

COMPUTERIZED SIMULATION EFFECTS ON CONCERN FOR
WATER ISSUES BY AGRIBUSINESS AND WATER
MANAGEMENT PROFESSIONALS

By

CYNTHIA LEANN SMITH

Bachelor of Science in Education

East Central Oklahoma State University

Ada, Oklahoma

1978

Submitted to the Faculty of the Graduate College
of the Oklahoma State University
in partial fulfillment of the requirements
for the Degree of
MASTER OF SCIENCE
December, 1984

THESIS
1984
SLW4C
Cop. 2



COMPUTERIZED SIMULATION EFFECTS ON CONCERN FOR
WATER ISSUES BY AGRIBUSINESS AND WATER
MANAGEMENT PROFESSIONALS

Thesis Approved:

Terence J. Mills
Thesis Adviser

S. L. Burbs

David Yellin

Norman N. Murhan
Dean of the Graduate College

PREFACE

This study is concerned with the influence of the Multi-User Computerized Water Management Simulator on the level of water resource concerns of professionals in agribusiness and water management occupations.

I would like to express my appreciation to Dr. Terence J. Mills, Chairman of my committee and my friend for his guidance and support; and to Dr. David Yellin and Dr. Sterling L. Burks for their assistance on my committee.

I would also like to thank and dedicate this to my parents, Doratha and Claudus Smith, who have inspired, counseled, and guided me throughout my life, and provided an excellent example in which to follow.

TABLE OF CONTENTS

Chapter	Page
I. INTRODUCTION.	1
Water Resource Management Simulator Description.	4
Nature of the Problem.	5
Significance of the Study.	7
Limitations of the Study	7
Definitions of Terms	8
II. SELECTED REVIEW OF THE LITERATURE	9
Introduction	9
Evolution of Simulation.	9
The Nature of Simulation	11
What Can be Taught Via Simulation.	11
Design and Development of Simulation Games	12
Simulation and Gaming in Natural Resource Management	13
Computerized Instruction	14
Natural Resource Attitudes	15
Water Curriculum	16
Summary.	17
III. DESIGN AND METHODOLOGY.	19
Introduction	19
Description of the Sample.	19
Testing Instrument	20
Administration of the Pre/Post-Test.	21
Presentation Format.	21
Method of Analyzing Data	22
IV. RESULTS OF THE STUDY.	23
Analysis of Pre/Post WRMS Water Concern Scale Scores	23
Question #1a.	23
Question #1b.	24
Question #2a.	25
Question #2b.	26
Question #3	27
Question #4	30
Summary.	33

Chapter	Page
V. CONCLUSIONS AND RECOMMENDATIONS	35
Conclusions.	35
Recommendations.	38
Recommendations for Further Research	39
A SELECTED BIBLIOGRAPHY.	40
APPENDIX	44

LIST OF TABLES

Table	Page
I. Participants Surveyed in Experimental and Control Groups . .	20
II. T-Test Pre-Test Comparison of Agribusiness and Water Manager Attitudes.	24
III. Summary T-Test Comparison of Agribusiness and Water Manager Pre-Test Water Concern Scores by Item.	25
IV. T-Test Comparison of Total Population Mean Pre-Post Test Scores.	26
V. T-Test Comparison by Item of Mean Pre-Test and Mean Post-Test Scores of the Total Population	27
VI. Attitude T-Test Comparison of Pre/Post Test Mean Scores of Agribusiness Professionals	28
VII. Attitude T-Test Comparison of Pre/Post Test Mean Scores of Water Management Professionals	29
VIII. T-Test Comparison of Agribusiness and Water Management Professionals Pre/Post Test Scores	29
IX. Summary of Attitude T-Test Comparison of Pre/Post Test Scores by Item of Agribusiness and Water Management Professionals.	31
X. Chi-Square Values and Summary Attitude Response Frequencies by Item for Agribusiness and Water Management Professionals.	32

CHAPTER 1

INTRODUCTION

As far as we can determine only one place in the universe has the unique substance, water. That place is the Earth! The only place in the universe where life exists. Life is possible only because of this 'magical' liquid and its unique chemical and physical properties. Its exceptional nature results in the dynamic hydrologic system of the Earth, whereby energy from the Sun keeps our planet habitable.

It is a fact that without water mankind could not exist. This statement can be verified by some of the contributions water has made to man and the environment. Water is considered to be the universal solvent, for it breaks down more substances than any other. This unique ability results in its use in solving both natural and man-made water quality problems. Not only does it dissolve and distribute natural material such as sulfates, nitrates, phosphates and other potentially helpful or harmful substances but it also dissolves man-made materials such as sewage, pesticides, and herbicides as well.

Water in ocean currents and in the atmosphere circulates and aids the Earth's climate by storing and redistributing heat. Water is used in growing and processing foodstuffs and even physically affects

the geography of our planet. All life, plant or animal, depends on this substance.

There are problems with water pollution due to increased industry and technology. In Europe thousands of lakes have become acidified and entire populations of fish and other aquatic organisms have been destroyed as a result of mercury, sulfate, and nitrogen-based acidic inputs from mining and industry (Oehme, 1978). Studies have revealed evidence that a very analogous situation is occurring in portions of the eastern United States and Canada (Barnes, 1979; Overrein, 1981).

Currently on a world-wide basis, millions of metric tons of petroleum hydrocarbons enter the aquatic environment yearly and these are a major source of marine pollution (Travers and Luney, 1976). In aquatic environments globally organisms concentrate noxious and poisonous substances from their liquid environment because these waters are polluted with petroleum, petroleum by-products, industrial wastes, and even domestic sewage (Mix, Riley, King, Tenholm, and Schaffer, 1977). Human activity can cause other problems when petroleum, heavy metals, agricultural pesticides and herbicides, and organic chemicals enter the aquatic environment as pollutants. Some of these pollutants have been found to be active carcinogens which may accumulate, metabolize and translocate in the aquatic organisms they contract. Many others, although not proven carcinogens, are suspected and under study (Kraybill, 1975).

In a recent U.S. Water Resources Council Study of U.S. water supplies identified water resources as the nations most serious longterm problem (Sheets, 1981). In not only this country but across our planet, water quality is in extreme danger.

Water is a finite resource. In quantity it may seem abundant but per capita use has increased more than 350% in the past 50 years (Barnes, 1979). For industry, home, agriculture, and simple personal use we may be left 'high and dry' in a very short time (Sheets, 1981; Nikolaieff, 1967). It has been estimated that by the year 2000 net use will be slightly below the lower limit of available useable water and near the estimated upper limit of supply by 2020 (Mills, 1977). Although public interest is growing many people are still painfully unaware of water problems we may be facing in the near future. School students are uninformed because water curriculum is not emphasized. In a study of college-bound high school graduates, it was indicated that a void existed in their education about water (Mills, 1979). In a study in 1976, it was established that as the public takes a greater role in land management decisions, their knowledge and attitudes take on more importance (Carlson and Baumgartner, 1979) and in several issues of the Journal of Environmental Education since 1973, many authors state the necessity of knowledge or attitudes as conditions for intelligent environmental policy making. It is imperative that natural resource conservation be included in the teaching of current events and citizens realize our daily dependence on water whether we live on the coast or far inland (Sea Grant, 1978).

