives from the Ministry of Education, Agriculture, Water & Electricity and Higher Education, is proposed and exemplified here. This council will act as a liaison between the governing ministries and the educational institutions.

The *Coordinated Training* body represents the educational institutions – the didactic forerunners in this cooperative effort. From developing a philosophy of education and curricula that include goals for learning, social values, needs and rights of society and its individuals to implementing pedagogical strategies, the institutions will lead the way in approaching the water problem. Strategies will include a focus on teacher training, learning materials, evaluation methods, certification and diploma, and engaging students and faculty in dialogue and valuable research.

Through formal and informal means, the *Coordinated Training* body will filter specific information on water to K-12 schools, colleges, and extended communities emphasizing theory as well as practice. *Formal* settings will be for the most part knowledge-centered and have long-term effects based on academic coursework, texts, and related material. *Informal* settings also support long-term efforts, will be more practical and may include seminars, workshops, conferences, and more. Private organizations that include regional groups, neighborhood councils, religious leaders and authorities, mass media, tribal groups, ethnic groups (in the case of Tucson), family groups and special interests groups will take the responsibility of disseminating information to the public about the sustainability of water, calling attention to the use of water—socially, environmentally and economically. Information coming from these groups help sustain short-term efforts and can take various
forms including workshops, seminars, sermons, radio/TV announcements, advertisements, brochures, newsletters, and meetings.

The models support this idea of an alliance between public and private organizations and help draw conclusions about the importance of private organizations in helping to solve community problems. Participants and research show an impact from links between the educational institutions and the work done by governing agencies like the Tucson Water Department and Water Resource Research Center. Like the participants in the study, these models propose that formal education is a solution for long-term effect and non-formal education is for short-term. The topics suggested by participants – water awareness, important of water, safe water, water in our lives, water management, conservation, irrigation, population, pollution, expanding cities, developing cities, and experiential skills development – match those in the models and help learners accept responsibility and understand the importance of individual and collective contributions in solving the water problem.

Finally, an evaluation method designed to work with the collaborative efforts ensures the progress and ultimately success of both formal and informal initiatives. Evaluation of the weaknesses and strengths of the program leads to improvements. Methods should be systematic; they should assess not only the outcomes of the program but also the affects from the evaluation itself.
CHAPTER VII SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This chapter is provided as a summary of the study and presents in order the purpose and objectives, method, major findings, conclusions, and recommendations. The chapter first recalls the study method, and then states conclusions based on the major study findings. The researcher offers recommendations for future research related to teaching and learning and developing curriculum in both the United States of America and Kingdom of Saudi Arabia.

Purpose and Objectives

The main purpose of this study was to explore the roles of formal and informal educational forums established in Tucson, Arizona to address conservation behaviors to the water problem, and to determine how to export the knowledge and experience gleaned from Tucson to areas with similar climates and water supply conditions but different cultural and educational systems like Saudi Arabia. These study objectives were to identify: 1) the roles of the formal educational process on students' water consumption behavior; this goal focused on: a) identifying the existing curricula of public schools in Tucson and b) identifying existing facilitators’ roles in the public schools; 2) the roles of the city of Tucson, Arizona in water conservation; 3) the roles of parental direction on children's water consumption behavior; 4) the roles of faith teachings and religious practice on changing people's water consumption behavior; 5) the roles of the academic programs and extension services offered by the University of Arizona on the water consumption behavior of students, farmers and the whole community; this goal focused on: a) the role of the Arizona Water Resources Research Center (WRRC); b) the roles of the Agricultural Education Department in preparing teachers to be aware of future water problems; and c) the roles of Agricultural
Extension to help farmers manage their water usage; 6) the roles of different media programs on citizens' water consumption behavior; and 7) to propose a new model for applying these programs in Saudi Arabia.

**Method**

The research design used in this study was descriptive. According to Fraenkel, and Wallen (1993) descriptive studies “describe a given state of affairs as fully and carefully as possible” (p. 11). The data collected from a general population, the Tucson high school seniors, and the Tucson water professionals. Study looked at their levels of knowledge and their awareness of the water problem. The population included 293 public citizens, 22 teachers, nine high school seniors, and seven professionals. The data was collected using questionnaires, focus group meetings, and interviews. The questionnaires, focus group meetings, and interviews were designed to help achieve the study objectives. The quantitative data was analyzed using SPSS software, specifically used: percentages, means, standard deviations, and correlation matrices. The qualitative data were collected through focus group meetings and interviews. Then the data were analyzed and organized by themes and their input and significance to the study were assessed.

