AN ASSESSMENT OF MICROCOMPUTER WATER INFORMATION DISSEMINATION SOFTWARE

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PREFACE

This study is concerned with assessment of microcomputer water information dissemination software. The study involved the identification of commercially available water education software for use with high school students. A random sample of the water education programs were tested with teachers and students of six high schools in Oklahoma. Test instruments were developed and administered to students to determine the effectiveness of the software programs in teaching water knowledge concepts and changing water concern levels. Comparison was also made between the evaluations of the student software users and teacher evaluations of the water educational software.

I wish to express my sincere gratitude to all the people who assisted me in this work and during my stay at Oklahoma State University. In particular, I am especially indebted to the chairman of my committee, Dr. Terence J. Mills, III, for his extreme interest, concern, invaluable guidance, and encouragement. My experiences in working with Dr. Mills have been very educational and enjoyable and they will indubitably prove helpful in the future.

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CHAPTER I

NATURE OF THE PROBLEM

Introduction

Water is our most important natural resource. All life depends on this resource for its existence. With our ever increasing human population, noticeable negative effects to this natural resource have also increased. We have yet to realize just how much of an impact we have placed and will continue to place on this precious resource. Being educated with regard to water resource issues will certainly be a benefit to all mankind and all other living organisms. One method used for learning about water resource issues is computer simulation.

Computer simulation for the purpose of water resource planning and management has become an important tool used by the management professional. Likewise, computer supported simulations can significantly increase learners' opportunities to relate concepts of vital, changing circumstances, and to test the probable effects of administrative decisions on water management problems simulated.

The nation's schools are moving to computerized instruction at a rapid rate. There is a proliferation of software appearing in the computer market place, several of

which are water related programs. Few or no formal evaluations or studies have been conducted leaving consumers to their own devices when considering specific water related software for instructional use.

It is hoped that this study will assist in the process of identifying quality software for environmental science in hydrology.

Statement of the Problem

As early as 1981, at least one-third of all U.S. high schools possessed microcomputers (1). Most of the research in educational computing has dealt with the types and amount of computer use in schools. There has not, however, been a great deal of formal research conducted on using the computer as an information dissemination tool (2). The lack of research using computers with public school subjects results, in part, from the difficulty of gathering data within the public school context. In addition, it is generally accepted that studies on computer software for water information dissemination should be performed only in the context within which it will be used. It follows that there is a need to:

1. Identify information dissemination software related to water.
2. Identify criteria by which external evaluations of software are made.
3. Compare objective application of criteria by teachers who select software with data on performance and perception from actual student software users.

The purpose of this study was to determine if computer software programs in water education for high school students influence attitude toward water resources, increase water knowledge, and are viewed the same by students and teachers. Specifically, the goals of the study were to:

A. Identify commercially available water education software for use with high school students;

B. Analyze and select the common criteria used in software evaluation;

C. Develop test instruments to measure teachers' and students' perceptions and students' water Knowledge;

D. Compare:

   1. high school student water software users' (experimental group) and non-users' (control group):

      a. level of concern over water issues;

      b. knowledge of concepts treated in the software program;

   2. high school teachers' vs. high school students' (experimental group) actual:

      a. evaluation of software;

      b. level of water knowledge gained from water water software;

      c. attitude towards computer education;

      d. attitude towards water education;

   3. high school student users' (experimental group):

      a. level of concern over water issues vs. knowledge of concepts treated in the software program;

      b. level of concern over water issues vs. evaluation of software;

      c. evaluation of software vs. knowledge of concepts treated in the software program;

4. high school student non-users' (control group) level of concern over water issues vs. knowledge of concepts treated in the software program.

Hypotheses

The hypotheses are stated in null form and will be tested at the 0.05 level of confidence.

H1 There is no significant difference between high school student water software users' level of concern over water issues and non-users' level of concern over water issues.

H2 There is no significant difference between all high school student non-users' level of concern over water issues and high school water software users' level of concern over water issues by each program.

H3 There is no significant difference between high school student water software users' knowledge of concepts treated in the software program and non-users' knowledge of concepts treated in the software program.

H4 There is no significant difference between high school student water software users' evaluation of the water software programs and teachers evaluation of the water software programs.

H5 There is no significant difference between high school students' mean evaluation score on each program and with high school teachers' mean evaluation score on each program.

H6 There is no significant difference between high school students' and high school teachers' responses to the statement (question 6), "I feel comfortable using computers."

H7 There is no significant difference between high school students' and high school teachers' responses to the statement (question 23), "More time should be spent learning with computer software programs."

H8 There is no significant difference between high school students' and high school teachers' responses to the statement (question 24), "I think water education is important."

H9 There is no significant difference between high school students' and high school teachers' responses to the statement (quesiton 25), "I think water education should be taught in the schools."

H10 There is no significant correlation between high school student water software users' concern over water issues and their knowledge qained from water software.

H11 There is no significant correlation between high school student water software users' level of concern over water issues and their evaluation of the software by program.

H12 There is no significant correlation between high school student water software users' knowledge gained from the program and their evaluation of the water software.

H13 There is no significant correlation between high school student non-users' level of concern over water issues and their water knowledge.

Research Questions

1. What commercially available high school water education software exists?
2. What are the criteria used on software evaluation forms and which of those criteria appeared most often?
3. How closely do teachers identify the level of water knowledge possessed by high school users and non-users of the water education software?

Limitations

1. Only those schools where science teachers had access to microcomputers were used in the study.
2. The programs randomly selected for the study could be not obtained in multiple copies. The lack of duplicate copies prevented the testing of a larger population.
3. Few schools had compatible hardware for using the software selected.

Assumptions of the Study

1. The participants responded honestly to the testing instruments.
2. The participants had sufficient time to complete the water software programs.

3. All teachers taught biology and all students were in biology classes at the time of the study.
4. Teachers conducted the testing procedure as requested. (Appendix H)

Definitions

Water Education. Learning physical, biological and social aspects of water.

Water Information Dissemination Software. Computer software containing physical, biological, and/or social aspects of water education that is presented on a disk for a microcomputer.

Commercially Available Programs. Microcomputer software made by developers and put into the computer market place to be purchaced and used by the general public.

Computerized Instruction in Education. The use of computers and microcomputers in public school educational settings, to teach all subjects, and not learning about the parts and functions of a computer.

Evaluation Criteria. Those attributes of a software program which are used to determine its educational value.

Control Group Test. The test taken by those high school students who did not use use the computer to view water education software. The test was composed of water concern and water subject matter questions.

Experimental Group Test. The test taken by those high school students who used the computer to view water education software. The test was composed of water concern, water subject matter and software evaluation questions.

Non-users. High school students who never used the software but were administered a control group test.

Users. High school students who used the water education software and then were administered a experimental group test.

Water Concern Test. A "water concern" scale developed by G. A. Watkins (3) that contains five items which seem to measure a concern for and about the water resource problem. The questions were numbers 5-9 on the control group test (Appendix E) and 26-30 on the experimental group test (Appendix F).

Subject Matter Content Test. Questions used on the test instruments which were obtained from information presented in the water software programs. The questions began with question number 31 on all five experimental group tests. (Appendix F)

Attitude Test Questions. Questions used on the test instruments to obtain teachers and students general reactions to water and computer education. The four attitude questions were numbers 6, 23, 24, and 25 on the teacher evaluation and the experimental group test. (Appendixes F and G)

CHAPTER II

REVIEW OF SELECTED LITERATURE

Introduction

A literature search was conducted in two subject areas, "water education" and "computers". The search continued throughout the study because of the many studies and articles recently being published in the areas of educational computing and water resource management. Although there are many articles published in these subject areas, few discuss the use of computerized instruction in water resource management. The literature found in the search has been grouped under six titles, as follows: (1) Water Education, (2) Using Computers in Education, (3) Problems Associated with Educational Computing, (4) Quality of Educational Software, (5) Studies in Computerized Instruction, and (6) Summary.

Water Education

Water is one of our most important natural resources. In 1984, an article in the journal American Forests stated (4), "photographs taken from a spacecraft have shown us an incredibly lovely and fragile globe of blue-green water and swirling white clouds. Such photographs confirm for us a fact: we are a self-contained water planet." Water sets the

Earth apart from all other known planets. Every living thing depends upon water, as does every factory and farm. Agriculture and industry use about 85% of the freshwater available for human use. The average amount of water consumption per person in U.S. cities in their home is 150 to 200 gallons a day. The human body itself is made up of 70% water (5).

All is not well with this seemingly unlimited resource. A concern of the Government's conservation agencies is the public attitude towards the development of environmental pollution by use and misuse of water resources. Water is so familiar, so commonplace, so much a part of our daily life that we tend to take it for granted, until it becomes fouled with pollution or the supply runs out (4). Toxic chemicals, use of water of for irrigation and cooling towers, decades of neglect of cities' waste water, and bad management decisions of governmental agencies (U.S. Corps of Engineers and the Bureau of Reclamation) have polluted and/or wasted many millions of gallons of useable water (6). By the year 2000, population growth alone will at least double the demand for water in half the countries of the world. Man is using the underground water source faster than the water cycle can replenish it. Already, 40% of one of the major underground water reservoirs in the central U.S., the Ogallala Aquifer, has been used up (7). Similar situations are occuring with other aquifers around the world.

Many experts say that the water of the Great Lakes may soon be unsafe to drink without advanced purification

technology. An example of a major water pollution problem comes from the Niagra Falls, New York, sewage treatment plant, whose brand-new carbon filters broke down in 1978 and still have not been replaced. This has led to the continued dumping of 60 million gallons of inadequately treated industrial waste water into the St. Lawrence river every day (8). Such occurances of water pollution problems are on the increase throughout the U.S. and the rest of the world. Governments can take significant actions, but they will not do anything without a very strong expression of public concern.

Public concern over water pollution problems can make a difference. Reports of high amounts of poisons in drinking water helped push the 1974 Safe Drinking Water Act through Congress, which directed EPA to establish maximum permitted levels of contaminants (9). Presently, laws pertaining to this water act are not strictly enforced, thus allowing pollution levels to rise above EPA's set standard levels. Enforcement has declined mainly because public attitude has changed from a high concern for the effects of environmental pollution in the 1970's to an apparent lower concern in the 1980's.

One way the public has been trying to solve the water problem - and it may be the only alternative in the future - is recycling waste water: cleaning and recleaning it until it's pure enough to drink. Waste water shouldn't taste any different from the way the water tastes now. Getting the

general public to believe this may take some doing (9). By the year 2000, treated wastewater is expected to supply 16% of the nation's total water needs, up from 4% in 1980 (10).

The total supply of water on the earth is tremendous. What water that exists on the planet today has existed since the earth's beginning. Our planet still provides ample sources of drinkable water through the water cycle. Our problems involve the distribution and use of water; it is our responsibilty to use it wisely. Conservation is the key to the future. Conservation saves water, money, and energy. It also serves an important fuction of creating an awareness and concern for water. Solutions to our current water problem come in four categories as stated by Tufty (11). They are:

> relocating or distributing amounts of fresh water; using less water or recycling water; preventing pollution at the source before it enters the water cycle; and organizing a national agency to look at the nation as a whole, in terms of water reqions rather than of politics.

In order for us to develop effective solutions to our water problems the public, including younger generations, must continually be educated about water and its importance to us and all living things. The public schools make a major contribution to the public's basic water knowledge. The extent to which the schools prepare students (the future voting public) for management of water resources is critical to wise resource management.

In 1954, a study done by Glidden (12), showed that typical high school seniors are not adequately informed on important principles of soil and water conservation.

Glidden's suggestion was that schools should place greater emphasis on the subject matter in these important areas of conservation or should modify curricula to include more subject matter in these areas. Another study done as recently as 1983 by Mills (13) on Water Resource Knowledge Assessment of College-bound High School Graduates showed that student responses indicated the level of knowledge to be low, particularly in the areas of contemporary issues, resource management, and historical influence. This study also points out that the general public may be lacking in water education which may prove to be one of the most important bodies of information required by those who would assume leadership roles in the country. Their decisions on water issues may very well affect the well-being of many generations to come.