The Water Resources Education Project's goal is to help youth and adults gain a better understanding of the technical principles and social issues involved in effective management of our water resources (Amend and Arnold, 1983). A basic objective is the application of computer-technology to the complex problem of water resource education (House, 1982).

This study deals with the use of computerized water resource management simulation and its use with adults who are either major users of water or are involved in water management occupations.

Water Resource Management Simulator Description

The Water Resource Management Simulator (WRMS) is an interactive digital computer which models a geographic region and its water supply and demand situation. The simulator, capable of modeling 9 different river basins, is operated by up to 30 participants using small control consoles. Water management decisions regarding (1) storage of surface and ground water, (2) sources of water, (3) rate of water use, (4) technology of water use, and (5) disposition of used water are made with controls on the individual consoles. The irrigation control module is typical of the control modules. This control transmits water demands to the computer in terms of acre feet, and is calibrated in multiples of 'today's' water use pattern in the modeled region for ease of understanding. The course of water for irrigation is selected by a sliding control which can select from 100% surface water to 100% ground water. The type of irrigation technology used is selected by a second sliding control. Flood irrigation demands about twice as much water for a given irrigation setting, but returns about half to the stream. Sprinkler irrigation is programmed to demand approximately half as much water as flood irrigation, but returns very little to the stream. This control may be set for any combination of these two irrigation types. Sliding controls on similar modules permits selection of water treatment

technology for industrial and municipal waste water and cooling technology for thermal electric plants. Five water use categories are provided in the model: (a) irrigation, (b) energy, (c) municipal and industry, (d) livestock, and (e) interbasin transfer. For each of these, water may be drawn from either ground or surface water resources. The simulator itself may be programmed for any set of ground and surface water conditions by changing data statements in the computer memory (Amend, 1981).

Nature of the Problem

This study's major purpose is to identify the effects of the multi-user computerized water resource management simulation (WRMS) on basic water resource attitudes. A group of 25 water managers and 26 agribusiness professionals were respectively randomly assigned to two groups, the control or pre-test group and the experimental or post-test group, and were administered the Watkins Water Concern Scale (Watkins, 1974). Interaction with the WRMS was the treatment for the experimental group. The pre-test data were then compared to the post-test data both in and between groups to answer the following questions.

1. What is the pre-WRMS level of concern toward water resource issues?
2. Does WRMS treatment significantly alter the level of water resource concerns?
3. What effects result from WRMS experience within and between agribusiness and water management populations?
4. What factors of water resource concern are significantly influenced by WRMS treatment?

How these questions are answered can determine the usefulness of the WRMS as an information dissemination tool for agribusiness professionals and water managers. Question 1 through 3 are stated in the following hypotheses:

- H₀1: There is no significant difference between mean pre-test scores of agribusiness and water management professionals.
- H₀2: There is no significant difference between mean pre-test scores of agribusiness and water management professionals by item.
- H₀3: There is no significant difference between the total population mean pre-test score and mean post-test score.
- H₀4: There is no significant difference between the total population mean pre-test score and mean post-test score by item.
- H₀5: There is no significant difference between mean pre-test and mean post-test scores by agribusiness professionals.
- H₀6: There is no significant difference between mean pre-test and mean post-test scores of water managers.
- H₀7: There is no significant difference in mean pre-test and mean post-test scores between agribusiness and managers of water resources.
- H₀8: There is no significant difference in mean pre-test (non-user) and mean post-test (user) scores between agribusiness and water managers by item.

H₀9: There is no significant difference between mean scores of agribusiness and water managers by item.

Significance of the Study

Simulation has been defined as an 'operating model of the real world made up of selected sets of interrelationships that reduce complex problems to manageable size for instructional purposes' (McLean, 1973, p. 377). With computer availability and use increasing, computer simulation as an instructional method is expected to increase also (Electronic Learning, 1982). Thus, there is a real and growing need to determine the potential of this teaching technique on all levels.

There is also a need to know what water management and agribusiness professionals know and what computerized instruction can teach them. Computer simulation when applied to one of our most precious resources, water, could assist in informing and creating a concerned and knowledgeable public (Cartwright, 1981).

Limitations of the Study

The population from which the study was drawn was from a group of personnel attending a seminar on water resource management in the state of Arkansas. Twenty-six agriculture business professionals and twenty-five water management personnel were randomly assigned to the control and experimental groups. Conclusions cannot be extrapolated beyond the population under study.

The researcher did not administer the pre- or post-test. It is assumed that the instructor administering the test followed proper procedure.

Definitions of Terms

Interactive Computer--A computer which is designed to allow a group of people to have input at any time. The results of this input are continuously monitored, summarized and displayed.

Pre-Test--Watkins Water Concern Scale given to the control group before interaction with the Water Resources Management Simulator.

Post-Test--Watkins Water Concern Scale given to the experimental group after interaction with the Water Resource Management Simulator.

Simulation--Duplicating artificially the conditions likely to be encountered in some set situation.

Agribusiness Professional--Person who is directly or indirectly involved in using water in agriculture for profit.

Water Management Professional--A person who in the course of their job is directly influencing the management of water resources.

Attitude--Favorable or unfavorable expression toward a class of objects (i.e. water) or events (i.e. water resource useage) (Knapp, 1972).

CHAPTER II

SELECTED REVIEW OF THE LITERATURE

Introduction

The literature reviewed in this chapter have been organized into the following areas: (1) the evolution of simulation, (2) nature of simulation, (3) what can be taught via simulation, (4) natural resource attitudes, (5) design and development of simulation games, (6) simulation and gaming in natural resource management, and (7) the use of simulation coupled with computers. The areas listed have been researched back through 1960.

Evolution of Simulation

Not surprisingly the roots of simulation techniques and training are in military and strategic areas. War games such as "wei-hei" developed in China around 3000 B. C. (Wilson, 1968) were played not only for enjoyment but to increase and challenge the intellectual and strategic skills of the players. After the turn of the eighteenth century, war games came to be viewed as a science rather than an art. As the view of war games changed so did their use. These games began to be used as an important part of military training and by 1960 there were between 150 and 200 war game models used exclusively for basic military training.

From simulation in war games business games were quite naturally developed and these were readily adapted to use in universities, industry and commerce. One of the leaders in developing these was the American Management Association, which created many top management simulations.