**Major Findings**

The quantitative and qualitative findings were organized according to the study objectives. The findings were:

1. The age distribution of the 293 general public who participated in the study was: ages 20 to 30 - 19.8%, ages 31 to 40 - 11.6%, 41-50 - 22.5%, 51-60 - 23.2%, and over age 61 - 22.9%. A majority (53.6%) of the participants were female and the remaining 46.4% were male.
2. The participants' level of education were: 0.7% had below a high school education, 30.7% had a high school education, 32.7% had a Bachelor's of Science degree, 11.9% had a Master of Science degree, 5.8% had a Doctor of Philosophy degree, and 18.1% had other degrees (e.g., MBA, MA, etc...).

3. The number of teachers per school level was 12 elementary school teachers, and 10 high school teachers. Their disciplines: twelve teach Science, four in Arts and Language, two in English, and there was one teacher for each of these majors: Special Education, Exceptional Education, Chemistry, Mathematics and Biology.

4. The formal school had the following major characteristics:
   a. Water education has two initiatives and addresses the issue in K-12 schools and in community and four-year colleges for long-term effectiveness.
   b. Public participants and teachers agreed that the current school curricula related to water was poor; public participants had the lowest mean rating of 2.35.
   c. Teaching students about water has to be beneficial in their real lives. The teaching method that included hands-on experiences and activities concerning water conservation were the best techniques. Relating water issues to local problems, inviting speakers from the water company to the schools to speak, and organizing field trips for the students were also effective techniques.
   d. Project Wet proved to be a valuable resource in connecting the impact of personal usage of water to the water shortage. Project Wet and the
Tucson Water Internship proved to be very important in training teachers and supplying them with current and updated information.

e. The outcomes of courses related to students' prior knowledge was obvious (i.e. students' concept maps and the relationship to water). Students who took biology or agricultural courses did an excellent job in their concept maps. They were able to explain the concept of water usage effectively. Moreover, students who had backgrounds in biology or agricultural courses not only explained the water resources and water usage, but also how Tucson ground water could be renewable.

f. Student evaluations should be focused on real life benefits not on grades and points.

5. Parents play an important role in helping their children to be “water wise” and can set good examples. Parents may not, however, be the best source of information for water consumption and conservation.

6. Religion plays an important role in solving the water problem in Tucson. Religion conveys a message that everything on the earth that is entrusted to us from God should be used wisely. Certain morals and values have helped people share and conserve natural resources for future generations.

7. The public participants, teachers, and interviewers agreed that the media is a primary source of water information. They added that the media plays a major role in capturing people's attention and in shaping attitudes towards the water shortage in Tucson. The Tucson Water Department spends, on average, $22,000 a month on local television programs to educate people about water problems. This money is
used for 30-60 second ads in English and Spanish (a large majority of people speak Spanish in Tucson). Also, the department uses radio and newspapers for advertisements to spread information among the public. The Water Department keeps records of the articles and broadcasts that deal with water issues.

8. Both the University of Arizona and Tucson Water Department play an important role in addressing the water shortage. Both include non-formal education as an educational objective for the public.

9. Training Tucson schoolteachers is major goal for both WRRC and the Tucson Water Department. They have three programs every academic year; each one trains around 12-15 teachers.

10. Pima County Cooperative Extension plays a unique role in providing practical information and education to both rural and urban residents in the Tucson area. Farmers get the most benefit from the program, which educates them on how to manage farm water and irrigations.

11. The Department of Agricultural Education in Tucson Arizona is not involved in the water shortage problem, but the employees are motivated to help and engage in dialogue with responsible people for water conservation.

12. Overall, the participants were highly motivated to help and get involved in solving the water problem. To some degree, all had information and knowledge related to the problem.

13. Education in water usage is most crucial because participants did not know the area of highest consumption or usage in the home. Only 5% of the participants chose the right order of highest to lowest amount of household water usage.
14. There was a negative correlation (-0.503, P = 0.01) between living in Tucson and the average water bill, which was the longer people lived there, the more experience they had in managing water usage.

15. Participants were highly motivated in solving the water problem. Nearly half of the participants, 46%, have house gardens with plants, and 54% have landscapes without plants, but with stones and other materials designed creatively to make them attractive.

16. Raising the price that consumers pay for water usage is one of the suggestions that participants offered in improving conservation. They believed this solution might encourage farmers to better manage their irrigation and eventually help solve the water problem.

17. Using water wisely and planning for the next generation is a big concern of the participants.

18. The majority (85%) of the participants got information from the water bill, 73% from the television, 69% from newspapers, 37% from friends, 28.7% from books and magazines, 23% from family, 23% from the Internet, 16% from lectures or speakers, 13.7% from the schools.