Using Computers in Education

Within our ever increasing fast-paced society, technology has played an important role. The computer has become part of the fabric of everything we do. The computer is involved with the way society lives, moves about, plays and conducts business. One important use of the computer has been its development as a educational tool. As an educational tool, the computer could be used to teach the public important water related knowledge which has not been taught very effectively in the public schools.

The development of the computer simulation had its beginning with the first computers in the late forties.

These early programmable machines were needed when scientific experiments with real systems proved to be too dangerous and costly. They were needed to solve complex equations to simulate the operation of nuclear reactors and model flight paths of rockets (14). For this same reason programs can and have been developed to simulate water management situations.

Computers have been gradually entering classrooms for nearly 30 years, but the arrival of the microcomputer has accelerated the process dramatically. By 1980, over 60 percent of the school districts in the United States had some sort of microcomputer (15). In 1981, over $98 million was spent to purchase some 35,000 microcomputers for the classroom (16). In 1985, junior and senior high school were predicted to have 400,000 microcomputers or about 16 machines per school (17). And in 1982, The Office of Technology Assessment predicted that by 1994 over four million microcomputers will be found in our schools (18).

This increase in microcomputers in the classroom will make a dramatic impact on the class structure and method of instruction. Unlike the situation with calculators, where an emotional fear of their use is evidenced, microcomputers are generally accepted as a valid educational tool. The antagonism toward the use of calculators led to a host of studies to ascertain their effects and reassure parents and teachers that they would not harm achievement. The willing acceptance of microcomputers has not created this need for research evidence, consequently, efforts are focused far more on

developing activities and materials for their use (19).

One of the uses of microcomputers is creating programs which simulate real-life experiences as do some of the larger and more high-tech computers. Science deals with studing our environment. Many science computer software programs are being created to simulate life experiences. Direct experience is generally accepted as the best learning device, but the complexities of environmental concerns are such that direct learning is frequently not possible. For one thing, there may be too much riding on an unknown or on variables in real-world situations. Students also lack the experience in making important real-life decisions. Thus, the rationale for using simulations in educational settings is based on the assumption that they are good alternatives for direct experience (2).

Is it possible that simulation programs will give students experience to make rational decisions? There are many high technology computers which are very effective in mimicking real-life situations. One such example of a high-tech computer simulation is the Water Resources Management Simulator which was created by a National Resources Education Project at Montana State University in Bozeman, Montana (20). The Water Resources Management Simulator deals with problems of water supply, water storage, and water utilization. It raises questions of ground water and surface reservoir management, snowpack and stream flow prediction, and efficiency of water use. It is designed so that students can interact

with the computer and each other at the same time. The data in the system comes from actual occurances in the real-world. Having this type of computer in the classroom environment has been found to be an effective learning device (21). This simulator is a good model for giving students the ability to make rational real-life decisions based on water education they have accquired from the program. Unfortunately this computer simulator costs approximately $4,500 and is large, making it difficult to move. Although it may be a more effective teaching tool, most school systems would have a hard time justifying the need for a high-tech computer program such as this one. Consequently, schools have had to acquire much cheaper software and more manageable hardware.

Problems Associated with Educational Computing

The computer as a teacher of simulations, provides students with the opportunity to become involved in important decision making processes which other forms of computer education may not provide. A computer simulator is most commonly used in the classroom as a supplement to traditional lessons and laboratories (22). One important point to make as suggested by Hallifield (23), is that the computer should be used as a tool for extended and transfer learning, and not as a subject that will displace more fundamental learning.

At the grade school and high school levels, micro-computer science software programs are in limited supply.

Not only is good quality software in limited supply but hardware for use in science classes is also hard to come by. The cost of purchasing computer equipment is most certainly the main reason for the limited supply of computer hardware and science software in public schools.

A situation which prevents implementation of science simulation software is that many school systems are purchasing and using their computers to teach computer literacy courses which deal with strictly programming and do not deal with subject areas in science. Schools are also using computer applications like word processing, spread-sheets, and data base management (24).

A survey done by J.R. Lehman (25) of microcomputer use in the high school science classroom showed that out of 193 science departments 41% of the science departments did not have a single faculty member using microcomputers in class. There are many possible reasons why microcomputers are not being used in science classes. One reason centers around a controversey concerning how computers are used in the classroom. One side of the argument as stated by Seymour Papert is that computers expand the mind verses Joseph Weizenbaum's idea that computers narrow the mind (26). The main reason for this argument is that very few studies have been done to back either man's idea.

Research indicates that in those schools where computers are used as instructional tools the students generally, learn more, retain more or learn the same amount faster (25). Un-

fortunately, no studies have been completed yet that tell us why that may be. A possible answer may be that computers in general attract students and maintain their interest for longer periods of time than other methods of instruction. According to Bracey (27), achievement gains aside, students often find computers more "human"--more patient, less critical--than humans. Knowing this, teachers may feel that the computer would be replacing them as educators and, therefore, choose not to to use computers in their classes.

Educators, parents, local businesses, computer manufactures, and software developers pressure schools to implement computers in the classroom. Also the Federal and state governments have put pressure on the schools to use computers. In many cases, as stated by Komoski (28), those school districts under pressure end up buying computer equipment not knowing a thing about how to use the equipment in their schools. It is most important that a needs assessment be carried out and an educational computing plan developed before the school even order computer equipment. The quality of educational computing in a school is going to depend on the quality of the software selected for use in that school and on the way in which teachers integrate the software into the overall curriculum.

Another reason for the low usage of microcomputers for instruction in classrooms is that the entrance of computers in the schools has happened at such a fast rate many teachers are inexperienced and lack adequate knowledge about inte-

grating computers in their classroom. Coursework is being offered around the country for the general public and teachers in educational computing. Key content factors for successful inservice computer training for teachers at enhancing classroom implementation include a combination of both computer programming and application. Presently, some colleges are requiring prospective teachers to take some kind of computer literacy course (29). Barbour (24) indicated that when teacher computer training dealt with applications in their subject areas, the teachers became more interested and were more willing to try simulation type programs in their classes.

Quality of Educational Software

Selection of appropriate software for classroom implementation is very difficult. With over 7000 products on the market, teachers are constantly faced with trying to identify high quality software programs that will fit within the schools' curriculum. Many software programs do not come equipped with materials such as teachers' guides and lists of instructional objectives which help provide an understanding of what the students will learn from the program (28). Without such information it makes it difficult for the teacher to use the software efectively as an educational tool. As mentioned by Komoski (28), educators have other problems in deciding what software to purchase.

> First, many software producers still refuse to grant previewing privileges, because they fear that

> their software will be illegally copied and then returned to them unpurchased. Second, even when software is availble for preview, it is not as easily evaluated as print or other, more familiar types of learning materials, because each software program must be examined in "real time" and should be tested with real learners. Third, even if a would-be purchaser were to make the investment of time and effort required to preview software programs and to evaluate them in relation to students' needs, the task of identifying a number of high-quality programs that meet these needs is still daunting.

Quality software development and implementation is hampered by software designers lacking knowledge about student behavior and teaching strategies. The designers are predominantly computer programmers and not educators. Software developers design motivational gimmicks for enhancing student interest, but lack expertise for creating computerized instruction that integrates well into the schools curriculum (30). Teachers many times find the software programs incompatable with the subject areas they are teaching.

An assessment of software was undertaken by the Educational Products Information Exchange (EPIE). Komoski (28) the excutive directer reports that an overall analysis of hundreds of programs in the last few years has demonstrated that six out of every 10 programs have been placed in the categories, "Not Recommended" or "Do Not Consider." Only three or four out of 10 have been placed in the "Recommended" category, and only about one out of 20 has been judged good enough to be placed in the "Highly Recommended" category. Another section of the assessment later reported that only

about one out of every five software programs examined had been learner tested by its publisher during its development. Thus most of today's software developers have been ignoring elements of software design that can greatly enhance the educational value of a software program such as classroom field-testing, and evaluation feedback from the students and teachers.

Educators need to evaluate software programs to insure that the software they do find will fit into their curriculum. Many organizations and educational institutions have developed their own evaluation forms for reviewing software. Many types of evaluation forms exist and they differ considerably in their format, length, and evaluation content. Some are only a page in length while others are several pages long. Some are essay-type forms and others are check-item forms. Common criteria found amongst the forms need to be identified to enhance a standard method of software evaluation.

Some would say that the present problems of microcomputer use in the classroom and the scarcity of high-quality software is to some extent a characteristic of the beginning of a new field. As developers and producers of educational software gain experience, quality should improve. Also teachers and school board members should become more familiar with implementing computer education into the curriculum, and most important, implementing microcomputer programs which simulate real-life situations and have been

field-tested with students in the school context in which the software will be used.

Studies in Educational Computing

Most studies in educational computing attempt to determine if microcomputer assisted instruction is more effective than the lecture method in achieving instructional objectives. The number of studies which test and evaluate science software is limited and the number of studies which involve water education software is even less. Wainwright (31) used a science microcomputer program containing chemistry concepts such as balancing equations and writing and naming chemical formulas to test its effectiveness with high school students. Wainwright's results showed that the software program he used did not help the students learn any better than conventional paper-and-pencil-worksheets.

Another study done by Vazquez (32) using chemistry microcomputer software to test its effectiveness in teaching basic chemistry concepts and principles to high school students verses a lecture format also showed no significant difference in the teaching methods. A qualitative report by Flowers (33) using a science water education software program POLUT, explains the effectiveness of the software when it is used with high school students. The program POLUT, allows students to "see" the consequences of certain actions taken to control water pollution. Both graphic and tabular results of manipulated varibles are printed on paper or a television

montitar in a matter of a few seconds. Many problem solving activities in the classroom often take days or weeks before results can be recorded and hypotheses tested. POLUT, provides students with immedate feedback on many possible hypotheses which are quickly tested by the computer. Immediate feedback appears to stimulate students to ask additional thoughtful questions and state alternative hypotheses. Flowers explains that the program POLUT, is an effective computer simulation type program because it allows students to develop skills used in problem solving tasks.

Another study done by Mills (34) using a water resource management simulator showed that the simulator was an effective water information dissemination tool, particularily at the senior high school and adult levels, and a method of increasing concern for water issues particularily with 16- to 18-year old high school students.

Summary

The review of literature has shown that water management problems do exist and that a possible reason for the problems is the lack of general water knowledge and the ability to make good management decisions. The research has also shown that using computers in educational settings can prove helpful in teaching the public the processes involved in making management decisions. In the review of literature, no compiliations of information dissemination microcomputer software relating to water education were found and no

studies were found which identified common content evaluation criteria to evaluate water software. Also, no studies were found showing a comparison of students vs. teachers in the evaluation of the effectiveness of the water education microcomputer software. Although Flowers reported on the effectiveness of a water education program he did not emperically test the effectiveness of the program.

The design and methodolgy of the study proposed in Chapter III attempts to gain emperical data to determine if microcomputer software programs in water education influence attitude toward water resources, increase water knowledge, and are viewed the same by students and teachers.

CHAPTER III

DESIGN AND METHODOLOGY

Introduction

The purpose of this study is to (1) identify micro-computer educational water software for high school students, (2) identify criteria used in software evaluation, and (3) determine if computer software programs in water education for high school students:

A. Influence attitude toward water resources.

B. Increase water knowledge.

C. Are viewed the same by students and teachers.

Software Search

A search for educational software designed for high school students in the subject areas of biological, physical and social aspects of water was begun during the month of June, 1985. To identify commercially available software, an ERIC Search was conducted using combinations of the following descriptors:

a. Water

b. Oceanography

c. Marine education

d. Environmental Education

e. Conservation

f. Natural Resources

g. Microcomputers

h. Computer simulation

i. Computer assisted instruction

Only two software programs, POLUT and The Acid Rain Game, were located using ERIC. A Resources In Computer Education (RICE) Search located an additional program, Water Pollution, using the same discriptors as the ERIC Search.

The lack of available water software identified by computer search prompted a hand library search using various catalogs (Appendix A) and the Clearinghouse of Information on Microcomputers in Education (CHIME), College of Education, Oklahoma State University (33). In addition, software publishers listed in the National Science Teacher Association computer software supplement (Appendix A) and about 50 other software publishers found in current computer periodicals were surveyed. A total of 19 water education computer software programs developed for high school students was found (Appendix B). Five programs were randomly selected from the total of 19 for use in the study (Appendix B). These programs were previewed to insure that they did indeed contain water education information, and then purchased from the software distributers.