Through simulation techniques, social science was able in the 1960's to develop simulations originally known as "Crisis Games". By imitating possible international crises they could provide alternatives in the event that similar real crises did occur (Guetzkow et. al., 1963). The simulation technique then rapidly spread to other areas including health care, welfare, transportation and others. By using simulation, these groups were able to develop and plan techniques and alternatives.

In the mid 1960's simulations were introduced into school classrooms where they quickly gained popularity and acceptance. Bruner (1967), a leading instructional theorist, made simulations an integral part of the Social Studies Curriculum Project, "Man A Course of Study" and recognized the academic variety that simulation has to offer.

Simulation games are now found at all levels of formal education and have experienced continuous growth and popularity. Unfortunately, there is little in the literature concerning application to water education. With the increasing use in industry, education, business and even at the personal level, the application of computer simulation as an instructional technique is encouraging and is virtually endless in its possibilities.

The Nature of Simulation

Simulation has been defined as "an operating model of the real world made up of selected sets of interrelationships that reduce complex problems to manageable size for instructional purposes" (McLean, 1973, p. 377). Taylor and Walford (1974) have identified three things that happen in any simulation. First, players accept roles which are modeled on existing real world roles. In this role playing, they make decisions based on their assessment of the situation in which they find themselves. Secondly, players experience the simulated consequences of their decisions and their performance in the role they assumed. Third, monitoring the consequences of their decisions they are asked to assess the relationship between their decisions and the results that occurred.

Maidment and Bronstein (1973) also identified these attributes and said:

Specific rules are contained within the simulation game which govern the sequence and methods of interaction. These rules limit and guide behavior in such a way that will insure that players experience success or failure in a manner similar to their counterparts in the real world who adopt the same goal attainment strategy (p. 18).

What Can Be Taught Via Simulation

The use of simulation games as a mode of education has been written about extensively, however actual empirical research studies have been few (Braskamp and Hodgetts, 1971). Conflicting conclusions have been drawn from the studies which have been done (Clarke, 1977). Therefore, the degree of effectiveness of simulation games is still to be determined.

The primary areas of learning according to Maidment and Bronstein (1973) are knowledge, skill and attitudes. In the first, participants (players) learn facts and principles, although the simulation technique of teaching them has not been shown to be superior to more traditional methods. In fact, if the aim of education is the learning of facts and principles then other methods are faster, more economical and efficient. Simulation is, however, quite efficient in areas where system structure and dynamics are integrated. In fact, real knowledge may not be realized until the system is seen as an integrated working unit. In this case simulation may provide an excellent opportunity for students to use, see, and experience for themselves how variables affect one another.

In the skills area, three predominate. These are in the fields of decision making, analyzing, and working socially with others. Simulation success then, does not depend on the players memorization of facts and figures, but on the above mentioned abilities and skills.

As far as attitudes are concerned, change may occur by way of role-playing and modeling real-life situations, which carry over into the participants real life. In fact, shifts in ideology and attitude have been documented (Dunlop, 1979).

Design and Development of Simulation Games

The outstanding feature of simulation is that these games can be designed and tailored to mirror true-to-life situations. The versatility of this game technique can make simulation instruction as personalized or as diverse as desired.

In the past 10-15 years rudimentary guidelines for designing and developing simulation games have been established (Tansey and Unwin, 1969; Gibbs, 1974; Hoover, 1980). These 'fundamental rules' are briefly outlined in six steps which provide a baseline for development and design. First, decide if simulation is the best way to teach the material selected. Next, identify the objectives to be taught. After completion of this task, design an actual model of the game by establishing rules, roles, resources and the simulation scenario to be followed. Fourth, run an actual simulation; playing of the simulation game will include such tasks as pre- and post-game briefing, also playing out the simulation on a trial basis may minimize the confusion for participants. Fifth, conduct an evaluation of the simulation. Finally, redesign the game to more closely reflect what is to be taught.

Simulation and Gaming in Natural Resource Management

There are five characteristics necessary to make simulation a viable technique for teaching about natural resource use and management. These are interlocking characteristics which produce desired effects through:

- a. presenting a simplified abstraction of the bare essentials of a situation free from trivia and irrelevance (such as background noise);
- b. concentrating on making explicit essential relationships and the fundamental interplay between key roles;
- c. unfolding time at a very much quicker rate than normal so that the implications of action in a dynamic situation can be clearly and repeatedly felt;

- d. allowing participants to 'sit on the hot seat' and feel the direct impact of consequences of decision making;
- e. offering opportunities for collective learning on self-directed lines (i.e., learning as much from one's mistakes and mistakes of others as from one's successes) (Taylor and Walford, 1974, p. 76).

Seemingly most of the lessons learned in natural resource management have been learned through reaction to crisis situations which were often coupled with dire consequences. In fact, with planning and thought beforehand many catastrophic situations could be avoided. Participants using simulation can learn from mistakes where they can avoid jeopardizing natural resources.

In today's world of business and education many simulation games involving natural resources have been developed. One such simulation, done as a systems approach to water management, was developed in 1976 (Biswas, 1976). This game dealt with all aspects of water management within an overall systems context and emphasized applications in a real world situation. Not only this but other simulations are effective in their ability to present the large scheme or concept.

Other examples of simulation games which are in use today are those dealing with water pollution studies, physical science experiments, and political and economic scenarios (Gawrowski and West, 1982).

Computerized Instruction

In the not too distant past computers were considered as a very expensive luxury. With present technology they are quite

often found in homes of even middle-class Americans (Noonan, 1981). One way they are being used in the educational setting is to simulate real or imaginary situations that are too technical, expensive, dangerous, or time consuming to perform in the usual school classroom.

Computerized instruction is usually in one of three forms: (1) drill and practice, (2) tutorial, or (3) simulation (Electronic Learning, 1982). Simulation is the form we are interested in since it is used in interaction with functioning models of real-life situations. Computer technology makes it possible to experience complex problems and experiment with alternatives in a safe, low cost manner (Amend and Arnold, 1983).

A common shortcoming of many computer simulation games is that participation is very often limited to only one or two individuals at a given time. Due to this, group interaction is missed. A multiuser interactive computer simulation, such as that provided by the WRMS allows group interaction in clarifying problems, considering alternatives, decision-making and cooperation.

Natural Resource Attitudes

A major concern of environmentalists today is the way attitudes affect the development and subsidence of environmental pollution by use and misuse of resources (Abram and Rosinger, 1972). Knapp (1972) lists a number of methods including verbal reinforcements and providing new information that have been successful in altering attitudes in some people. Serious problems concerning management of natural resources face our population today. Better

management of existing resources and development of new technologies is essential, Natural resource policies must be based on sound principles, and citizens must understand the procedures by which these policies are developed.