Conclusions

The general purpose of this study was to identify the significant roles of the formal and non-formal education toward water shortage in Tucson. All participants believed that education is the best solution for the problem in the long run. Participants were motivated to contribute and get involved with solving the problem. Participants believed that all the
public and private organizations have to involve and cooperate to find a solution to the problem. The following conclusions were drawn:

1. Participants indicated that society has to promote education about water usage in Tucson to protect the nation and future generations.

2. Participants believed that all people have ability to contribute to solving the problem.

3. Participants agreed that rules and regulations have to be imposed concerning the issue of water usage.

4. Participants believed that the information and the message about the water issue should be clear and reach everyone.

5. Participants believed that farmers have to change their behavior toward managing water irrigation processes and apply new methods of irrigation.

6. This study concluded that water is crucial to future development in Tucson, and regulations to control water usage should first consider personal uses, then agriculture and industry.

**Recommendations**

These recommendations are based on the study’s findings and focus on education and extensions. The following recommendations were made for both Tucson and Saudi Arabia:

**Education:**

1. Water curriculum materials associated with the Arizona Department of Education should be developed.

2. There should be training for teachers, and information about how to educate students on water usage should be more readily available to them. The training should focus on methods of teaching, i.e. be applicable to real life, link to the local water problem,
and benefit future generations.

3. Undergraduate courses should tie directly to the needs of society. Courses should cross disciplines, i.e. arts, sciences, business, and focus on changing students’ attitudes and behaviors.

4. Teachers, agricultural educators, and water extension specialists in both Tucson and Saudi Arabia should use hands-on activities, field trips, and different delivery methods to deliver water conservation.

**Extension:**

1. Informal education, which people receive from the media, their religion, and any other civic organization, should work with experts in education and curricula design so that their programs benefit as well as educate society.

2. Cooperation is needed to effectively address the issue and solve the water problem in Tucson. The Department of Agricultural Education at the University of Arizona should collaborate with the Department of Agricultural Extension and Rural Sociology at King Saud University at Saudi Arabia to solve the water problem in both the U.S. and Saudi Arabia; both countries have the resources to teach and extensive knowledge about water and agricultural issues.

3. Cooperation and integration should be developed among the states; trade in water, food, and animal production should be global.

4. Places of worship could address the water and environmental problem in sermons. Religious leaders should emphasize morals and values to encourage people to solve their problems.
5. Extension should focus on farmers to help them manage their irrigation systems.

6. University extension should provide educational programs to train both urban residents and farmers on the importance of water conservation.

7. Educators should conduct further studies, which focus on water conservation and the best educational methods to teach people how to apply the sustainability of water conservation.

8. Decision makers in Saudi Arabia have to work together to establish a good system of education to address the water problem and should model Tucson’s techniques to solve it. The average water usage in Tucson was 152-gallons a day per person. In Saudi Arabia, the average is 260-gallons a day per person.

The population in Saudi Arabia around 22 million.

**Weaknesses**

1- The research investigated the role of that different influences play on water education such as family, religion, school, higher education and extension, but it did not evaluate the size of the role each played in comparison to the others. Therefore, the research was unable to report on which aspect is more important and crucial for successful education.

2- The current research was more focused on water resources and general usage of water, but was unable to go in depth about home water usage and people's behavior in using water. Questions about how many showers people take per day, how much laundry people do per month, and other questions related to people's behavior still need to be answered.
APPENDIX A

COVER LETTER AND DATA COLLECTION INSTRUMENT PUBLIC PEOPLE
Dear Citizen of Tucson,

I am a doctoral student in the Department of Agricultural Education and Studies at Iowa State University. Part of my research focuses on Tucson households and their behavior regarding water shortages. Your knowledge and information regarding the water shortage in Tucson are very important, and will lead to:

- Providing water information;
- Developing educational curricula;
- Designing a media program related to the water shortage; and
- Applying the Tucson water management model in a similar environmental area.

We appreciate you time and effort to answer this questionnaire and to attend the focus group meeting. We would like to thank you for helping us in this research. It would be impossible to gather this information without your assistance.

Sincerely,

Mohammad Al-Shayaa
Graduate Student
E-mail - mas@iastate.edu
Home in Tucson 293-4541

Dr. Lynn Jones
Associate Professor
Agricultural Education & Studies
201 Curtiss Hall
Iowa State University
Ames, Iowa 50011
Office: (515) 294-0898
FAX: (515) 294-0530
Determining the Factors that Influence People's Behavior Towards Water Shortage Problems: Case Study in Tucson, Arizona

PART 1: Personal Information

Please note that your answers are used for the sake of this research only and no disclosure of the information to any third party is guaranteed

1. Please check your age range:
   [ ] 20-30.
   [ ] 31-40.
   [ ] 41-50.
   [ ] 51-60.
   [ ] 61 and above.

2. Gender:
   [ ] Male. [ ] Female.

3. Highest educational level:
   [ ] None.
   [ ] Below high school
   [ ] High school
   [ ] Bachelor's of Science (B.Sc.) Degree.
   [ ] Master of Science (M.Sc.) Degree.
   [ ] Doctor of Philosophy Degree (PhD).
   [ ] Other degrees (e.g., MBA, MA, etc.)