Software Evaluation Criteria

The next step was to identify and analize the criteria

by which external (to the learner) evaluation of software is determined. Software evaluations are usually performed by using some form of an evaluation checklist. There are many types of checklists which can be used evaluate software. A list of evaluation checklists was obtained from the participants in the 1985 Educational Software Evaluation Consortium (34). From the 28 participating organizations, 10 (35%) software evaluation forms were obtained. One other evaluation form was obtained from the National Council of Teachers of Mathematics (35). From these 11 forms total, specific criteria used to judge software were tallied and the more common identified (Appendix C). When comparing the different evaluation forms much of the criteria was repetitious. Also, some of the criteria had the same meaning but were worded differently. All repetition was avoided when the list of software criteria was developed. The most common criteria on the evaluation forms and those best suited as judged by the researcher, for the evaluation of the five randomly selected programs were used in the test instruments.

Development of Test Instruments

Test forms in multiple choice format were developed so that data could be recorded on computer answer sheets and analyzed with a computer. Each computer software program had three separate tests developed to gather data from three populations. The tests were for (1) high school students not using the software program (control group), (2) high school

students using the software program (experimental group), and (3) high school teachers who evaluated the program.

Computer Software Non-user Test

On the non-user test (Appendix D) the first two questions were used to identify the type of test such as user, non-user or teacher and which of the five computer programs the content came from so that the computer could read the data correctly. For general information purposes, the next two questions ask the student their grade level and the number of science classes they had taken. To determine the level of water concern of the control group the five item (questions 5-9) Water Concern Scale was used (3). The last part of the test contained content test questions writ-ten by the software authors concerning the subject matter presented in the software program. This data was to be com-pared with similar data from the experimental group.

Computer Software User Test

On the user test (Appendix E), computer identification questions were also used along with some general information guestions concerning use of microcomputers. To determine the level of water concern and knowledge possessed by high school students using the computer program, the same test items were administered to the experimental group as was to the control group. In addition, the experimental group responded to items taken from the list of criteria common to computer

software evaluation forms (questions 8-22). Also questions 6, 23, 24, and 25 consisted of general attitude questions concerning opinions of computer education and water education. This evaluation data was to be compared with that of teachers to check for congruence.

Teacher Evaluation Test

For each of the five water education computer software programs, a three part teacher evaluation form was constructed (Appendix F). Part I deals with general attitude toward use of computers. Part II, questions 7-25, deals with corresponding evaluation questions asked of the experimental group, and Part III, where the teacher predicted the percent of the control group answering each question correctly on the content section, and then what percent of the experimental group would respond correctly to each content question.

General Computer Evaluation Questions

The general computer evaluation section on the test instruments did not necessarily contain all the criteria common to the software evaluation forms. For example, the criteria 'best group size', was not included on the tests because the experimental group was subject only to single person use. The criteria used in this study had to address both students and teachers. The computer software evaluation criteria; (1) content is accurate, (2) content has soundness and validity, (3) summary of student performance tests, (4)

meets objectives and/or goals, and (5) rating the program, were not used on the test forms because those criteria could not be fully understood and answered appropriately by the students. These criteria were directed more towards teachers and not the students. Each evaluation question was given five points with five being a score for the most positive attitude about the program and a score of one being the most negative attitude about the program. The maximum positive evaluation score any program could receive was 65.

Content Questions

The content questions were derived directly from the software programs. In most cases, the exact questions in the program's evaluation or test were used in developing the test instruments. This was the case in the test form made for the software program, Water Pollution which contained 10 questions. Also, in the program The Water Cycle, content questions came directly from the 20 questions on the software test. In the program The Hydrologic Cycle, questions on the developed test form came directly from the instruction packet that came with the software program. The Hydrologic Cycle content section contained 20 questions. In the program Water and Weather Series, content test questions came directly from the program but only 20 (45%), of the programs test questions were used. These 20 questions were randomly selected from the total number of questions. In the last program, Streams and Rivers, content questions came from the software test

but 8 of 12 questions were changed from a graphic form to multiple choice format so that the answers to the questions could be recorded on a computer sheet for analysis.

High School Science Teachers

Ten teachers were sent a packet containing one or more program disks, a set of tests for the control group, a set of tests for the experimental group, and a Teacher Evaluation Test. In addition, step by step procedures were outlined, and the contents of the packet and their use explained to the teacher (Appendix H). Teachers were asked to randomly select and test the control and experimental groups. They were also asked to (1) preview the software and evaluate its effectiveness and (2) predict the proportion of correct responses given by high school students for the content questions developed from the software programs.

High School Science Classrooms

High school students and their teachers in the State of Oklahoma participated in the study. Of the six high schools participating in the study, all in the eastern part of the state, two were located in a large metropolitan area (population 380 thousand), one in large community (population 40 thousand), one in a small community (population 8,500), and two located in rural towns (populations of 1,700 and 850).

CHAPTER IV

RESULTS OF THE STUDY

This chapter presents of the findings of the study based on the comparisons of the student software users, non-users, and teacher evaluations.

Available Water Education Software

Research Question One

The first part of the study was to identify commercially available water education software for use with high school students. Nineteen programs were identified. The topics they covered ranged from specific issues like acid rain to general topics like the water cycle. From the 19 programs, five programs were randomly selected for the study (Appendix B).

The five programs were first reviewed before they were administered to the high schools. In reviewing the software programs, many differences were found. Some of the major differences in the programs were:

1. The time involved in completing the program
2. The amount of content material
3. The type and amount of evaluation questions to measure the program's objectives

4. The subject matter
5. The hardware requirements of the software
6. The presentation of subject matter, such as gaming, tutorial, simulation, informational, drill and practice, etc.

These differences influenced test construction and the type of data gathered from the study. The first three differences mainly affected test construction. The tests were made as short as possible to give students plenty of time to look at the software before answering the test forms. The amount of time it took each student to complete the program and test depended upon which program they used. The last three differences (4-6) mainly influenced the type of data gathered and their influence will be discussed in the final chapter.

Computer Software Evaluation Criteria

Research Question Two

The second part of this study was to acquire software evaluation forms and then analyze and select the criteria to be used in the software evaluation sections of the test instruments. Thirty-five criteria were identified from 11 separate evaluation forms (Appendix D). Fifteen questions were developed from the most common criteria and used on the test instruments.

Hypotheses Tested

The third part of the study envolves the evaluation of

the data collected from high students and teachers. Lists of the computer programs and the population of students and teachers participating in the study are presented in Table I.

TABLE I

COMPUTER PROGRAMS AND PARTICIPANTS OF THE STUDY

Computer Program	Student		Teachers
	Non-user	User	
Hydrologic Cycle	118	31	2
Water Pollution	31	22	2
Water Cycle	34	13	1
Water and Weather	77	21	2
Streams and Rivers	79	23	3
Total	339	110	10

High School Students Concern for Water Issues

Hypothesis One

To determine if water programs influenced high school students concern over water issues, 339 students not using the programs and 107 students who used one of the five programs were tested using the Watson Water Concern Scale. Each of the questions on the Concern Scale had a possible

score of five. A score of 25 is the highest positive score possible. Table II shows a comparison of mean responses.

TABLE II

t-TEST COMPARISON BETWEEN MEAN WATER CONCERN SCALE SCORES FOR STUDENT WATER PROGRAM USERS AND NON-USERS

	No.	Mean	t	Df	Significance
Users	107	15.73	1.92	444	0.054
Non-users	339	15.15			

As indicated on Table II, the results of the t-test show a significant relationship. The computed t value of 1.92 did not, however, call for the rejection of the null hypothesis (P .05). The slight difference in mean response could probably occur due to chance only 54 times in 1000. To identify which of the software programs contributed to the difference on the water concern test, users of each program were compared with 339 non-users having a mean response of 15.15.

Hypothesis Two

The relationship between high school student nonusers' level of concern over water issues and users' level of concern over water issues by each program is shown in Table III.

TABLE III

t-TEST COMPARISON BETWEEN NON-USERS AND USERS MEAN WATER CONCERN SCALE SCORES BY PROGRAM

Program	N Non-User User	Mean Non-user User	t	Sig.
Hydrologic Cycle	339 31	15.15 14.87	0.53	0.59
Water Pollution	339 22	15.15 17.36	-3.66	0.0003
Water Cycle	339 13	15.15 16.38	-1.58	0.11
Water and Weather	339 18	15.15 14.72	0.63	0.52
Streams and Rivers	339 23	15.15 15.78	-1.06	0.28

As indicated on Table III, the results of the t-test show a significant relationship for the program Water Pollution. Users of the Water Pollution program showed the greater water concern mean score while scores on the Hydrologic Cycle, and Water and Weather programs were actually lower than the water concern mean score of 339 high school students non-users. The computed t value of -3.66 for the Water Pollution program called for the rejection of the null hypothesis (P .05).

High School Students Knowledge

of Water Concepts

Hypothesis Three

To determine if the water education programs users had higher knowledge levels than non-users, mean scores on the subject matter section of the tests were compared between groups for each of the 5 programs. The relationship is shown in Table IV.

TABLE IV

t-TEST COMPARISON OF MEAN KNOWLEDGE SCORES OF WATER SOFTWARE USERS AND NON-USERS BY SOFTWARE PROGRAM

Computer Program	Student	No.	Mean	t	sig.
Hydrologic Cycle	Users	31	9.87	4.6	0.0001
	Non-users	118	6.95		
Water Pollution	Users	22	7.09	4.07	0.0002
	Non-users	31	4.83		
Water Cycle	Users	13	11.46	1.48	0.158
	Non-users	34	9.38		
Water & Weather	Users	21	6.05	-3.56	0.0006
	Non-users	77	8.97		
Streams & Rivers	Users	23	9.43	8.91	0.0001
	Non-users	79	4.72		

As shown in Table IV, users of the Hydrologic Cycle, Water Pollution and Streams and Rivers programs had statistically significant gains over non-users. The computed t value for each of the three programs called for the rejection of the null hypothesis (P .05). No significant difference existed between users and non-users of the Water Cycle program and the Water and Weather program.

Student and Teacher Program Evaluation

Hypothesis Four

The relationship between high school student water software users' mean evaluation scores of the program and teachers' mean evaluation scores of the water software program was tested. The results are shown in Table V. Question number ten in the evaluation test section, "What grade level do you think this material is appropriate for?", could not have number values assigned to the answers, so it was not used. Question 20, "The books, worksheets, charts, etc, that came with the program were helpful.", was also not used because not all of the programs had such materials. Therefore, the question could not be answered correctly by the teachers and students. By not using questions 10 and 20 the maximum positive evaluation score was 65 and not 75.

TABLE V

t-TEST COMPARISON OF MEAN EVALUATION SCORES FOR ALL PROGRAMS FOR STUDENT WATER SOFTWARE USERS AND TEACHERS

	No.	Mean	t	Df	Sig.
Student Users	110	47.86			
			.108	118	.91
Teachers	10	47.60			

No significance difference existed between student and teacher mean evaluation scores for all programs combined. Therefore, the computed t value of .108 called for accepting the null hypothesis.

Hypothesis Five

A comparison of student with teacher mean evaluation scores on each program is shown in Table VI. The comparison revealed Water Pollution with the greatest difference between student and teacher evaluation. (student mean = 48.41, at 0.08 level of confidence). The computed t value for each program called for accepting the null hypothesis. Table VII shows mean evaluation scores of students and teachers ranked from high to low. The two programs ranked highest by students were the two ranked lowest by teachers.