There has been little research conducted in the application of interactive computer simulation to information dissemination and especially attitude shifts (Mills, 1983). The Energy Environment and Water Resource Management simulators were both designed to improve awareness and understanding of major problems, such as technical principles and management alternatives present in the areas of energy and water (Dunlop, 1978; Mills, 1984). Research done in these two areas indicate that levels of concern are significantly shifted when interaction with a computer simulator occurs in a population (Dunlop, 1979; Cartwright, 1981; Mills, 1984). However, much is to be done in this area in order to fully understand the potential influence of interactive computer simulation on natural resource concepts and attitudes.

Water Curriculum

In 1961, educators began to see the importance of teaching water conservation to young people, but there was no organized curriculum at this time (Foster, 1964). Others tried to teach conservation methods by showing its interrelation to man and his welfare (Amick, 1965). Most of this teaching was done in the classroom with small groups by demonstrating different concepts related to water (Leyendecker, 1961). In 1964 a study recommended that programs of water education be taught in schools along with

careful use of water resources and wise legislation (Knowlton, 1964). But until recently there has not been any sequential type of water curriculum available.

Some of the more popular and widely used literature and teaching aides for the public school are: Water and Man, The Curriculum Water Guide, printed by the Bureau of Reclamation Southwestern Region, the Multidisciplinary Water Awareness Program for grades K-12 developed by the California Departments of Water Resources and Education, and from the Investigating Your Environment Series: A Lesson Plan for Water Use Simulation available from the U.S. Department of Agriculture.

Summary

Under the following headings the author has described:

1. Simulation as it has evolved from ancient games to business games, to present day computer simulation.
2. The nature of simulation identifying techniques such as role-playing, leading to the development of problem solving and learning methods.
3. What can be learned in simulation focusing on decision making, analytical, and social skills.
4. Natural resource attitudes are becoming increasingly more important in controlling pollution by way of laws and interactive computer simulation is one way to focus concern on specific areas.
5. Design and development of simulation games using six common rules or guidelines for development.

6. Simulation and gaming in natural resource management which shows how games are designed to produce desired results and how computer simulation and gaming are being applied.

7. Computerized instruction is the section which deals with how computers are being used to educate groups and some major characteristics, both good and bad, of this method.

8. Water curriculum research reviewed resulted in the conclusion that there are very few water education materials available.

All in all there is a great need in today's society to have environmentally educated and concerned citizens. Researching the use of computerized simulation as a tool to achieve this objective is imperative.

CHAPTER III

DESIGN AND METHODOLOGY

Introduction

The purpose of this study is to determine if interaction with a Multi-User Computerized Water Resource Management Simulator influences the level of water resource concerns for professionals in agribusiness and water management occupations. WRMS presentations were given to groups comprised of agricultural leaders participating in the Oklahoma State University Agricultural Leadership program and water managers of municipal state and federal offices specifically involved in water management in the state of Arkansas. The sessions were two hours long and consisted of first a slide presentation and then interaction with the WRMS. Questions were welcomed at any time during the presentation.

Description of the Sample

One random sample was drawn from a group of water management personnel attending a seminar on water resource management in Arkansas. The second random sample was taken from Agricultural leaders participating in the Oklahoma State University Leadership Program. These leaders were young adults selected on the basis of evidence of broad, well balanced concerns, interests and abilities affecting contributions to agriculture and society. The water management group consisted of municipal, state and federal employees specifically involved in water management in Arkansas.

federal employees specifically involved in water management in Arkansas. Table I shows the number of participants by occupation and assignment to control (pre-test) and experimental (post-test) groups.

TABLE I
PARTICIPANTS SURVEYED IN EXPERIMENTAL AND CONTROL GROUPS

	Experimental	Control	Total
Agricultural Leaders	12	14	26
Water Managers	<u>10</u>	<u>15</u>	<u>25</u>
TOTAL	22	29	51

Testing Instrument

The Water Concern Scale (Watkins, 1974) was used to measure effects of WRMS treatment. Test items were on an attitudinal scale which measures level of concern of an individual toward water resources. The Water Concern Scale consists of five items which by way of factor analysis have been determined to measure a concern for and about water resource problems. Subjects responded to each of these questions by answering within the five Likert-type categories of: strongly agree, agree, undecided, disagree, and strongly disagree. These items (see Appendix) were then weighed on a scale of 1 to 5 (1 for strongly agree, 5 for strongly disagree), with 5 indicating a greater

level of concern for water resources. Question 2 and 5 were reverse coded in scoring. Total scores could then range from 5 to 25, with 25 indicating the deepest level of concern.

A pre-test was given to 29 members of the population immediately before they were introduced to the WRMS. The second half of the population was tested immediately after interaction with the WRMS. This procedure reduced pre/post-test contamination.

Validity of the scale was determined using Guttman scale scores which were compared to certain socioeconomic variables such as income, social position and racial background.

Administration of the Pre/Post-Test

The participants were instructed that their names were not required and that this test had nothing to do with their job or evaluation. All questions were answered on a Bureau of Test and Measurements standard answer sheet and responses tabulated by computer.

The pre-test was administered to approximately one-half of the water management and agribusiness groups immediately before they were introduced to the WRMS. Assignment to experimental and control groups for water managers was considered random since one-half of the group arriving first was assigned to the control group. The same condition was met for agribusiness professionals. The post-test was administered to the remainder of the subjects immediately after having interacted with the WRMS.

Presentation Format

The program using the simulator began with a short, 20 minute slide presentation that introduced the simulator and its controls and

some background information. The slide show has a uniform printed outline which has been developed in order to keep the information presented constant. After the presentation the WRMS was placed at the front of the room. Control panels were then assigned to participants and the interaction began. Questions were encouraged at any time during and after the presentation and discussion was held at the end of the two hour session.

Method of Analyzing Data

Pre-test and post-test responses were statistically analyzed using analysis of variance two-tailed t-test in conjunction with Chi-square two-way classification. Computer programming was done using Oklahoma State University's main frame computer. The data results were considered for significance at the $p \leq .05$ level.

CHAPTER IV

RESULTS OF THE STUDY

The concern of the first three chapters has been a general introduction to the study, a review of related literature, and a discussion of the design of the study. Chapter IV is a presentation of the findings of the study based on pre-test and post-test responses. The presentation of the results of the data analysis are presented in the same sequence as were the questions directing the study.

Analysis of Pre/Post WRMS Water Concern Scale Scores

Question #1a

What is the pre-WRMS level of concern of agribusiness and water management professionals toward water resource issues? To answer question number one the following hypothesis was stated.

H_0 1: There will be no significant difference between mean pre-test scores of agribusiness and water management professionals.