4. If the highest educational degree is Bachelor's Degree or higher, please determine your academic major: ____________________________________________

5. Please list your current profession: ________________________________

6. Please list the number of people who are living in your home ______

7. Please list the area of your home in square feet ______

8. Is there a garden within your home? (YES / NO)
   If yes, please list the area of your garden in square feet: ______
   Also, please list the types of plants and quantities present in your home garden: ______________________________________________________
9. Please list your average monthly water bill: ______________

10. Did you attend any course/workshop regarding water problems? (YES / NO)
    If YES, please list the year(s) in which you attended them ______________
    If NO, do you plan to attend any in the future? (YES / NO)

11. Where do you get your information regarding water problems? (Select all that apply)

    [ ] School
    [ ] Television
    [ ] Newspaper
    [ ] Books, magazines, etc.
    [ ] Friends
    [ ] Family
    [ ] Internet
    [ ] Lectures/speakers
    [ ] Utility bills
    [ ] Other, please specify: ______________________________________________________
PART 2: Personal Knowledge

A) This section aims to measure the participant's degree of basic knowledge about the water sources in general and the water shortage problem in Tucson, Arizona, in particular. Please answer the following questions by circling YES or NO

<table>
<thead>
<tr>
<th></th>
<th>Rainfall represents a source of water in Tucson</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Rivers are a source of water in Tucson</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>3</td>
<td>Groundwater is a source of water in Tucson</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>4</td>
<td>Tap water is a source of water in Tucson</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>5</td>
<td>Snowfall is a source of water in Tucson</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>6</td>
<td>Six percent of Earth's water is suitable for human consumption</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>7</td>
<td>Groundwater is not renewable</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>8</td>
<td>All groundwater is fresh</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>9</td>
<td>Groundwater is not affected by human usage</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>10</td>
<td>Rainfall does not penetrate to the groundwater</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>11</td>
<td>Pollution of the water resources (for example, rivers, lakes, and groundwater, etc) is possible.</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>12</td>
<td>Watering by drip irrigation is cheaper than by sprinkler</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>13</td>
<td>Watering the plants in mid-day is less expensive than watering them in the morning</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>14</td>
<td>Gardening usage consumes most water in the average household</td>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>15</td>
<td>Water level in Lakes, rivers, and ground is affected by household water usage</td>
<td>YES</td>
<td>NO</td>
</tr>
</tbody>
</table>

B) Rank the following house water usage from 1 to 4 in terms of the amount of consumption of water in the average household: (1 being the most consumption and 4 being the least)

[ ] Gardening usage.
[ ] Kitchen usage.
[ ] Bathroom usage.
[ ] Laundry usage.
PART 3: Personal Opinion

A) This section aims to view the participant's opinion about the best way to solve the water shortage problem in Tucson, Arizona. Please answer the following questions by circling the appropriate number such that (1) represents the case when you strongly disagree, (2) disagree, (3) neutral, (4) agree, and (5) strongly agree.

<table>
<thead>
<tr>
<th>No.</th>
<th>Question</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Water shortage is a governmental problem only</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>2</td>
<td>Public people can help solve the problem</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>3</td>
<td>Education system can help solve the problem</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>4</td>
<td>Current school curricula are adequate to help solve the problem</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>5</td>
<td>Parents' direction to their kids can help solve the problem</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>6</td>
<td>Involvement of worshipping centers in the city can help solve the problem</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>7</td>
<td>Current TV educational programs are adequate to provide an insight into the problem for the public</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>8</td>
<td>Current newspaper/magazines articles regarding the problem provide an adequate insight about the problem</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>9</td>
<td>Encouraging authors to write short stories about the problem can help solve it</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
</tbody>
</table>
B) The following question will try to measure the skill level in the survey’s participants in case he/she will be involved in a voluntarily program that aims to inform others about the water shortage problem in Tucson. Please list if the following characteristics apply to your behavior and nature, such that (1) represents the case when it strongly does not apply, (2) if it somewhat does not apply, (3) Neutral, (4) Somewhat applies, and (5) Strongly applies.