TABLE VI

t-TEST COMPARISON OF STUDENT WITH TEACHER MEAN EVALUATION SCORES ON EACH PROGRAM

Computer Program	Evaluators	No.	Mean	t	Sig.
Hydrologic Cycle	Students	31	48.06	-0.88	0.41
	Teachers	2	53.5		
Water Pollution	Students	22	48.41	1.82	0.08
	Teachers	2	40.5		
Water Cycle	Students	13	43.85	-0.47	0.65
	Teacher	1	49.0		
Water & Weather	Students	21	46.05	-0.73	0.47
	Teachers	2	49.0		
Streams & Rivers	Students	23	51.0	1.44	0.16
	Teachers	3	47.0		

TABLE VII

STUDENT AND TEACHER PROGRAM EVALUATION MEAN SCORES IN RANK ORDER

	Software Program	Student Mean Score	Software Program	Teacher Mean Score
1.	Streams & Rivers	51.0	Hydrologic Cycle	53.5
2.	Water Pollution	48.41	Water Cycle	49.0
3.	Hydrologic Cycle	48.06	Water & Weather	49.0
4.	Water & Weather	46.05	Streams & Rivers	47.0
5.	Water Cycle	43.85	Water Pollution	40.5

Comparison of Students' and Teachers' Attitude Towards Computer Education and Water Education

Hypotheses Six, Seven, Eight, and Nine

Four Questions (6, 23, 24, and 25), on the experimental groups' test and on teachers' evaluation were compared to test for significant differences. Question 6 contained the statement "I feel comfortable using computers." Question 23 contained the statement "More time should be spent learning with computer software programs." Question 24 contained the statement "I think water education is important." Question 25 contained the statement "I think water education should be taught in the schools." Teachers and students were asked to give their opinion about the statements. Each question was given five points with a score of one being the most positive attitude and a score of five for the most negative attitude. The mean scores of the two groups were compared and the results are shown in Table VIII. Three of the four questions had a significant difference between student and teacher attitudes. The computed t values of question 6 (hypothesis 6), question 24 (hypothesis 8), and question 25 (hypothesis 9), called the rejection of the null hypotheses. The mean attitude scores of the teachers for the three questions were higher than the students' mean attitude scores. The students' mean attitude score was higher for question 23 (hypothesis 7), and the computed t value called

for accepting the null hypothesis.

TABLE VIII

COMPARISON OF STUDENT AND TEACHER ATTITUDES TOWARDS COMPUTER AND WATER EDUCATION

Questions	Evaluators	No.	Mean	t	Sig.
Question 6	Students	110	2.22	2.9	0.0141
	Teachers	10	1.4		
Question 23	Students	107	1.99	-1.33	0.2134
	Teachers	10	2.5		
Question 24	Students	107	2.26	2.82	0.0162
	Teachers	10	1.6		
Question 25	Students	107	2.48	2.31	0.0400
	Teachers	10	1.9		

A low mean score equals the most positive answer.

Table IX shows the frequencies and percentages of responses given on questions 6, 23, 24, and 25 by teachers and the experimental group. The five responses range from answer number one "strongly agree" to answer number five "strongly disagree."

TABLE IX

FREQUENCIES AND PERCENTAGES OF RESPONSES ON QUESTIONS CONCERNING ATTITUDES OF STUDENTS AND TEACHERS ON COMPUTER EDUCATION AND WATER EDUCATION

Question		Responses					Total
		1	2	3	4	5	
6	Students						
	Freq.	25	49	26	7	3	110
	Percent	22.7	44.6	23.6	6.4	2.7	100
	Teachers						
	Freq.	8		2			10
	Percent	80.0		20.0			100
23	Students						
	Freq.	35	47	19	3	3	110
	Percent	32.7	43.9	17.8	2.8	2.8	100
	Teachers						
	Freq.	2	3	4		1	10
	Percent	20.0	30.0	40.0		10.0	100
24	Students						
	Freq.	19	46	37	5		110
	Percent	17.8	43.0	34.6	4.7		100
	Teachers						
	Freq.	5	4	1			10
	Percent	50.0	40.0	10.0			100
25	Students						
	Freq.	16	37	44	7	3	110
	Percent	15.0	34.6	41.1	6.5	2.8	100
	Teachers						
	Freq.	3	5	2			10
	Percent	30.0	50.0	20.0			100

On question six, (I feel comfortable using computer.), 80% of the teachers strongly agreed with the statement, while only about 23% of the students answered "strongly agree" on the same question. On question 23, (More time should be spent learning with computer software programs.), approximately 76% of the students agreed or strongly agreed with the statement while only 50% of the teachers strongly agreed with the statement. On question 24, (I think water education is important.), 50% of the teachers strongly agreed with the statement, while only about 18% of the students strongly agreed with the statement. On question 25, (I think water education should be taught in the schools.), 80% of the teachers agreed or strongly agreed to the statement, while only about 50% of the students agreed or strongly agreed with the same statement.

Correlation of Experimental Groups'
Mean Scores on Water Concern,
Water Knowledge, and
Software Evaluation

Hypotheses Ten, Eleven, and Twelve

Table X shows the results of testing for significant correlations between the experimental group's mean scores of water concern, water knowledge, and software evaluation for each program.

TABLE X

CORRELATION OF EXPERIMENTAL GROUPS' MEAN SCORES ON WATER CONCERN, WATER KNOWLEDGE, AND SOFTWARE EVALUATION

Program	No.	Test/ Mean Score	Pearson r	Prob. of Sig.
Hydrologic Cycle	31	Concern/Content 14.87 / 49.35%	0.277	0.131
		Concern/Evaluate 14.87 / 48.06	0.084	0.655
		Content/Evaluate 49.35%/ 48.06	0.221	0.233
Water Pollution	22	Concern/Content 17.36 / 70.91%	0.372	0.088
		Concern/Evaluate 17.36 / 48.41	0.436	0.042
		Content/Evaluate 70.91%/ 48.41	0.4	0.065
Water Cycle	13	Concern/Content 16.38 / 57.31%	-0.388	0.190
		Concern/Evaluate 16.38 / 43.85	-0.021	0.947
		Content/Evaluate 57.31%/ 43.85	-0.612	0.026
Water & Weather	21	Concern/Content 14.72 / 30.24%	0.575	0.013
		Concern/Evaluate 14.72 / 46.05	0.144	0.568
		Content/Evaluate 30.24%/ 46.05	0.475	0.030
Streams & Rivers	23	Concern/Content 15.78 / 78.62%	0.341	0.112
		Concern/Evaluate 15.78 / 51.0	-0.227	0.298
		Content/Evaluate 78.62%/ 51.0	0.462	0.026

In testing hypothesis ten, a significant positive correlation existed when the students mean water concern score was compared with their content score in the program Water and Weather. This called for rejecting the null hypothesis (P .05). The four other programs had positive correlations but the results called for accepting the null hypothesis.

In testing hypothesis eleven, a significant positive correlation existed when the students mean water concern score was compared with their mean evaluation score in the program Water Pollution. This called for rejecting the null hypothesis (P .05). The four other programs did not have significant correlations, therefore, the results called for accepting the null hypothesis. The program Water Cycle, and the program Streams and Rivers, had negative correlations.

In testing hypothesis twelve, significant correlations existed when the students mean content score of water knowledge was compared with their mean evaluation scores. The programs Water and Weather and Streams and Rivers had significant positive correlations while the program Water Cycle had a significant negative correlation. These three programs called for the rejection of the null hypothesis. The program Hydrologic Cycle, and the program Water Pollution, both had a positive correlation but neither value was significant.

Correlation of Control Groups' Mean Water Concern Score and Mean Water Knowledge Percentage Score

Hypothesis Thirteen

Table XI shows the results of testing for significant correlations between the control groups' mean water concern score and mean water knowledge percentage score for each program.

TABLE XI

CORRELATION OF CONTROL GROUPS' MEAN WATER CONCERN SCORE AND MEAN WATER KNOWLEDGE PERCENTAGE SCORE

Program	No.	Test/ Mean Score	Pearson r	Prob. of Sig.
Hydrologic Cycle	118	Concern/Content 14.42 / 34.79%	0.26	0.004
Water Pollution	31	Concern/Content 16.23 / 48.39%	0.476	0.007
Water Cycle	34	Concern/Content 15.18 / 46.91%	0.132	0.457
Water & Weather	77	Concern/Content 15.88 / 44.87%	0.367	0.001
Streams & Rivers	79	Concern/Content 15.13 / 39.35%	0.233	0.039

In testing hypothesis thirteen, all programs had a positive correlation when the students mean water concern was compared with their mean content percentage score. In all programs except the Water Cycle, there was a significant correlation, therefore, the results called for rejecting the null hypothesis (P .05). The results of the correlation for the program Water Cycle, call for accepting the null hypothesis.

Comparison of Teacher's Predicted Content Scores and Actual Student Performances

Research Question Three

Each computer program's objectives were measured by a series of test questions. Teachers were given these test items and asked to predict the percent of correct responses they would expect from high school students. Correct responses were predicted for students never using the water software and for students who took the test after using the computer software. The percent of predicted correct responses were categorized in the following groups:

1. 90 - 100%
2. 75 - 89%
3. 60 - 74%
4. 31 - 59%
5. 0 - 30%

Each test question percent correct category predicted by the teacher was compared with the actual percent category

achieved by the users and non-users of the water software. The proportion of test items where the students' performances had equal, higher, and lower scores than of those predicted by the teacher are reported in Table XII.

TABLE XII

SHIFT IN TEACHER PREDICTED AND ACTUAL PERCENT CATEGORIES BY PROGRAM

Program	Before Program Pred. vs. Actual Stud. Performance			After Program Pred. vs. Actual Stud. Performance		
	% Equal	% Higher	% Lower	% Equal	% Higher	% Lower
Hydrologic Cycle	32	20	47.5	15	5	80
Water Pollution	25	45	30	35	0	65
Water Cycle	30	20	50	10	5	85
Water & Weather	35	40	25	2.5	0	87.5
Streams & Rivers	41.6	33.3	25	22.2	44.4	33.3

Teachers' prediction of high school students performance where computer software had not been used shows no dominant pattern. Generally, teacher estimates were congruent with student performance about one third of the time.

When the student has used the water software, however,

teacher prediction of achievement and actual student achievement are considerably different. Four of the five water programs show students performing considerably lower than teachers predicted. In all cases, the proportion of students scoring lower than predicted increased with use of the water education software.

CHAPTER V

SUMMARY, FINDINGS, AND RECOMMENDATIONS

Summary

This study has (1) identified the microcomputer water information dissemination software available on the market place, (2) identified the criteria commonly used to evaluate microcomputer software, and (3) determined that microcomputer software programs in water education for high school students:

A. Influence attitude toward water resources.

B. Increase water knowledge.

C. Are viewed differently by students and teachers.

Findings

Available Water Education Software

Research question one was attempting to find out how many water education software programs are available in the current market place for educational purposes. An extensive computer and hand library search identified only 19 water education microcomputer programs. Considering the importance, depth, and breadth of the conceptual schemes associated with water, this small number of computerized water

education software is surprising. And when taking into consideration the conclusion from the assessement of software done by (EPIE), that only one in twenty programs is of high quality; leaves the amount high quality water education software existing for use in the classroom very questionable.

Computer Software Evaluation Criteria

Research question two was attempting to answer what common criteria are used on microcomputer software evaluation forms. The evaluation forms used in the study differed greatly in their format. But, analysis of the criteria used to evaluate educational software revealed considerable continuity of criteria across the eleven different forms studied. The uniformity of criteria being used nationally makes the results of this study readily exportable to other educational contexts.

Comparison of Water Software Users with Non-users

Hypothesis one was tested to determine if exposure to water education software influenced concern for water issues. A comparison of high school student water software users' with non-users' scores on the Watson Water Concern Scale indicated that overall there was a higher score for users. The slight increase in mean scores is statistically significant at the 0.054 level of confidence (Table II). This finding (although not at p .05 level) indicates that use of

the water software increased the level of concern over water issues. In testing water concern for each program (hypothesis two), the program Water Pollution, had the highest mean water concern score (Table III). The difference in user vs. non-user mean score was significant at the 0.0003 level of confidence. These results infer that this water software program was responsible for the overall higher water concern mean score for users. Considering the need for a sound water conservation ethic, as well as an informed public on water knowledge, Water Pollution represents a promising educational information dissemination tool.

Hypothesis three was tested to determine if the use of water educational microcomputer programs influenced high school students' level of water knowledge. Mean scores on the knowledge test were compared by program. Increased mean scores on the programs, Hydrologic Cycle, Water Pollution, and Streams and Rivers, were statistically significant at least at the 0.0002 level of confidence (Table IV). An anomaly exists in that the users of the program, Water and Weather, did worse than non-users. The 21 students using the program, Water and Weather, responded disproportionally low. Four of the five programs show higher user mean scores. It can be concluded that, except for the Water and Weather program, these programs do teach water concepts to high school students. It must be noted, however, that the number questions asked per program were not equal. The number of questions in sequence of how the programs are listed in Table

IV are 20, 10, 20, 20, and 12 respectively. Thus non-users, a random sample of high school students, responded correctly less than 50% of the time; this indicates low levels of water knowledge possessed by high school students and supports prior research indicating this fact.