Table II compares the pre-test (see Appendix) mean attitude score of agribusiness to that of water management professionals. Before WRMS interaction agribusiness professionals held a slightly greater concern for water resource issues although this difference

was insignificant at the .05 level. Therefore the null hypothesis was not rejected.

TABLE II
T-TEST PRE-TEST COMPARISON OF AGRIBUSINESS AND WATER MANAGER ATTITUDES

Group	N	X	SD	t	P
Agribusiness	14	18.86	1.7	0.5	0.62
Water Managers	15	18.47	2.4		

Question #1b

What is the pre-WRMS level of concern toward water resource issues by item?

H_0 : There will be no significant difference between mean pre-test scores by item of agribusiness and water management professionals.

The data presented in Table III compares mean pre-test scores by item of agribusiness and water management professionals. Only on item 2, "Water reclaimed from waste is as good as any other water", did a significant difference occur. Item 2 favored agribusiness professionals. Significant differences did not exist between the two groups on item 1, 3, 4, and 5, although there was a slight mean increase evident. The t-value of 3.1 on item 2 called for the rejection of the null hypothesis

on that item ($p \leq .05$). For items 1, 3, 4, and 5, the null hypothesis was also rejected.

TABLE III
SUMMARY T-TEST COMPARISON OF AGRIBUSINESS AND WATER
MANAGER PRE-TEST WATER CONCERN SCORES BY ITEM

Question	Source	N	X	SD	DF	t	p
1.	Agribusiness	14	2.71	1.2	27	-0.9	0.37
	Water Managers	15	3.13	1.3			
2.	Agribusiness	14	3.92	0.8	27	3.1	0.005*
	Water Managers	15	2.73	1.2			
3.	Agribusiness	14	3.64	1.0	27	-0.4	0.67
	Water Managers	15	3.80	0.9			
4.	Agribusiness	14	4.00	1.0	27	-0.2	0.86
	Water Managers	15	4.06	1.0			
5.	Agribusiness	14	4.57	0.5	27	-0.9	0.38
	Water Managers	15	4.73	0.5			

*Significant at the .05 level of confidence.

Question #2a

Does WRMS interaction alter the level of water resource concern?

H₀3: There will be no significant difference in the total populations mean pre-test score and the mean post-test score.

The data presented in Table IV compares mean pre-test scores and mean post-test scores of the total population. Although pre-test scores

were numerically higher there is no significant difference at the .05 level, thus the null hypothesis was not rejected.

TABLE IV
T-TEST COMPARISON OF TOTAL POPULATION
MEAN PRE-POST TEST SCORES

Total Population	N	X	SD	t	p
Pre-test	29	18.655	0.61	1.05	0.31
Post-test	22	18.045			

Question #2b

Does WRMS interaction alter the by-item level of water resource concern?

H₀4: There will be no significant difference in total population mean pre-test scores and mean post-test scores by item.

Comparisons of total population pre-post test results are shown in Table V. No significant differences occurred in pre/post test scores of the total population on items 2, 3, and 5, therefore, for these items the null hypothesis was not rejected. Items 1, "We really haven't thought about cutting down our use of water", and 4, "Nature has a way to solve water supply problems before they get serious", called for rejection of the null hypothesis ($p \leq .05$).

TABLE V
T-TEST COMPARISON BY ITEM OF MEAN PRE-TEST AND MEAN POST-TEST
SCORES OF THE TOTAL POPULATION

Question	Source	N	X	SD	DF	t	p
1.	Pre-	29	2.93	1.25	49	5.57	0.0001*
	Post-	22	1.50	0.51	39		
2.	Pre-	29	3.31	1.20	49	0.29	0.73
	Post-	22	3.41	1.26	44		
3.	Pre-	29	3.72	0.96	49	1.19	0.24
	Post-	22	4.04	0.93	46		
4.	Pre-	29	4.03	1.02	49	2.56	0.01*
	Post-	22	4.59	0.50	43		
5.	Pre-	29	4.66	0.48	49	-0.61	0.54
	Post-	22	4.50	1.10	27		

*Significant to the .05 level of confidence.

Question #3

What effects result from WRMS experience within and between agribusiness and water management populations?

H₀5: There will be no significant difference between mean pre/post-test scores of agribusiness professionals.

The data presented in Table VI compares mean pre- and post-test scores of agribusiness professionals. As indicated the level of concern for water resource issues drops significantly after interaction with

the WRMS. This finding ($p = 0.0004$) is significant and calls for rejection of the null hypothesis.

TABLE VI
ATTITUDE T-TEST COMPARISON OF PRE/POST TEST MEAN
SCORES OF AGRIBUSINESS PROFESSIONALS

Source	Group	N	X	SD	t	p
Agribusiness	Pre-	14	18.86	-1.94	9.96	0.0004*
	Post-	12	16.92			

* Significant to the .05 level of confidence.

Table VII clearly shows that interaction with the WRMS increases the water concern level of water management professionals. However, this increase is not significant at the .05 level, and calls for the acceptance of the null hypothesis.

H₀7: There will be no significant difference in mean pre/post-test scores between agribusiness and managers of water resources.

Table VII compares mean attitude scores of WRMS (post-test) and non-users (pre-test) by profession. No significant difference exists between agribusiness and water management non-user populations. However, a significant difference does occur between users in the two groups. Water managers tend to exhibit a slight rise in concern level while that of agribusiness professionals is lower after WRMS interaction. Thus, the null hypothesis was rejected.

TABLE VII
ATTITUDE T-TEST COMPARISON OF PRE/POST TEST MEAN
SCORES OF WATER MANAGEMENT PROFESSIONALS

Source	Group	N	X	SD	t	p
Water Managers	Pre-	15	18.47	-0.94	0.97	0.34
	Post-	10	19.40			

TABLE VIII
T-TEST COMPARISON OF AGRIBUSINESS AND WATER MANAGEMENT
PROFESSIONALS PRE/POST TEST SCORES

Group	Source	N	X	SD	t	p
Pre-	Agribusiness	14	18.9	1.7	0.5	.62
	Water Managers	15	18.5	2.4		
Post-	Agribusiness	12	16.9	1.23	9.98	.005*
	Water Managers	10	19.4	1.99		

* Significant at the .05 level of confidence.

H₀8: There will be no significant difference in mean pre/post-test scores by item between agribusiness and water management professionals.

Comparison of mean by item responses between WRMS users and non-users for water management and agribusiness groups is shown in Table IX.

Agribusiness subjects using the WRMS compared with non-users showed significant differences on item 1, "We really haven't thought about cutting down our use of water", and item 2, "Water reclaimed from waste is as good as any other water", with p values of 0.004 and 0.009 respectively. On items 3, 4, and 5, no significant difference in attitude was shown by item. For items 1 and 2 the null hypothesis was rejected. For items 3, 4, and 5 it was not rejected.