<table>
<thead>
<tr>
<th>No</th>
<th>Question</th>
<th>Strongly Does not Apply</th>
<th>Somewhat Does not Apply</th>
<th>Neutral</th>
<th>Somewhat Applies</th>
<th>Strongly Applies</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I have the suitable communication skills for talking to other people about the best actions to prevent the waste of water</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>2</td>
<td>I have the learning capabilities to learn the various aspects of the water problem and solutions in Tucson</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>3</td>
<td>I have the time to participate in this program.</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>4</td>
<td>I have the patience and the motivation to participate in this program.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>I can actively participate in the program by providing ideas.</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>6</td>
<td>I know a wide range of people who might be able to help in this program</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>7</td>
<td>I have enough understanding of the problem.</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>8</td>
<td>I have enough knowledge about the problem.</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>9</td>
<td>My current usage of water reflects my concern about the water problem in Tucson</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
<tr>
<td>10</td>
<td>My current usage of water can set an example to my neighbors, friends, family and/or others.</td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
</tr>
</tbody>
</table>

(C) How long have you been in Tucson? ............ Years
APPENDIX B

COVER LETTER AND DATA COLLECTION INSTRUMENT
TEACHERS
A Survey for Teachers

Determining the Factors that Influence People's Behavior Towards Water Shortage Problems: Case Study in Tucson, Arizona

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Graduate Student
E-mail - mas@iastate.edu
Home in Tucson 293-4541

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Agricultural Education & Studies
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Ames, Iowa 50011
Office: (515) 294-0898
FAX: (515) 294-0530
Please answer the following questions:

1. Which level of grade do you teach in school?

2. In your opinion, what would be the most effective for teaching more efficient use of water resources?
3. How should students become aware of water shortage issues and learn to conserve and best use water?

4. How do you evaluate your teaching methods regarding water shortage on your students?
5. Please list your recommendations regarding teaching water shortage through:
   i. Designing Curriculum:

   ii. Training teachers:

   iii. Others:
APPENDIX C

THE FOCUS GROUP MEETING QUESTIONS

(1) The best possible techniques to address the problem to the public, and increase their awareness.

(2) The best ways to solve the problem according to your experience and the nature of the city of Tucson.

(3) How can parents help children improve their attitude regarding water shortages?

(4) How can religion help to solve the water shortages problem in Tucson?

(5) What are the most common factors that lead people to change their behavior towards water shortages?

(6) What is your understanding of the water law in Tucson?

(7) What do you think the best role of agricultural development and urban water usage?
APPENDIX D

INTERVIEWS WITH PROFESSIONALS

- **Interview with workshop designers about water shortage**
  1. Please list educational activates including seminars, workshops, and classroom instruction, which you engage in to promote awareness of water shortage and conservation methods.
  2. How do you select teachers (trainees) to attend the workshops?
  3. What qualities do you look for in people that assist you in conducting workshops?
  4. How long have you been training teachers and other professionals?
  5. How does the media help promote water programs in Tucson?

- **Interview with water extension**
  1. How do you contact people?
  2. About how many people do you reach per week?
  3. What method do you use to set out your message about efficient use of water?
  4. What methods do you promote for water conservation?
  5. How do you evaluate your success at reaching the public?
  6. How do you develop new methods and avenues to convey information and practices regarding water use?
  7. What changes would you make to your program if there where no constraints?
Interview with crops irrigation specialist

1. How do you contact and reach farmers?

2. How do farmers get their information about irrigation?

3. What method do you use to set out your message about efficient use of water?

4. What methods do you promote for water conservation?

5. How do you evaluate your success at reaching the public?

6. How do you develop new methods and avenues to convey information and practices regarding water use?

7. What changes would you make to your program if there were no constraints?

Questions for interviewing the head of Agricultural Education Department at the University of Arizona

1. Does the undergraduate program in agricultural education require any background in water management or irrigation?

2. Does the undergraduate program focus on water education?

3. Does the Teacher certificate offered in the department require any background in water conservation?

4. Does the department have a relationship with any organization like Pima county extension that deals with water extension?

5. I would like to know if the department has any relationship with organizations that have something to do with water.
APPENDIX E

HUMAN SUBJECTS REVIEW COMMITTEE APPROVAL FORMS
TO: Mohammad Al-Shayaa  
FROM: Human Subjects Research Office  

PROJECT TITLE: "Determining the Factors that Influence the People's Behavior Towards the Water Shortage Problem: Case Study in Tucson, Arizona" 

RE: IRB ID No.: 03-588  
APPROVAL DATE: June 25, 2003  
REVIEW DATE: June 20, 2003  
LENGTH OF APPROVAL: 1 year  
CONTINUING REVIEW DATE: July 24, 2004  

TYPE OF APPLICATION: ☒ New Project ☐ Continuing Review 

The Human Subjects Review Study has been approved. Please make sure that you obtain the consent of the parents and participants before you conduct the study.