Teacher and Student Program Evaluation

Hypothesis four was tested to determine if teachers and high school students evaluate water software equally. The mean evalution score of 110 student users of the software was compared with that of ten high school teachers. Only a 0.26 difference in mean scores existed. This was not a significant figure and the computed t value called for accepting the null hypothesis (Table V). When mean evaluation scores were compared by program (Hypothesis five), the two programs evaluated as best by students were the same two evaluated lowest by teachers (Table VI and VII).

Attitudes Towards Computer Education and Water Education

Hypotheses six, seven, eight, and nine were tested to determine if teachers' and students' attitudes towards computer education and water education were congruent. Comparison of mean scores showed that on three of the four questions, teachers had a more positive attitude. The three questions were: (6) I feel comfortable using computers., (24) I think water education is important., and (25) I think

water education should be taught in the schools.

On question 23, "More time should be spent learning with computer software programs.", the students had a more positive attitude. The results shown in Table III would seem to be as expected. For instance, when looking at question 6, the teachers had to have access to computers in order to participate in the study, and therefore, those techers would most likely be familiar with computers and have a more positive attitude towards using computers than students.

When considering question 24 and 25, the teachers used in the study were all science teachers and most certainly would have been taught in their training, water education concepts. Therefore, the teacher would have the greater knowledge of water concepts and possess a greater concern for water education.

When considering question 23, articles have mentioned that computers generally attract students and maintain their interest for longer periods of time; and this statement would therefore, agree with the results that students think more time should be spent using computer software programs.

Table IX shows the actual frequencies and percentages of responses given on questions 6, 23, 24, and 25 by teachers and the experimental group. The data in Table IX is more specific and it also shows the same results as Table VIII.

Correlations of Software User Scores

Hypotheses ten, eleven, and twelve were tested to deter-

mine if any correlations existed between the student users' (experimental group), mean scores of the water concern test, water knowledge test, and the software evaluation for each program. The highest correlation of any of the comparisons was not above a 0.65 correlation, but there were significant correlations. A significant correlation existed when the students mean water concern score was compared with their mean percentage content score in the program, Water and Weather. Both mean scores were the lowest of all programs. This significant correlation suggests that students with a low content score will also have a low water concern score or vise-versa.

A significant correlation existed when the students mean water concern score was compared with their mean evaluation score in the program, Water Pollution. The mean water concern score was the highest score for all of the programs and the evaluation score was second highest for all programs. This significant correlation suggests that students with a high evaluation score of the program will also have a high content score or vise-versa.

Significant correlations existed when students mean percentage content score was compared with their mean evaluation score in the programs, Streams and Rivers, Water and Weather, and Water Cycle. The Streams and Rivers program had the highest mean scores of all programs. This significant correlation suggests that students with a high evalution score will also have a high water concern score. The pro-

gram, Water Pollution also had this positive correlation (.4), but (.4) was not significant at the 0.05 level of confidence ($p = 0.065$). The Water and Weather program had the lowest mean percentage content score and the second lowest mean evaluation score. This significant correlation also suggests that students with a low evaluation score will also have a low content score. The scores of the Water Cycle program were similar with the Water and Weather program. The results shown in Table X do suggest that water education software programs with high evaluations by students, have educational value.

Correlations of Non-users Scores

Hypothesis thirteen was tested to determine if any correlations existed between the control groups' mean water concern scores and their mean water knowledge percentage scores. Table XI shows that the correlations on all but the Water Cycle program were significant. These significant correlations suggest that with the control group population used in this study whose mean content score was high, would also have a high water concern score and this would not be do to chance.

Comparison of Teachers' Predicted and Actual Student Performance

Research question three attempted to identify if a congruence existed between what teachers predicted students

learned from software instruction and what the students actually learned. For each test of a content based question, teachers, following review of the software, predicted the percent of high school students that would answer the question correctly before using the program and after using the program. Students were then asked these questions and their responses compared with those predicted by the teacher. This was done for both student users and non-users of the software.

Table XII shows a relative low congruence between what non-users of the software know and what teachers predicted. Only about 1/3 of the time was there a congruence between teacher prediction and actual percentage students answered correctly in the same category. What high school students know about the water resources is not readily apparent to teachers!

The estimated influence of four of the five water computer programs was judged excessively high by teachers. On these programs, over 60 percent of the time, students' knowledge was lower than that estimated by the teacher. Teachers had considerably more faith in the ability of the computer to teach than was warrented! This is perhaps due to the view of computers and capabilities presented in the media.

The programs Water Pollution and Streams and Rivers stand out. They had the highest level of student/teacher congruence and the lowest proportion of students doing worse than predicted. These two programs appear to live up to

teacher expectations more than the others.

Recommendations

One of the main goals of educational computing in science is for educators and software developers to combine their efforts to produce the best possible software for use in the classroom and at the same time have it be most effective in helping students learn important decision making processes. In this study a list was developed which identified all current information disseminating microcomputer software related to water for high school students. The importance of teachers to have such knowledge at their finger-tips could greatly increase the individual teacher's ability to select and implement this type of instructional software into the classroom. Software developers could also use this information to assist them in improving the current water software on the market and to developing new software in areas of water education which have not been developed into software programs. There is a need to develop high quality software dealing with topics within broad areas such as the water cycle, physical properties of water, public use of water, types of water pollution, effects of water pollution, treatment of water pollution, and management of water resources.

This study has also shown that many software evaluation forms exist. The study has developed a list of the common evaluation criteria used on the forms. There is a need for

such criteria to appear on a single evaluation form which could be used by all evaluaters of educational software. Such a form could also be used by software developers to insure that the software they create will satisfy as many of the criteria appearing on the common evaluation form as possible. If developers of educational software knew what was the most acceptable software program to produce and what software would get a high rating by educators using a common evaluation form, the quality of software would certainly improve.

Most evaluations of educational software are performed by teachers, educators, and producers of software. Even if a common evaluation form was developed for software evaluation, there is still a need for software to be tested and evaluated by students. A greater difference in teacher prediction of software effectiveness and actual student achievement may occur. Also, there exists a possibility that students may be the better evaluators of the software. The results of this study showed that teachers did not predict the students performances accurately. Also the results showed that the Water Pollution program and the Streams and Rivers program were evaluated high by students using criteria commonly used for this purpose by professionals. High school students are apparently good judges of what is educationally sound water education software. The two programs they rated high using the professional criteria were also those that apparently can increase their concern for water issues and substantially

increase their knowledge. The same two programs also had the highest student/teacher congruence. The Hydrologic Cycle program also increased water concern levels, but the Water Pollution program in particular showed this ability. If students are good judges of what appears to be quality software as this study has shown, should not all software be evaluated by students. It should be recommended that all software go through a two step evaluation process before it is used in the classroom. First, software should be evaluated by educators using a common evaluation form and second, the software should be evaluated by students.

The most effective software packages appear to be the Water Pollution Program and the Streams and Rivers program. This study appears to show that some water education microcomputer software programs can significantly increase both water knowledge and concern for water issues. A question which still needs to be mentioned is, are these significant differences enough to be judged educationally significant, and if so should these programs be purchased for use in the classroom?

The Water Pollution program was a simulation type program. Students were asked to enter data affecting the amount of pollution entering a body of water and the program would then show the affects of the pollution on aquatic organisms. The results of the water pollution were shown on graphs and tables. The review of literature has shown that simulation computer programs are effective information

dissemination tools.

The Streams and Rivers program was a basic informational type program which used many graphics. At the end of the instruction part, a test was given over the subject matter. Possibly, because of its simplicity, the students did well on this program. The Hydrologic Cycle program had a format similar to the Streams and Rivers program, but it was a much more lengthy and elaborate program. This may have caused the students to rank the program poorly.

The Water Cycle program also had a informational type format. It also had explanations of simple experiments which could be performed. The program would process the data entered into the program and give the results in numerical expressions. This program, however, had two disks which had to be acessed from one disk to another. There was some type system error in this procedure which may have made it difficult for students and teachers to use the program. This system error may may have caused the poor rating of the program. There was also less data obtained on this program, which may have led to less accurate results.

The Water and Weather program was a tutorial and gaming program. A possible low ranking by the students on this program, could be the fact, that the students were more attentive to the gaming aspect of the program and less attentive to the information presented in the program.

As a final recommendation, the Water Pollution program should be analyzed in greater detail. It appears that sim-

ulation type computer programs may be the best software to use as an information dissemination tools. The Water Pollution program appears to work in a similar fashion as the the program POLUT, described by Flowers (32). The program Water Pollution, allows students to interact with the computer and become more interested in the program. The program also enabled students to develop skills used in problem solving tasks. The POLUT program may have done the same. An explanation of why the water concern levels of the students were raised when the program, Water Pollution was used may be that the students had a better understanding of the Water Concern Scale questions as a result of use with the software. The Water Concern Scale questions dealt with making problem solving decisions about water resource issues as did the Water Pollution program. This program seems to have educational value and should be purchased and used in the classroom especially, when the mean water knowledge scores of non-users was below 50%. This of course assumes that the content on the water software programs is a representative sample of all water education concepts.

The results of the study also showed that students had a high interest in using microcomputer software programs. If the students show an interest in using microcomputers, and if they have low levels of water knowledge, perhaps, increasing use of microcomputers in the classroom would prove to be a benefit to education and using water software programs would increase students water knowledge so that important water

resource management decisions could be made as the students become members of the voting public.

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APPENDIXES

APPENDIX A

CATALOG SOURCES FOR COMPUTER SOFTWARE

Lathrop, A., Editor. The 1985 Educational Software Preview Guide. Califoria TECC Library & Microcomputer Center, San Mateo County Office of Education, Redwood City, CA, 1985.

MENU--The International Software DataBase. The Software Catalog 1985/86. Elsevier Science Publishing Co., Inc., New York, Amsterdam, Oxford.

NSTA, Supplement of Science Education Supplier, Computers/ Software, NSTA, Washington, D.C., 1985.

Systems Development Department. The Software Encyclopedia 1985/86. R.R. Bowker Company, New York and London, 1985.

APPENDIX B

WATER EDUCATION COMPUTER SOFTWARE FOR HIGH SCHOOL

Acid Rain. Diversified Educational Enterprises, Inc., 725 Main Street, Lafayette, IN 47901.

Density and Salinity of Water. Allen Woolway, Focus Media, Inc., 839 Stewark Avenue, P.O. Box 865, Garden City, NY 11530.

Water Budget, Earth Science Democomp Series. James Blake, Focus Media, Inc., 839 Stewark Avenue, P.O. Box 865, Garden City, NY 11530.

Weather and Climate, the Oceans, Earth Science Series 2. Media, Inc., 839 Stewark Avenue, P.O. Box 865, Garden City, NY 11530.

Fish and Fishing. Cambridge Development Laboratory, Inc., 1696 Massachusetts Avenue, Cambridge, MA 02138.

Ground Water, Earth Science Series. International Business Machines Corporation, P.O. Box 1328-S, Boca Raton, FL 33432.

*Hydrologic Cycle, Earth Science Series. Rita D. Haberlin and Patricia A. Kulda, International Business Machines Corporation, P.O. Box 1328-S, Boca Raton, FL 33432.

Life in the Oceans. Right On Programs, Division of Computeam, Inc., 140 E. Main Street, Huntington, NY 11743.

Moisture in the Atmosphere, Earth Science Series. International Business Machines Corporation, P.O. Box 1328-S, Boca Raton, FL 33432.

POLUT. Diversified Educational Enterprises, Inc., 725 Main Street, Lafayette, IN 479021.

Pond Ecology. Scott, Foresman & Co., 1900 East Lake Avenue, Glenview, IL 60025.

Reservoirs. Dorsett Educational Systems, Inc., P.O. Box 1226, Norman, OK 73070.

Rock & Water Cycle. Educational Computing System, Inc., 136 Fairbanks Road, Oak Ridge, TN 37830.