In comparison of water managers using the WRMS and non-users, results were similar, but not the same. Significant differences were observed on items 1, 2, and 4, "Nature has a way to solve water supply problems before they get serious." No significant difference was observed on items 3 and 5. These results indicate the null hypothesis for items 1, 2, and 4 be rejected and non-rejection for items 3 and 5.

Question #4

What areas of water resource concern are influenced by WRMS treatment?

H_0 : There will be no significant difference by item between mean scores of agribusiness and water managers.

Table X shows summary by item response frequencies and χ^2 values comparing agribusiness and water management professionals. Pre-test significant differences existed favoring water managers on item one and favoring agribusiness professionals on item 4. On the post-test however, of the persons using the WRMS, no significant difference was shown on any of the five items. Therefore, the null hypothesis was not rejected.

TABLE IX

SUMMARY OF ATTITUDE T-TEST COMPARISON OF PRE/POST TEST SCORES
BY ITEM OF AGRIBUSINESS AND WATER MANAGEMENT PROFESSIONALS

Question	Source	Agribusiness			Water Managers		
		X	t	p	X	t	p
1.	Pre-	2.17	-3.2	.004*	3.13	3.75	.001*
	Post-	1.50			1.50		
2.	Pre-	3.92	-2.8	.009*	2.73	2.43	.022*
	Post-	2.92			4.00		
3.	Pre-	3.64	0.51	.61	3.80	1.23	.23
	Post-	3.83			4.30		
4.	Pre-	4.40	1.26	.22	4.00	2.12	.05*
	Post-	4.42			4.80		
5.	Pre-	4.57	-0.79	.44	4.73	.37	.72
	Post-	4.25			4.80		

* Significant to the .05 level of confidence.

TABLE X

CHI-SQUARE VALUES AND SUMMARY ATTITUDE RESPONSE FREQUENCIES BY ITEM FOR
 AGRIBUSINESS AND WATER MANAGEMENT PROFESSIONALS

Item	WRMS Users % Chi-Square				WRMS Non-Users % Chi-Square			
	Agree & St. Agree	St. Disag.	χ^2	p	St. Agree	St. Disag.	χ^2	p
1. Agribusiness Water Managers	100.0 100.0	0.0 0.0	0.0	0.0	57.1 40.0	42.9 60.0	0.85	0.36
2. Agribusiness Water Managers	41.7 20.0	25.0 60.0	2.8	0.25	7.1 53.3	78.6 33.3	7.67	0.02*
3. Agribusiness Water Managers	8.3 10.0	75.0 80.0	0.21	0.90	21.4 13.3	71.4 73.3	0.55	0.76
4. Agribusiness Water Managers	0.0 0.0	100.0 100.0	0.0	0.0	14.3 13.3	78.6 80.0	0.01	1.00
5. Agribusiness Water Managers	0.0 0.0	100.0 100.0	0.0	0.0	0.0 0.0	100.0 100.0	0.00	0.00

* Significant at the .05 level of confidence. (Numbers may not add to 100 because those which were undecided were disregarded in the count.)

Summary

1. Pre-test scores by occupation show that without exposure to WRMS there is no significant difference in the level of water resource concern. Initial concern levels were similar.

2. The data show for the entire population tested there is no significant difference in pre- and post-test scores.

3. There was a significant difference by item in pre-test scores in favor of agribusiness professionals on item 2.

4. A significant difference in level of concern existed by item on pre/post-test scores on the total population. The difference favored the pre-test on item 1 and the post-test on item 4.

5. Data show agribusiness professionals have a significantly lowered mean level of concern after WRMS treatment.

6. After WRMS treatment the level of concern of water managers is raised, but not significantly.

7. In comparing agribusiness and water managers pre-test and post-test scores, it was determined that a significant post-test difference occurs in level of concern between the two groups favoring water managers.

8. No significant difference by item existed in pre/post-test scores of agribusiness professionals on items 3, 4, and 5.

9. For agribusiness professionals a significant difference by item did occur on items 1 and 2. Both instances favored the pre-test.

10. No significant difference by item existed in pre/post-test scores of water managers on items 3 and 5.

11. Water managers did show significant differences by item on pre/post-test scores on items 1, 2, and 4. For item 1, the pre-test was favored and on items 2 and 4, the post-test was favored.

12. Data show that concern for water issues significantly favors WRMS non-users, with a significant difference on item 2. On the post-test, however, users of the WRMS showed no significant difference on any of the five items.

Analysis of data indicate there is value in the WRMS as a tool for moderating attitude of agribusiness professionals. The greatest change in level of overall concern was made by the agribusiness group.

CHAPTER V

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

In general, WRMS treatment did not create significant differences in concern levels after interaction ($X = 16.92$ agribusiness; $X = 19.40$ water managers).

Agribusiness professionals and water managers were significantly different only on item 2, "Water reclaimed from waste is as good as any other water", before interaction. One possible explanation for this finding is that water managers may be aware of problems caused by unsolved waste removal whereas agribusiness professionals are more aware of using waste water for agricultural purposes, however, more study in this area is needed to accurately answer this question. After contact with the WRMS there was no significant difference found on any of the five items. By this, water concern levels appeared to be modified by interaction with the simulator.

Comparison of pre/post-test data for the entire population by item reveal significant differences on items 1 and 4, which deal with "We really haven't thought about cutting down our use of water," and "Nature has a way to solve water problems before they get too serious."

On these two items the level of concern is significantly changed. Item 1 favors the pre-test group, while the post-test group is favored by item 4.

Data on pre/post-test scores of agribusiness professionals show that interaction effectively moderates their rather high level of concern while that of water managers increases, but not significantly so.

In comparing pre/post-test scores of the two occupations, post-test scores show significant differences ($p = 0.005$) favoring water managers. This is possibly due to pre-existing attitudes or experiences that this group holds in the area of water resource management and which agribusiness professionals do not. Reasons for differences, however, are unexplained at this time.

By item, pre-test significant differences exist for both water managers and agribusiness professionals on item 2. On the post-test no significant difference was apparent on any item.

To agree with items 2 and 5, and to disagree with items 1, 3, and 4 denotes a high concern for water problems. A significant relationship exists for item 2, where a greater proportion of WRMS users were in agreement, indicating a lower concern than non-users. Although not significant, the non-users also show greater concern for water problems on items 1, 4 and 5 by agribusiness professionals and on item 1 for water managers. The tendency for both groups to agree to item 1 is counter to the response pattern observed for the remaining items. A high score supposedly reflects an attitude of greater concern for water issues.