Your human subjects research project application, as indicated above, has been approved by the Iowa State University IRB #1 for recruitment of subjects not to exceed the number indicated on the application form. All research for this study must be conducted according to the proposal that was approved by the IRB. If written informed consent is required, the IRB-stamped and dated Informed Consent Document(s), approved by the IRB for this project only, are attached. Please make copies from the attached "masters" for subjects to sign upon agreeing to participate. The original signed Informed Consent Document should be placed in your study files. A copy of the Informed Consent Document should be given to the subject.

If this study is sponsored by an external funding source, the original Assurance Certification/Identification form has been forwarded to the Office of Sponsored Programs Administration.

The IRB must conduct continuing review of research at intervals appropriate to the degree of risk, but not less than once per year. Renewal is the PI’s responsibility, but as a reminder, you will receive notices at least 60 days and 30 days prior to the next review. Please note the continuing review date for your study.

Any modification of this research project must be submitted to the IRB for review and approval, prior to implementation. Modifications include but are not limited to: changing the protocol or study procedures, changing investigators or sponsors (funding sources), including additional key personnel, changing the Informed Consent Document, an increase in the total number of subjects anticipated, or adding new materials (e.g., letters, advertisements, questionnaires). Any future correspondence should include the IRB identification number provided and the study title.

You must promptly report any of the following to the IRB: (1) all serious and/or unexpected adverse experiences involving risks to subjects or others; and (2) any other unanticipated problems involving risks to subjects or others.

HSRO/ORC 8/02
Your research records may be audited at any time during or after the implementation of your study. Federal and University policy require that all research records be maintained for a period of three (3) years following the close of the research protocol. If the principal investigator terminates association with the University before that time, the signed informed consent documents should be given to the Departmental Executive Officer to be maintained.

Research investigators are expected comply with the University’s Federal Wide Assurance, the Belmont Report, 45 CFR 46 and other applicable regulations prior to conducting the research. These documents are on the Human Subjects Research Office website or are available by calling (515) 294-4566.

Upon completion of the project, a Project Closure Form will need to be submitted to the Human Subjects Research Office to officially close the project.

C: Agricultural Education & Studies
INFORMED CONSENT DOCUMENT

Title of Study: Determining the Factors that Influence the People’s Behavior Towards the Water Shortage Problem: Case Study in Tucson, Arizona.

Investigators: Mohammad Al-Shayaa.

This is a research study. Please take your time in deciding if you would like to participate. Please feel free to ask questions at any time.

INTRODUCTION

The purpose of this study is to study the problem of water shortage in Tucson, Arizona, and learn about the community attitudes towards it and towards the efforts to solve this problem. At this part of the study, the awareness of the children about this problem is measured by means of drawing a kind of a concept map that shows his/her knowledge of the water issue in the city in terms of the sources of the water, the impact of water pollution, and the good ways to save water. You are being invited to participate in this study because you are a children resident of Tucson.

DESCRIPTION OF PROCEDURES

If you agree to participate in this study, your participation will last for about 45 minutes. During the study you may expect the following study procedures to be followed. First, the child will be asked to draw a concept map that describes what he/she knows about various issues of the water problem in Tucson as described earlier. The drawing step will last no more than 35 minutes. After that, a 10 to 15 minutes review period will follow during which the investigator will be ask the child about the various components of his/her concept map.

RISKS

There are no foreseeable risks at this time from participating in this study.

BENEFITS

If you decide to participate in this study there may be no direct benefit to you. It is hoped that the information gained in this study will benefit society by providing valuable information about the curriculums development and proposing better efforts to increase the children awareness of the water shortage problem.

COSTS AND COMPENSATION

You will not have any costs from participating in this study. You will not be compensated for participating in this study.
PARTICIPANT RIGHTS

Your participation in this study is completely voluntary and you may refuse to participate or leave the study at any time. If you decide to not participate in the study or leave the study early, it will not result in any penalty or loss of benefits to which you are otherwise entitled.

CONFIDENTIALITY

Records identifying participants will be kept confidential to the extent permitted by applicable laws and regulations and will not be made publicly available. However, federal government regulatory agencies and the Institutional Review Board (a committee that reviews and approves human subject research studies) may inspect and/or copy your records for quality assurance and data analysis. These records may contain private information.

To ensure confidentiality to the extent permitted by law, the following measures will be taken. Subjects will be assigned a unique code and letter and will be used on forms instead of their name. Only the investigator and his academic supervisor will have access to the study records. The concept maps and any remarks taken by the investigator will be kept in a locked filing cabinet and they will be retained until May 2004 before erasure or destruction. If the results are published, your identity will remain confidential.