*Streams and Rivers, The Skies Above, The Waters Below. J. Marks, 1982, Aquarius People Materials, Inc., P.O. Box 128, Indian Rocks Beach, FL 33535.

*Randomly selected for inclusion in this study.

Surface Water, Earth Science Series. International Business Machines Corporation, P.O. Box 1328-S, Boca Raton, FL 33432.

The Oceans, The Skies Above, The Waters Below. J. Marks, 1982, Aquarius People Materials, Inc., P.O. Box 128, Indian Rocks Beach, FL 33535.

*Water Cycle. Nasco, 901 Janeville Avenue, Fort Atkinson, WI 53538.

*Water Pollution. Educational Materials and Equipment Co., P.O. Box 17, Pelham, NY 10803.

*Water & Weather Series, Morris Gartner, 1983, Focus Media, Inc., 839 Stewark Avenue, P.O. Box 865, Garden City, NY 11530.

*Randomly selected for inclusion in this study.

APPENDIX C

COMPUTER SOFTWARE EVALUATION

FORMS REVIEWED

A - CALIFORNIA LIBRARY MEDIA CONSORTIUM
Alexandria City Public Schools computer Software Evaluation Form

B - NATIONAL COUNCIL FOR TEACHERS IN MATHEMATICS
Software Evaluation Checklist

C - INDIANA CLEARINGHOUSE FORM COMPUTER EDUCATION
Northwest Consolidated Schools of Fairland & School of Library and Info Science IU

D - TEXAS EDUCATION COMPUTER COOPERATIVE
Courseware Evaluation Form

E - ARIZONA STATE UNIVERSITY COLLEGE OF EDUCATION
MICROCOMPUTER RESEARCH CLINIC
Microcomputer Software Review

F - MICROSIFT - NORTHWEST REGIONAL EDUCATIONAL LABORATORY
Courseware Discription

G - E.P.I.E. INSTITUTE
Microcomputer Courseware Evaluation Form

H - CALIFORNIA TECC SOFTWARE LIBRARY AND CLEARINGHOUSE
Evaluation of Instructional Courseware

I - CLEARINGHOUSE OF INFORMATION IN MICROCOMPUTER EDUCATION, OKLAHOMA STATE UNIVERSITY
Software Evaluation Form

J - SECTOR PROJECT, UTAH
Sector Courseware Evaluation Form

K - ALBERTA EDUCATION
Clearinghouse Evaluators' Guide for Microcomputer - Based Courseware

*Code used to denote source using specific criteria; see APPENDIX D.

APPENDIX D

COMMON EVALUATION CRITERIA

Evaluation Criteria	*ABCDEFGHIJK
Learning will happen	D G K
Practice is necessary/testing during program	C G K
Content is accurate, has soundness/validity	ABCD FG IJK
Content has educ. value and significance	-AB D FG IJK
Content is free from sterotypes	-AB FGH K
Well defined purpose & instructional focus	-AB FG I K
Content is clear & logical	ABC FG JK
Difficulty - designed for target audience	-A CD FGHIJK
and/or test students ability	**********
Graphics/color/sound are appropriately used	-AB FGH JK
Package is motivational, arouses interest	-A CD FGHIJK
Stimulates student creativity and /or	ABC F IJK
requires thought, student involvement	**********
Feedback is adequate	-ABCD FGH JK
Learner controls rate and sequence	-AB D FGHIJK
Learning may be extended to diff. situations	AB D G JK
Support materials are necessary	-AB DEFGHIJK
Support materials are comprehensive	A FG JK
Support materials are effective	A C FG JK
Info. displays are effectively organized	-ABCD FGH JK
No teacher intervention	-ABCD FG I K
Easy for teacher or student to use software	A D FGHIJK
Uses computers capabilities	A F H K
Program reliable in normal use	A H JK
Best group size	ABCDE G I K
Execution time	-ABCD G I K
Freedom from disruption by system errors	ABC GHI K
Simplicity of user input	B D JK
Campatability with other materials used	BC GHI K
and/or fits into curriculum	**********
Social characteristics-competition/cooperation	H K
Summary of student performance tests	BCDE G JK
Good directions	- B D GHI K
Meets objectives and/or goals	CD FGHIJK
Would repeat program	CD G
Prerequisite skills	C FG J
Rating the program	ABCDEFGHI K
Teacher controls data - input, output	HI K

- Criteria repeated most often on the evaluation forms and most suited for the evaluation of the five randomly selected programs by students and teachers.

*Code for source using this criteria

APPENDIX E

STUDENT NON-USER EVALUATION FORMS

STUDENT EVALUATION : PRETEST

Hydrologic Cycle

The questions you are about to answer are about water. You will not be graded on your answers, therefore, your name is not required. Scores will be averaged and compared. It is important that you answer each question to the best of your knowledge.

DIRECTIONS: Please write Student Pretest where your name would be on the answer sheet and then answer the following questions and statements by marking the appropriate letter on the computer sheet.

1. I am taking test form (see title) (A) Teacher Evaluation (B) Student Evaluation : Post Review (C) Student Evaluation : Pretest

2. The test I am taking is (see subtitle) (A) Hydrologic Cycle (B) Water Pollution (C) Water Cycle (D) Water & Weather Series (E) Streams and Rivers.

3. My grade level is (A) 8th (B) 9th (C) 10th (D) 11th (E) 12th

4. The number of sciences classes I have had is (A) 1 (B) 2 (C) 3 (D) 4 (E) 5

5. We really haven't thought about cutting down our use of water. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

6. Water reclaimed from waste is as good as any other water. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

7. Mankind has a right to free and unlimited use of water. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

8. Nature has a way to solve water supply problems before they get serious. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

9. It's the people who should do something about the water problem. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

10. What is the source of energy for the hydrologic cycle? (A) Gravity (B) Radioactivity (C) The sun (D) Water (E) Mountain building

11. Which of the following is not a part of the hydrologic cycle? (A) Lithosphere (B) Biosphere (C) Atmosphere (D) Oceans (E) Mantle

12. What is the process that passes water through the pores of plants? (A) Evaporation (B) Percolation (C) Outgassing (D) Transpiration (E) None of these

13. What is the entrance of water into the soil called? (A) Porosity (B) Capillarity (C) Infiltration (D) Permeability

14. Approximately how much of the earth's total water supply is found in the ocean? (A) 30% (B) 50% (C) 75% (D) 97%

15. Which of the following makes up about 2% of the total earth's water supply? (A) Freshwater lakes (B) Rivers (C) The soil (D) Glaciers and icepacks (E) Ground water

16. Which of the following contains more water than all of the world's rivers? (A) Glaciers and icepacks (B) The ground (C) Lakes (D) All of the above

17. What happens whenever water changes from the gaseous state to the liquid state? (A) Heat is released. (B) Heat is absorbed. (C) Water is evaporated. (D) Only B and C occur.

18. How does water make its way from the ocean to land areas? (A) By evaporation and runoff (B) By ground water runoff and surface runoff (C) By evaporation, condensation, and precipitation (D) By evapotranspiration and precipitation

19. What happens to most of the water that falls as rain? (A) It stays in the soil. (B) It runs off the land in streams. (C) It returns to the atmosphere by evapotranspiration. (D) It sinks into the ground water zone.

20. What is the source of water for the underground zone? (A) Lakes (B) Precipitation (C) Rivers (D) Springs

21. What is the average annual rainfall over the continental United States? (A) 10 inches (B) 20 inches (C) 30 inches (D) 40 inches (E) 50 inches

22. From where does metropolitan Los Angeles obtain its water? (A) Northern California (B) The Colorado River (C) Owens Valley and Mono Lake Basin (D) Ground water (E) All of the above

23. Which section of California receives the most rainfall? (A) The southern third (B) The Central Valley (C) The northern third

24. Which section of the United States receives the most rainfall? (A) The western states (B) The eastern states

25. Which section of the United States consumes the most water? (A) The West (B) The East

26. Which of the following consumes water that is withdrawn? (A) Irrigation (B) Public Water Supply (C) Hydropower (D) Industrial cooling

27. Which of the following withdraws the most water? (A) Public water supply (B) Industry (C) Irrigation (D) Recreation

28. What is the amount of per capita domestic (in-home) water use in the United States? (A) 2000 gallons a day (B) 90 gallons a day (C) 300 gallons a day (D) 1000 gallons a day

29. Which of the following has occurred in this century, partly as a result of human activities? (A) Glaciers have expanded. (B) Sea level has risen. (C) More water sink into the ground wate zone. (D) All of the above have occurred.

STUDENT EVALUATION : PRETEST

Water Pollution

The questions you are about to answer are about water. You will not be graded on your answers, therefore, your name is not required. Scores will be averaged and compared. It is important that you answer each question to the best of your knowledge.

DIRECTIONS: Please write Student Pretest where your name would be on the answer sheet and then answer the following questions and statements by marking the appropriate letter on the computer sheet.

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2. The test I am taking is (see subtitle) (A) Hydrologic Cycle (B) Water Pollution (C) Water Cycle (D) Water & Weather Series (E) Streams and Rivers.

3. My grade level is (A) 8th (B) 9th (C) 10th (D) 11th (E) 12th

4. The number of sciences classes I have had is (A) 1 (B) 2 (C) 3 (D) 4 (E) 5

5. We really haven't thought about cutting down our use of water. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

6. Water reclaimed from waste is as good as any other water. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

7. Mankind has a right to free and unlimited use of water. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

8. Nature has a way to solve water supply problems before they get serious. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

9. It's the people who should do something about the water problem. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

10. As the temperature of a body of water decreases dissolved oxygen levels (A) decrease (B) increase (C) remain the same (D) decrease then increase.

11. Before stocking a lake with game fish, what is the most important factor to check? (A) Dissolved oxygen content (B) Water temperature (C) Rate of flow (D) Type of waste being dumped

12. As the flow rate of a body of water decreases the dissolved oxygen levels (A) decrease (B) increase (C) remain the same (D) increase and then decrease.

13. BOD is an abbreviation for (A) beneficial organic decay (B) biochemical oxygen demand (C) biological organic decomposition (D) benethic oxidation and decay.

14. All of the following are true about water except it (A) is found in all living things (B) can contain dissolved gases and minerals (C) is most dense at 0 degrees Celsius (D) can be treated to remove harmful matter.

15. As the concentration of organic wastes in a body of water increases the BOD (A) decreases (b) increases (C) stays the same (D) increases then levels off.

16. Which body of water has the highest BOD? (A) 1 degree Celsius lake with 5 ppm of secondary treated industrial waste (B) 1 degree Celsius slow river with 5ppm of primary treated sewage (C) 20 degree Celsius fast river with 13pp of untreated industrial waste (D) 20 degree Celsius pond with 15pp of untreated sewage.

17. Organisms that decompose wastes even after the dissolved oxygen level drops to 0 are (A) Anaerobic (can do without oxygen) (B) Aerobic (need oxygen) (C) undergoing respiratory distress (D) in need of secondary treatment.

18. Most game fish die in bodies of water with dissolved oxygen levels of less than (A) 3 ppm (parts per million) (B) 5 ppm (C) 10 ppm (D) 14 ppm.

19. Secondary treatment of wastes before dumping into waterways is more desirable than just primary treatment because (A) it kills harmful microorganisms (B) it keeps the BOD low (C) none of the above (D) both A and B

STUDENT EVALUATION : PRETEST

The Water Cycle

The questions you are about to answer are about water. You will not be graded on your answers, therefore, your name is not required. Scores will be averaged and compared. It is important that you answer each question to the best of your knowledge.

DIRECTIONS: Please write Student Pretest where your name would be on the answer sheet and then answer the following questions and statements by marking the appropriate letter on the computer sheet.

1. I am taking test form (see title) (A) Teacher Evaluation (B) Student Evaluation : Post Review (C) Student Evaluation : Pretest

2. The test I am taking is (see subtitle) (A) Hydrologic Cycle (B) Water Pollution (C) Water Cycle (D) Water & Weather Series (E) Streams and Rivers.