Scores of agribusiness professionals decreased significantly after interaction with the WRMS, while those of water managers increased but not significantly so. Possibly because of their occupation

water managers are more acutely aware of water problems and issues than agribusiness persons. Therefore, while they do maintain a relatively high level of concern this is tempered by realistic ideas about water and its use. Agribusiness people on the other hand, have a level of concern initially higher than that of water managers and only after interaction is that attitude moderated to a more realistic level.

The information gained in this study supports the assumption that the WRMS is an effective tool for moderating concern for water issues a agribusiness professionals. It slightly raises concern levels of water managers, but not significantly so. Mills (1983) in a similar study examined a population of adults attending environmental science training programs and determined via pre/post-test data that their rather high level of concern was moderated after WRMS interaction. The adults in Mills' study possessed a high level of concern for water resource issues and this concern was decreased by WRMS use. In a study of high school WRMS users (Mills, 1983) and non-user groups a significant increase in both knowledge and water concern lev levels resulted from use of the WRMS. The initial mean score for water concern was significantly lower than that of adults, however. Data suggest the effect of WRMS use on attitude depends on the level of water resource concern prior to interaction. Where high levels of concern exist, WRMS treatment appears to moderate attitudes toward water issues, except in this study where occupation appears to have a great deal to do with treatment. Ransey and Rickson's (1976) study of high school students attitudes found that high knowledge levels are related to moderate attitude. This gives credence to the use of the WRMS as a moderator of extreme bias.

Instruction via computer has been introduced into modern education with relatively little background research. This study, dealing with computer simulation and education of water concepts and issues, indicates the need for greater scrutiny of this type of instruction. From data collected we can conclude that populations react with varying degrees of interest and application to this instructional method.

Also indicated in this study and those done previously, the response pattern to item 1 is consistently lower. Populations with high concern levels are not expected to score in this manner, therefore, the recommended scoring for item 1 on Watson's Water Concern Scale may not be valid.

Wise management of our water resources is dependent upon a concerned and educated public, however, with large segments of the public inordinately concerned with water issues and other large segments with little or no concern, communication would indeed be difficult to achieve. Solving water management problems in this situation would be formidable if not impossible. If the WRMS does indeed moderate concern levels (increase low levels; reduce high levels) it could be used as a method of helping populations to communicate, compromise and reduce water management problems. This study indicated that this is indeed the case and interaction with the WRMS may be one way to decrease tensions and alleviate stress related to the solving of water resource problems and issues.

Recommendations

The following recommendations are made with the improvement of the WRMS as an attitude moderator in mind.

1. Have an audio tape made to go along with the slide presentation to assure each group receives the same information.

2. Ascertain that sufficient time be allowed for simulator interaction.

3. The WRMS does influence attitudes and could with further research be used by government agencies or private industry for this reason.

4. The WRMS should be considered by governmental agencies and private industry as a method to moderate attitudes toward environmental water issues.

5. Those who do use the WRMS take careful examination of this and other computer simulations concerning the effects of populations interacting with the simulator.

Recommendations for Further Research

It is recommended that further research be done to enable us to:

1. Better establish the parameters of attitude shifts influenced by WRMS interaction.

2. Determine the effect of time allotted on performance.

3. Determine how long-lasting are the effects of WRMS interaction.

4. Check the validity of the scoring of item 1 on the Watkins Water Concern Scale.

5. Determine the effects of WRMS interaction on populations which deal with water resources on a 'for profit' basis.

A SELECTED BIBLIOGRAPHY

- Abram, Robert E. and George Rosinger. "Behavioral Science Applications in Environmental Quality." The Journal of Environmental Education, 4 (Fall, 1972), pp. 1-6.
- Amend, J. R. Water Resource Management Simulator Handbook. Bozeman, Montana: Montana State University, 1980.
- Amend, John R. and Anita A. Arnold. "A Public Education Program in Water Resource Management." Journal of Geological Education, Vol. 31, (1983), p. 362.
- Amick, Robert W. Conserving Our Natural Resources: A 4-H Leader's Guide. Washington, D.C.: Department of Agriculture, 1965.
- Anderson, Duncan. "Tourist Guide to U.S. Water: Poisoned or Pure?" American Health, Vol. 1 (July-August, 1983), p. 18.
- Barnes, R. A. "The Long Range Transport of Air Pollution: A Review of European Experience." Journal of the Air Pollution Control Association, Vol. 29, No. 12 (1979), pp. 1219-1235.
- Biswas, A. K. Systems Approach to Water Management. New York: McGraw-Hill Book Co., Inc., 1976.
- Blosser, P. E. (editor). Instructional Materials in Natural Resources, Information Bulletin, No. 1. Columbus, Ohio: Clearinghouse for Science, Mathematics, and Environmental Education, 1982.
- Braskamp, Larry A. and R. M. Hodgetts. "The Role of an Objective Evaluation Model in Simulation Gaming." Simulation and Games, Vol. 2, No. 2 (June, 1971), pp. 197-212.
- Bruner, J. S. Towards A Theory of Instruction. New York: Norton, 1967.
- Carlson, John E. and David Baumgartner. "The Effects of Natural Resources Camps on Youth." The Journal of Environmental Education, 5 (1974), pp. 1-7.
- Cartwright, Dennis D. "Energy Environment Simulator vs. Lecture: Methods of Developing Energy Awareness and Attitude in Individuals of Various Cognitive Levels." (Unpublished Ph.D. dissertation, Idaho State University, 1981.)
- Clarke, W. "A Research Note of Simulation in the Social Studies." Simulation and Games, Vol. 1, 2 (June 1970), 203-210.

- "The Computing Primer, Part III: How Educators Use Microcomputers."
Electronic Learning, January, 1982, pp. 22-24.
- Dunlop, D. C. "An Energy-Environment Simulator: Its Effects on Energy-Related Attitudes." Journal of Environmental Education, 10 (1979), pp. 43-45.
- Gawrowski, J. D. and C. E. West. "Computer Literacy." ASCD Curriculum Update. Alexandria, Virginia: Association for Supervision and Curriculum Development, 1982.
- Gibbs, G. T. Handbook of Games and Simulation Exercises. Beverly Hills, California: Sage Publications, Inc., 1974.
- Guetzkow, Harold. Simulation in International Relations: Developments for Research and Teaching. Englewood Cliffs, NJ: Prentice-Hall, Inc., 1968.
- Hendee, J. C. "No, to Attitudes to Evaluate Environmental Education." Journal of Environmental Education, 3 (1972), p. 65.
- Hoover, Kenneth H. College Teaching Today: A Handbook for Post Secondary Instruction. Boston: Allyn and Bacon, Inc., 1980.
- House, V. W. (editor). "How to Hatch a Simulator." Upstream/Downstream, Water Resources Education Project. Bozeman, Montana: Montana State University Extension Service, 1982.
- Jaus, Harold H. "The Effect of Environmental Education Instruction on Teachers' Attitudes Toward Teaching Environmental Education." Science Education, 62 (1974), pp. 79-84.
- Knapp, Clifford E. "Attitudes: Values in Environmental Education." Journal of Environmental Education, 3, 4 (Summer, 1972), pp. 26-39.
- Knowlton, Clark S. "Facts and Ironies of the Water Situation in the Southwest." Western Review (August, 1964), pp. 17-25.
- Kraybill, H. "The Distribution of Chemical Carcinogens in the Aquatic Environments." Progress in Experimental Tumor Research, Vol. 20 (1975), pp. 3-34.
- Leyendecker, Philip J. Let's Demonstrate Soil and Water Conservation for Better Farming, Better Living. University Park: New Mexico State University, 1961.
- Maidment, Robert and R. H. Bronstein. Simulation Games: Design and Implementation. Columbus, Ohio: C. E. Merrill Publishing Co., 1973.
- Maloney, Michael P. and Michael P. Ward. "Ecology: Let's Hear from the People." American Psychologist, Vol. 87, No. 6 (1973), pp. 583-586.