QUESTIONS OR PROBLEMS

You are encouraged to ask questions at any time during this study. For further information about the study contact Mohammad Al-Shayya at 515-232-3554 or Professor B. Lynn Jones at 515-294-0898. If you have any questions about the rights of research subjects or research-related injury, please contact the Human Subjects Research Office, 2810 Beardshear Hall, (515) 294-4566; austinger@iastate.edu or the Research Compliance Officer, Office of Research Compliance, 2810 Beardshear Hall, (515) 294-3115; dament@iastate.edu

**************************************************************************

SUBJECT SIGNATURE

Your signature indicates that you voluntarily agree to participate in this study, that the study has been explained to you, that you have been given the time to read the document and that your questions have been satisfactorily answered. You will receive a copy of the signed and dated written informed consent prior to your participation in the study.

Subject’s Name (printed) __________________________________________

(Subject’s Signature) __________________________________________

(Date) ______________________________________________________

(Signature of Parent/Guardian or Legally Authorized Representative) __________________________________________

(Date) ______________________________________________________

HSRO/OCR 05/02
INVESTIGATOR STATEMENT

I certify that the participant has been given adequate time to read and learn about the study and all of their questions have been answered. It is my opinion that the participant understands the purpose, risks, benefits and the procedures that will be followed in this study and has voluntarily agreed to participate.

(Signature of Person Obtaining Informed Consent) ____________________________  (Date) ____________________________
Using Existing Results and Data: An Explanation

The purpose of this project is to study the problem of water shortage in Tucson, Arizona, and making use of the evaluation results of the efforts that have been made to tackle this problem in terms of increasing the awareness of the people in general and the farmer in particular about this problem. Using these results helps in investigating the usefulness of using these efforts in a similar environment like Saudi Arabia. These various existing efforts include, but not limited to:

1. Developing the appropriate educational curriculums for the various educational levels in the schools in Tucson.
2. Tackling the problem in the courses offered by the Agricultural Education Department at the University of Arizona, Tucson.
3. Designing TV shows and extensional programs.
4. Holding seminars and workshops by the City of Tucson and other organizations.
5. Using Billboards and other illustrative means in the streets in order to encourage the people to watch their water usage.
Dear parent/guardian:

I am a doctoral student in the Department of Agricultural Education and Studies at Iowa State University. Part of my research focuses on high school students' understanding of the water resource. It will help the future design of the curriculum for high schools in agricultural and science education.

The interviews will be conducted as follows: the first one will last 35 minutes and students will be asked to develop a concept map, with the help of the researcher, of their knowledge about water resource. The second one will take 10-15 minutes and students will be asked to review their concept map that developed in the first interview to see if it is correct or not.

All responses will be kept in a strict confidence. Participants have the right to stop the interview at any time. Since this work involves minor children, permissions should be obtained from their guardian for the interview.

Dear parent/guardian if allow your child to participate in this study, please fill out the attached form.

Thank you for considering allowing me to interview your child. If you have any further questions, please contact me.

Sincerely,

Mohammad Al-Shayaa
Graduate Student
Email- mas@iastate.edu
Home- (515)232-3554

Dr. B. Lynn Jones
Associate Professor
Email - Xljones@iastate.edu
Work (515)294-0898
APPENDIX F
STUDENTS CONCEPT MAPS

Student Concept Maps for Water Cycle

&

Student Concept Maps for Water Resources and Water Usage in Tucson, Arizona
Appendix F1: All the nine students concept map of The Water Cycle
Appendix F2. Alison’s concept map of: Tucson water resources and water usage. Took agricultural courses.
Appendix F3. Brooklyn's concept map of: Tucson water resources and water usage. Took agricultural courses
Appendix F4. Lee's concept map of Tucson water resources and water usage

Did not take agricultural or biology courses
Appendix F5. Lincoln's concept map of: Tucson water resources and water usage. Took agricultural and biology courses.
Appendix F6. Lisa's concept map of: Tucson water resources and water usage.
Took agricultural and biology courses.
Appendix F7. Lori's concept map of: Tucson water resources and water usage
Did not take agricultural or biology courses
Appendix F8. Mary's concept map of: Tucson water resources and water usage
Did not take agricultural or biology courses
Appendix F9. Thomas's concept map of: Tucson water resources and water usage. Did not take agricultural courses.
Appendix F10. Williams's concept map of: Tucson water resources and water usage. Did not take agricultural or biology courses.
APPENDIX G

MATERIAL AND PUBLICATION DESIGNED OR DISTRIBUTED
BY
TUCSON WATER DEPARTMENT
City of Tucson, Arizona

2- Beat the Peak
3- Brush up with just one cup
4- Cover - Pools: The Collection the World's Finest Pool Covers.
5- Contact Information (has all important telephone number in Tucson Water Department)
6- Homeowners' guide to using water wisely
7- H2O Tucson: the latest news for Tucson water customers
8- How to save water & energy
9- Keep us safe from waste (office notes)
10- Leak detector tablets
11- Let's learn about wastewater treatment
12- Reclaimed water for residential reclaimed water users
13- Reclaimed water system
14- Shower flow measurement
15- Showerhead
16- Tucson toolkit: perspectives on our water for middle school students
17- Tucson water education: water Education master plan
18- Tucson water history: a reference book
19- Water from here to eternity and back again (newspaper)
20- Water use it wisely
21- What is reclaimed water