3. My grade level is (A) 8th (B) 9th (C) 10th (D) 11th (E) 12th

4. The number of sciences classes I have had is (A) 1 (B) 2 (C) 3 (D) 4 (E) 5

5. We really haven't thought about cutting down our use of water. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

6. Water reclaimed from waste is as good as any other water. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

7. Mankind has a right to free and unlimited use of water. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

8. Nature has a way to solve water supply problems before they get serious. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

9. It's the people who should do something about the water problem. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

10. What is water? (A) H2 (B) H2O (C) H2SO4 (D) H2O2

11. At what temperature (Degrees Celsius) does water freeze? (A) -32 (B) 10 (C) 0 (D) 32

12. Water boils at what temperature (Degrees Celsius)? (A) 98.6 (B) 212 (C) 100 (D) 220

13. Is a summer sea breeze cooler than a land breeze? (A) yes (B) no

14. What part (%) of sunlight is reflected back to space by the air and clouds? (A) 50% (B) 30% (C) 20% (D) 10%

15. What is a monsoon? (A) a heavy rain (B) an onshore wind (C) a strong dry wind (D) a big storm

16. What part (%) of rainfall is evaporated from the soil and plants? (A) 5% (B) 64% (C) 79% (D) 31%

17. What part (%) of rainfall runs off directly to the rivers? (A) 25% (B) 5% (C) 10% (D) 52%

18. If the Antartic Ice Cap melts the sea will rise by... (A) 3 meters (B) 1 meter (C) 30 to 60 meters (D) 5 to 6 meters

19. When air rises... (A) it becomes cooler. (B) it doesn't change temperature. (C) it becomes warmer. (D) it becomes drier.

20. Air currents travel from... (A) low pressure to high pressure. (B) not at all (C) high pressure to low pressure. (D) north to south.

21. Does air heat up faster over... (A) a bog. (B) the water. (C) the soil. (D) Air heats up equally over all areas.

22. Would air pressure be higher over... (A) a mountain top (B) a warm part of the surface (C) pressure isn't changed by temperature (D) A cool part of the surface

23. Does water evaporate faster at... (A) room temperature (B) high temperatures (C) low temperatures (D) temperature does not matter

24. Which affects evaporation? (A) heat (B) both light and heat (C) light (D) pressure

25. Can water evaporate at a temperature below its boiling point? (A) yes (B) no

26. Energy from the sun causes seawater... (A) to become saltier (B) solar energy does not effect the sea (C) to become less salty (D) to sink

27. If the same amount of heat escapes as is absorbed--the temperature... (A) rises (B) falls (C) remains the same (D) rises then falls

28. In the northern hemisphere an anticyclone rotates... (A) clockwise (B) they don's rotate at all (C) counterclockwise (D) north to south

29. Typical thunderstorms have... (A) wind, rain, and clouds (B) heavy rains (C) clouds (D) strong winds

STUDENT EVALUATION : PRETEST

Water & Weather Series

The questions you are about to answer are about water. You will not be graded on your answers, therefore, your name is not required. Scores will be averaged and compared. It is important that you answer each question to the best of your knowledge.

DIRECTIONS: Please write Student Pretest where your name would be on the answer sheet and then answer the following questions and statements by marking the appropriate letter on the computer sheet.

1. I am taking test form (see title) (A) Teacher Evaluation (B) Student Evaluation : Post Review (C) Student Evaluation : Pretest

2. The test I am taking is (see subtitle) (A) Hydrologic Cycle (B) Water Pollution (C) Water Cycle (D) Water & Weather Series (E) Streams and Rivers.

3. My grade level is (A) 8th (B) 9th (C) 10th (D) 11th (E) 12th

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6. Water reclaimed from waste is as good as any other water. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

7. Mankind has a right to free and unlimited use of water. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

8. Nature has a way to solve water supply problems before they get serious. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

9. It's the people who should do something about the water problem. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

10. When the rate of condensation is equal to the rate of evaporation, the air is said to be...
(A) supersaturated (B) supercooled (C) saturated
(D) unsaturated.

11. Evaporation takes place most slowly when the air is...
(A) humid (B) dry (C) saturated (D) hot.

12. As the temperature decreases, the amount of dew...
(A) varies (B) increases (C) stays the same
(D) decreases.

13. You have a glass filled with ice-cold soda pop. Moisture will appear most quickly on a day which is...
(A) warm and dry (B) cold and dry (C) warm and humid
(D) cold and humid.

14. As the amount of cloud cover increases, the rate of evaporation from the earth's surface will...
(A) increase (B) decrease (C) stay the same (D) vary.

15. Which in not an example of evaporation? (A) gaseous water forming from liguid water (B) cooling of your skin after a swim (C) water boiling (D) cloud formation from water vapor

16. The ability of the atmosphere to hold water vapor is determined by its... (A) humidity (B) oxygen content (C) pressure (D) temperature.

17. If the amount of moisture in the air increases while the temperature remains the same, the realitive humidity will... (A) decrease (B) vary upwards or downwards (C) increase (D) remain constant.

18. Where would you normally find the greatest difference in temperature readings between the wet and dry-bulb thermometers of a psychomemeter? (A) the seashore (B) an inland city (C) a tropical rain forest (D) the desert

19. The liquid inside a wet-bulb thermometer is...
(A) cobalt chloride (B) water (C) alcohol (D) mercury

20. Dew point is measured in... (A) liters (B) grams (C) percent (D) degrees.

21. The air contains the smallest amount of water vapor during... (A) Fall (B) Spring (C) Summer (D) Winter.

22. A humid day is one which is... (A) is hot (B) has a lot of moisture in the air (C) is foggy (D) is rainy.

23. Snow crystals have... (A) 10 sides (B) 8 sides (C) 6 sides (D) 4 sides.

24. The process of changing gaseous water to liquid water is called... (A) precipitation (B) condensation (C) sublimation (D) evaporation.

25. Most high clouds are made of... (A) condensation nuclei (B) water droplets (C) ice crystals (D) water vapor.

26. Approximately how many cloud droplets are equal to the size of a raindrop? (A) 1 thousand (B) 1 hundred (C) 10 (D) 1 million

27. One centimeter of rain is equivalent to about... (A) 100 centimeters of snow (B) 10 centimeters of snow (C) 1 centimeter of snow (D) 2 centimeters of snow.

28. If the temperature remains at zero degrees C. or below from the clouds all the way down to the ground, any precipitation will be in the form of... (A) sleet (B) glaze (C) wet snow (D) dry snow.

29. Which represents the correct order of cloud formation? The moist air... (A) evaporates - rises - cools to dew point - condenses (B) cools to dew point - rises - evaporates - condenses (C) rises - cools to dew point - evaporates - condenses (D) evaporates - cools to dew point - rises - condenses.

STUDENT EVALUATION : PRETEST

Streams and Rivers

The questions you are about to answer are about water. You will not be graded on your answers, therefore, your name is not required. Scores will be averaged and compared. It is important that you answer each question to the best of your knowledge.

DIRECTIONS: Please write Student Pretest where your name would be on the answer sheet and then answer the following questions and statements by marking the appropriate letter on the computer sheet.

1. I am taking test form (see title) (A) Teacher Evaluation (B) Student Evaluation : Post Review (C) Student Evaluation : Pretest

2. The test I am taking is (see subtitle) (A) Hydrologic Cycle (B) Water Pollution (C) Water Cycle (D) Water & Weather Series (E) Streams and Rivers.

3. My grade level is (A) 8th (B) 9th (C) 10th (D) 11th (E) 12th

4. The number of sciences classes I have had is (A) 1 (B) 2 (C) 3 (D) 4 (E) 5

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8. Nature has a way to solve water supply problems before they get serious. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

9. It's the people who should do something about the water problem. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

10. The greatest amount of rain falls at... (A) higher elevations (B) lower elevations.

11. In the eastern United States most rivers flow toward the (A) Atlantic Ocean (B) Gulf of Mexico (C) Pacific Ocean (D) both A and B (E) both B and C.

12. In the western United States most rivers flow toward the (A) Atlantic Ocean (B) Pacific Ocean (C) Mississippi River (D) both A and C (E) both B and C.

13. A feature which appears at the bottom of a waterfall is a... (A) delta (B) deposit (C) pothole (D) meander

14. During heavy rainstorms, water sometimes gradually erodes the tops of waterfalls causing them to become longer. This process is called... (A) headward erosion (B) headward deposition (C) meandering (D) braiding.

15. Waterfalls usually develop in places where... (A) softrock overlays hardrock (B) hardrock alone exists (C) hardrock overlays softrock (D) softrock alone exists.

16. When a river meets an ocean or lake what is the feature that often forms? (A) seamount (B) meander (C) pothole (D) delta

17. If a stream flows through a raised sandy area what type of stream occurs? (A) waterfall (B) headward erosional stream (C) meandering stream (D) braided stream

18. A river in flat area with no mountains will tend to be a (A) braided river (B) meandering river (C) waterfall (D) headward erosional river.

19. In a meandering stream, deposition occurs on (A) the high outside bank (B) the low inside bank (C) both A and B (D) neither bank.

20. In a meandering stream, erosion takes place on (A) the high outside bank (B) the low inside bank (C) both A and B (D) neither bank.

21. A double delta may form... (A) after a flood (B) when the sea level changes (C) when a river changes course (D) all of the above.

APPENDIX F

STUDENT USER EVALUATION FORMS

STUDENT EVALUATION : POST REVIEW

Hydrologic Cycle

The questions you are about to answer are about water. You will not be graded on your answers, therefore, your name is not required. Scores will be averaged and compared. It is important that you answer each question to the best of your knowledge.

DIRECTIONS: Please write POST REVIEW where your name would be on the answer sheet and then answer the following questions and statements by marking the appropriate letter on the computer sheet. Answer questions 1-6 before previewing the program.

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3. The number of science classes I have had is (A) 1 (B) 2 (C) 3 (D) 4 (E) 5 or more.

4. My previous experience on a computer is (A) 0 to 20 hours (B) 21 to 40 hours (C) 41 to 60 hours (D) 61 to 80 hours (E) over 81 hours.

5. How many educational microcomputer programs have you used or seen in your classes prior to this program? (A) 0 (B) 1 to 3 (C) 4 to 6 (D) 7 to 9 (E) 10 or more

6. I feel comfortable using computers. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

Please answer the following questions after running the program.

7. The computer software that I am working with is on (A) IBM Hydrologic Cycle (B) APPLE Water Pollution (C) APPLE Water Cycle (D) APPLE Water & Weather Series (E) APPLE Streams and Rivers.

8. This was a high quality program compared to others you have used or seen. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

9. I enjoyed using this program. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

10. I would share this information with a friend. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

11. What grade level do you think this material is appropriate for? (A) 4th and 5th (B) 6th and 7th (C) 8th and 9th (D) 10th and 11th (E) 12th or more.

12. There was enough visual material (graphics) to help me. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

13. The length of the program is appropriate for a single lesson or class period. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

14. I was able to control the rate and sequence of presentation and review. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

15. I was able to operate the program without teacher assistance. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

16. The directions were easy to understand. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

17. My mistakes were explained for me. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

18. The content is free of race, ethnic, sex and other stereotypes. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

19. This computer program is as useful as other learning materials such as books, worksheets, charts, lectures and films. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

20. The books, worksheets, charts, etc. that came with the program were helpful. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

21. I find this program "exciting." (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

22. This program should be used in sciences classes.
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23. More time should be spent learning with computer software programs. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

24. I think water education is important. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

25. I think water education should be taught in the schools. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

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27. Water reclaimed from waste is as good as any other water. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disgree

28. Mankind has a right to free and unlimited use of water.
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29. Nature has a way to solve water supply problems before they get serious. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

30. It's the people who should do something about the water problem. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

31. What is the source of energy for the hydrologic cycle?
(A) Gravity (B) Radioactivity (C) The sun (D) Water
(E) Mountain building

32. Which of the following is not a part of the hydrologic cycle? (A) Lithosphere (B) Biosphere (C) Atmosphere (D) Oceans (E) Mantle

33. What is the process that passes water through the pores of plants? (A) Evaporation (B) Percolation
(C) Outgassing (D) Transpiration (E) None of these

34. What is the entrance of water into the soil called?
(A) Porosity (B) Capillarity (C) Infiltration
(D) Permeability

35. Approximately how much of the earth's total water supply is found in the ocean? (A) 30% (B) 50% (C) 75% (D) 97%

36. Which of the following makes up about 2% of the total earth's water supply? (A) Freshwater lakes (B) Rivers (C) The soil (D) Glaciers and icepacks (E) Ground water

37. Which of the following contains more water than all of the world's rivers? (A) Glaciers and icepacks (B) The ground (C) Lakes (D) All of the above

38. What happens whenever water changes from the gaseous state to the liquid state? (A) Heat is released. (B) Heat is absorbed. (C) Water is evaporated. (D) Only B and C occur.