- Maloney, Michael P., Michael P. Ward, and G. Nicholas Braucht.
 "Psychology in Action: A Revised Scale for the Measurement of Ecological Attitudes and Knowledge." American Psychologist, Vol. 121, No. 11 (1975), pp. 787-790.
- McLean, H. W. "Simulation Games: Tools for Environmental Education." The Elementary School Journal (April, 1973), pp. 374-380.
- Miller, R. "A Delphi Study of the Future Agricultural Water Resource Needs in Oklahoma." (Unpublished Ed.D. dissertation, Oklahoma State University, 1979.)
- Mills, T. J. "An Assessment of Water Resource Education for the K-16 Curricula." (Paper presented to the Oklahoma Water Education Planning Conference, Moore, Oklahoma, October, 1977.) Stillwater: Oklahoma State University, Department of Curriculum and Instruction, 1977.
- _____. "Water Resource Knowledge Assessment of College-Bound High School Students." Oklahoma Academy of Science Proceedings, Vol. 63 (1983), pp. 232-251.
- _____. "Computerized Water Resource Management Simulator Effects on Water Knowledge and Attitudes." Annual Conference of the National Association for Environmental Education Proceedings, John H. Baldwin, March, 1984.
- Mix, M. C., R. T. Riley, K. J. King, S. Tenholm, and R. Schaffer. Fate and Effects of Petroleum Hydrocarbons in Marine Ecosystems and Organisms. New York: Pergamon Press, 1977.
- Moursond, David. "Precollege Computer Literacy: A Personal Computing Approach." International Council for Computers in Education, University of Oregon, 1981.
- Nokolaieff, George. The Water Crisis. New York: H. W. Wilson, 1967.
- Noonan, Larry. "Computer Simulation in the Classroom." Creative Computing, 7 (October, 1981), pp. 132-138.
- Oehme, Frederick W. Toxicity of Heavy Metals in the Environment. New York: Marcel Dekker, Inc., 1978.
- Overrain, Lars N. "Acid Precipitation as an Environmental Problem in Europe." Paper presented to California Symposium on Acid Precipitation, California Air Resources Board, San Francisco, California, January 14-15, 1981.
- Sheets, Kenneth. "Water: Will We Have Enough to Go Around?" U. S. News and World Report (June, 1981), pp. 34-38.
- Stamm, D. R. and J. E. Bowes. "Environmental Attitudes and Reaction." Journal of Environmental Education, 3, 3(1972), pp. 56-60.

- Tansey, P. J. and D. Unwin. Simulation and Gaming in Education. New York: Methuen Educational Ltd., 1969.
- Taylor, John L. and Rex Walford. Simulation in the Classroom. New York: Penguin, 1974.
- _____. "A Conceptual Framework for Water Education: An Educator's Guide to Goals, Concepts, and General Objectives for Curriculum Development." Water and Man Inc., Salt Lake City (1979), p. 4.
- _____. "The Need for Marine and Aquatic Education: To Inform Americans About the World of Water." Sea Grant. Newark, Delaware: University of Delaware, 1978, pp. 20-21.
- Travers, W. B. and P. R. Cuney. "Drilling, Tankers and Oil Spills on the Atlantic Outer Continental Shelf." Science, 194 (1976), pp. 791-796.
- Watkins, G. A. "Developing a Water Concern Scale." Journal of Environmental Education, 5 (Summer, 1974), pp. 54-58.
- Wilson, A. War Gaming. New York: Penguin, 1969.

Appendix

Water Concern Scale

Item	Score	Question
1		<u>We really haven't thought about cutting down our use of water.</u>
	1	strongly agree
	2	agree
	3	undecided
	4	disagree
2	5	strongly disagree
	4	disagree
	3	undecided
	2	agree
	1	strongly agree
3		<u>Mankind has a right to free and unlimited use of water.</u>
	1	strongly agree
	2	agree
	3	undecided
	4	disagree
4	5	strongly disagree
	4	disagree
	3	undecided
	2	agree
	1	strongly agree
5		<u>It's the people who should do something about the water problem.</u>
	5	strongly agree
	4	agree
	3	undecided
	2	disagree
	1	strongly disagree

VITA 2

Cynthia LeAnn Smith

Candidate for the Degree of

Master of Science

Thesis: COMPUTERIZED SIMULATION EFFECTS ON CONCERN FOR WATER ISSUES
BY AGRIBUSINESS AND WATER MANAGEMENT PROFESSIONALS

Major Field: Curriculum and Instruction

Biographical:

Personal Data: Born in Gene Autrey, Oklahoma, Ardmore Air Force Base, October 5, 1956, the daughter of Doratha and Claudus Smith.

Education: Graduated from Tushka High School, Tushka, Oklahoma, in May, 1974; received the Associate of Science degree from Murray State Junior College in 1976; received the Bachelor of Science in Education degree from East Central Oklahoma State University in 1978; completed the requirements for the Master of Science degree at Oklahoma State University in December, 1984.

Professional Experience: Junior High School Science Teacher, Dickson Public Schools, Dickson, Oklahoma, 1978-1981; Middle School Science Teacher, Okemah Public Schools, Okemah, Oklahoma, 1981-1982; Middle School Science Teacher, Stillwater Public Schools, Stillwater, Oklahoma, 1982-1983; Graduate Teaching Assistant, Oklahoma State University, 1983-1984.

Professional Organizations: Oklahoma Science Teachers Association, National Science Teachers Association, Dickson Classroom Teachers Association, Okemah Classroom Teachers Association, Stillwater Classroom Teachers Association, Oklahoma Education Association, National Education Association, National Federation of Wildlife.