Video:
- Tucson water zanjero program: Da Drops Video
- Tucson water / beat the peak: cooking up conservation

Brochure:
1- Your water connection (news & tips for Tucson water customers)
2- Water information now
3- Why is my water colored

Package Summer Internship Program—2003
APPENDIX H

MATERIAL AND PUBLICATION DESIGNED OR DISTRIBUTED
BY
THE WATER RESOURCE RESEARCH CENTER (W.R.R.C.)
The University of Arizona, Tucson, Arizona

1- Notes placed on refrigerator: Be Creative Have Fun Save Water.
2- Office notes: Don’t Be a Drip Fix Those Leaks.

Brochure:

3- The Seven Principles of XERISCAPE, Xeriscape means low-water -using it does not mean dry and barren looking.
4- Converting to Xeriscape: renovate your landscape with style.
5- Want to get rid of your Bermuda grass lawn?
6- Why Conserve? Quiz
7- Cool rules for coolers or how to live in cool and thrifty comfort
8- Saving Water Got Questions?
9- Water Harvesting
10- Plants for 4 types of desert landscapes
11- Can I use my graywater
12- Waves - of - ways to save water
13- Functioning of aging low-consumption toilets in Tucson: a follow-up with rebate program participants

Poster:

1- We live in a desert
2- Arizona WET (Water Education for Teachers)
3- Arizona water map
4- How we use the aquifer

Small books

1- Desert waters from ancient aquifers to modern demands.
2- My well V. your surface water right: how western states manage interconnected groundwater and surface water.

Other publication

1- Arizona changing river: how people have affected the rivers.
2- Arizona water information directory
3- Desert landscaping CD-ROM
4- Indian water right: Negotiating the future
5- Instream flow rights: a strategy to protect Arizona's streams
6- Water in the Tucson area: seeking sustainability
7- Newsletters (monthly)
8- Arizona water resource
9- Water education
10- Arizona WET K-6 curriculum on nonpoint source water pollution
11- Water conservation: functioning of aging low-consumption toilets in Tucson
12- Residential graywater reuse study

**Water information resources:**
This information given to public people and any visitor to both the city of Tucson and the (WRRC)

- City of Tucson: [http://www.ci.tucson.az.us/water/](http://www.ci.tucson.az.us/water/)
- Arizona Department of Water Resources: [http://www.adwr.state.az.us](http://www.adwr.state.az.us)
- Water Wiser: [http://www.waterwiser.org](http://www.waterwiser.org)
- Central Arizona Water Conservation District: [http://www.cap-az.com](http://www.cap-az.com)
- Pima Association of Governments: [http://www.pagent.org](http://www.pagent.org)

**Contact information** (Important Tucson Water: telephone numbers)

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**During the workshop:**

**Arizona WET**
Nonpoint Source Water Pollution Curriculum
Grades 9-12

**Pamphlet Packet**

**Information**

- ADWR: Conservation Requirements for the Second Management Period
- Air pollution and your health. (Pima County Department of Environment Quality)
- Are you committing sewercide? (Pima County Wastewater Management Department)
- Arizona Index to Topographic Maps. (USGS)
- Arizona Wetland Resources. . (USGS)
- Careers in Water Testing: test the waters! (Water Pollution Control Federation)
- The Conservation Reserve program. (USDA)
- Illegal Dumping: it's everyone's problem. (Pima County Wastewater Management Department)
- It's Arizona's water: nonpoint Source Pollution. (ADEQ)
- (NAQWA) National Water Quality Assessment Program. (USGS)
- Polluted. (EPA)
- Preventing Waterborne Disease. (EPA)
APPENDIX I

MATERIAL AND PUBLICATION DESIGNED OR DISTRIBUTED BY
PIMA COUNTY COOPERATIVE EXTENSION
The University of Arizona, Tucson, Arizona

1- Water measurement in Arizona
2- Cotton irrigation management
3- Available soil moisture for cotton production
4- Timing the first post establishment cotton irrigation
5- Determining the amount of irrigation water applied to a field
6- Consumptive use of water by major crops in the Southwestern United State
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To my parents, for your financial and emotional support and supplications, I say: without you I am nothing in this life. You have been the first to educate and set a good example for me. Thank you to my brothers, Khalif and Abdullah, who did a lot for me, and also to the rest of my sisters, brothers, and family.

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