39. How does water make its way from the ocean to land areas? (A) By evaporation and runoff (B) By ground water runoff and surface runoff (C) By evaporation, condensation, and precipitation (D) By evapotranspiration and precipitation

40. What happens to most of the water that falls as rain? (A) It stays in the soil. (B) It runs off the land in streams. (C) It returns to the atmosphere by evapotranspiration. (D) It sinks into the ground water zone.

41. What is the source of water for the underground zone? (A) Lakes (B) Precipitation (C) Rivers (D) Springs

42. What is the average annual rainfall over the continental United States? (A) 10 inches (B) 20 inches (C) 30 inches (D) 40 inches (E) 50 inches

43. From where does metropolitan Los Angeles obtain its water? (A) Northern California (B) The Colorado River (C) Owens Valley and Mono Lake Basin (D) Ground water (E) All of the above

44. Which section of California receives the most rainfall? (A) The southern third (B) The Central Valley (C) The northern third

45. Which section of the United States receives the most rainfall? (A) The western states (B) The eastern states

46. Which section of the United States consumes the most water? (A) The West (B) The East

47. Which of the following consumes water that is withdrawn? (A) Irrigation (B) Public Water Supply (C) Hydropower (D) Industrial cooling

48. Which of the following withdraws the most water? (A) Public water supply (B) Industry (C) Irrigation (D) Recreation

49. What is the amount of per capita domestic (in-home) water use in the United States? (A) 2000 gallons a day (B) 90 gallons a day (C) 300 gallons a day (D) 1000 gallons a day

50. Which of the following has occurred in this century, partly as a result of human activities? (A) Glaciers have expanded. (B) Sea level has risen. (C) More water sink into the ground wate zone. (D) All of the above have occurred.

STUDENT EVALUATION : POST REVIEW

Water Pollution

The questions you are about to answer are about water. You will not be graded on your answers, therefore, your name is not required. Scores will be averaged and compared. It is important that you answer each question to the best of your knowledge.

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30. It's the people who should do something about the water problem. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

31. As the temperature of a body of water decreases dissolved oxygen levels (A) decrease (B) increase (C) remain the same (D) decrease then increase.

32. Before stocking a lake with game fish, what is the most important factor to check? (A) Dissolved oxygen content (B) Water temperature (C) Rate of flow (D) Type of waste being dumped

33. As the flow rate of a body of water decreases the dissolved oxygen levels (A) decrease (B) increase (C) remain the same (D) increase and then decrease.

34. BOD is an abbreviation for (A) beneficial organic decay (B) biochemical oxygen demand (C) biological organic decomposition (D) benethic oxidation and decay.

35. All of the following are true about water except it (A) is found in all living things (B) can contain dissolved gases and minerals (C) is most dense at 0 degrees Celsius (D) can be treated to remove harmful matter.

36. As the concentration of organic wastes in a body of water increases the BOD (A) decreases (b) increases (C) stays the same (D) increases then levels oFf.

37. Which body of water has the highest BOD? (A) 1 degree Celsius lake with 5 ppm of secondary treated industrial waste (B) 1 degree Celsius slow river with 5ppm of primary treated sewage (C) 20 degree Celsius fast river with 13ppm of untreated industrial waste (D) 20 degree Celsius pond with 15ppm of untreated sewage

38. Organisms that decompose wastes even after the dissolved oxygen level drops to 0 are (A) Anaerobic (can do without oxygen) (B) Aerobic (need oxygen) (C) undergoing respiratory distress (D) in need of secondary treatment.

39. Most game fish die in bodies of water with dissolved oxygen levels of less than (A) 3 ppm (parts per million) (B) 5 ppm (C) 10 ppm (D) 14 ppm.

40. Secondary treatment of wastes before dumping into waterways is more desirable than just primary treatment because (A) it kills harmful microorganisms (B) it keeps the BOD low (C) none of the above (D) both A and B

STUDENT EVALUATION : POST REVIEW

The Water Cycle

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(D) unsaturated.

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(D) cold and humid.

35. As the amount of cloud cover increases, the rate of evaporation from the earth's surface will... (A) increase (B) decrease (C) stay the same (D) vary.

36. Which in not an example of evaporation? (A) gaseous water forming from liguid water (B) cooling of your skin after a swim (C) water boiling (D) cloud formation from water vapor

37. The ability of the atmosphere to hold water vapor is determined by its... (A) humidity (B) oxygen content (C) pressure (D) temperature.

38. If the amount of moisture in the air increases while the temperature remains the same, the realitive humidity will... (A) decrease (B) vary upwards or downwards (C) increase (D) remain constant.

39. Where would you normally find the greatest difference in temperature readings between the wet and dry-bulb thermometers of a psychomemeter? (A) the seashore (B) an inland city (C) a tropical rain forest (D) the desert

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47. Approximately how many cloud droplets are equal to the size of a raindrop? (A) 1 thousand (B) 1 hundred (C) 10 (D) 1 million

48. One centimeter of rain is equivalent to about...
(A) 100 centimeters of snow (B) 10 centimeters of snow
(C) 1 centimeter of snow (D) 2 centimeters of snow.

49. If the temperature remains at zero degrees C. or below from the clouds all the way down to the ground, any precipitation will be in the form of... (A) sleet
(B) glaze (C) wet snow (D) dry snow.

50. Which represents the correct order of cloud formation? The moist air... (A) evaporates - rises - cools to dew point - condenses (B) cools to dew point - rises - evaporates - condenses (C) rises - cools to dew point - evaporates - condenses (D) evaporates - cools to dew point - rises - condenses.

STUDENT EVALUATION : POST REVIEW

Water & Weather Series

The questions you are about to answer are about water. You will not be graded on your answers, therefore, your name is not required. Scores will be averaged and compared. It is important that you answer each question to the best of your knowledge.

DIRECTIONS: Please write POST REVIEW where your name would be on the answer sheet and then answer the following questions and statements by marking the appropriate letter on the computer sheet. Answer questions 1-6 before previewing the program.

1. I am taking test form (A) Teacher Evaluation (B) Student Evaluation : Post Rewiew (C) Student Evaluation : Pretest

2. My grade level is (A) 8th (B) 9th (C) 10th (D) 11th (E) 12th

3. The number of science classes I have had is (A) 1 (B) 2 (C) 3 (D) 4 (E) 5 or more.

4. My previous experience on a computer is (A) 0 to 20 hours (B) 21 to 40 hours (C) 41 to 60 hours (D) 61 to 80 hours (E) over 81 hours.

5. How many educational microcomputer programs have you used or seen in your classes prior to this program? (A) 0 (B) 1 to 3 (C) 4 to 6 (D) 7 to 9 (E) 10 or more

6. I feel comfortable using computers. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

Please answer the following questions after running the program.

7. The computer software that I am working with is on (A) IBM Hydrologic Cycle (B) APPLE Water Pollution (C) APPLE Water Cycle (D) APPLE Water & Weather Series (E) APPLE Streams and Rivers.

8. This was a high quality program compared to others you have used or seen. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

9. I enjoyed using this program. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

10. I would share this information with a friend. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

11. What grade level do you think this material is appropriate for? (A) 4th and 5th (B) 6th and 7th (C) 8th and 9th (D) 10th and 11th (E) 12th or more.

12. There was enough visual material (graphics) to help me. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

13. The length of the program is appropriate for a single lesson or class period. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

14. I was able to control the rate and sequence of presentation and review. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

15. I was able to operate the program without teacher assistance. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

16. The directions were easy to understand. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

17. My mistakes were explained for me. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

18. The content is free of race, ethnic, sex and other stereotypes. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

19. This computer program is as useful as other learning materials such as books, worksheets, charts, lectures and films. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

20. The books, worksheets, charts, etc. that came with the program were helpful. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

21. I find this program "exciting." (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

22. This program should be used in sciences classes.
(A) strongly agree (B) agree (C) neutral
(D) disagree (E) strongly disagree

23. More time should be spent learning with computer software programs. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

24. I think water education is important. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

25. I think water education should be taught in the schools. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

26. We really haven't thought about cutting down our use of water. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

27. Water reclaimed from waste is as good as any other water. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disgree

28. Mankind has a right to free and unlimited use of water.
(A) strongly agree (B) agree (C) undecided
(D) disagree (E) strongly disagree

29. Nature has a way to solve water supply problems before they get serious. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

30. It's the people who should do something about the water problem. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

31. What is water? (A) H2 (B) H2O (C) H2SO4 (D) H2O2

32. At what temperature (Degrees Celsius) does water freeze?
(A) -32 (B) 10 (C) 0 (D) 32

33. Water boils at what temperature (Degrees Celsius)?
(A) 98.6 (B) 212 (C) 100 (D) 220

34. Is a summer sea breeze cooler than a land breeze?
(A) yes (B) no

35. What part (%) of sunlight is reflected back to space by the air and clouds? (A) 50% (B) 30% (C) 20% (D) 10%

36. What is a monsoon? (A) a heavy rain (B) an onshore wind (C) a strong dry wind (D) a big storm

37. What part (%) of rainfall is evaporated from the soil and plants? (A) 5% (B) 64% (C) 79% (D) 31%

38. What part (%) of rainfall runs off directly to the rivers? (A) 25% (B) 5% (C) 10% (D) 52%

39. If the Antartic Ice Cap melts the sea will rise by... (A) 3 meters (B) 1 meter (C) 30 to 60 meters (D) 5 to 6 meters

40. When air rises... (A) it becomes cooler. (B) it doesn't change temperature. (C) it becomes warmer. (D) it becomes drier.

41. Air currents travel from... (A) low pressure to high pressure. (B) not at all (C) high pressure to low pressure. (D) north to south.

42. Does air heat up faster over... (A) a bog. (B) the water. (C) the soil. (D) Air heats up equally over all areas.

43. Would air pressure be higher over... (A) a mountain top (B) a warm part of the surface (C) pressure isn't changed by temperature (D) A cool part of the surface

44. Does water evaporate faster at... (A) room temperature (B) high temperatures (C) low temperatures (D) temperature does not matter

45. Which affects evaporation? (A) heat (B) both light and heat (C) light (D) pressure

46. Can water evaporate at a temperature below its boiling point? (A) yes (B) no

47. Energy from the sun causes seawater... (A) to become saltier (B) solar energy does not effect the sea (C) to become less salty (D) to sink

48. If the same amount of heat escapes as is absorbed--the temperature... (A) rises (B) falls (C) remains the same (D) rises then falls

49. In the northern hemisphere an anticyclone rotates... (A) clockwise (B) they don's rotate at all (C) counterclockwise (D) north to south

50. Typical thunderstorms have... (A) wind, rain, and clouds (B) heavy rains (C) clouds (D) strong winds

STUDENT EVALUATION : POST REVIEW

Streams and Rivers

The questions you are about to answer are about water. You will not be graded on your answers, therefore, your name is not required. Scores will be averaged and compared. It is important that you answer each question to the best of your knowledge.

DIRECTIONS: Please write POST REVIEW where your name would be on the answer sheet and then answer the following questions and statements by marking the appropriate letter on the computer sheet. Answer questions 1-6 before previewing the program.

1. I am taking test form (A) Teacher Evaluation (B) Student Evaluation : Post Rewiew (C) Student Evaluation : Pretest

2. My grade level is (A) 8th (B) 9th (C) 10th (D) 11th (E) 12th

3. The number of science classes I have had is (A) 1 (B) 2 (C) 3 (D) 4 (E) 5 or more.

4. My previous experience on a computer is (A) 0 to 20 hours (B) 21 to 40 hours (C) 41 to 60 hours (D) 61 to 80 hours (E) over 81 hours.

5. How many educational microcomputer programs have you used or seen in your classes prior to this program? (A) 0 (B) 1 to 3 (C) 4 to 6 (D) 7 to 9 (E) 10 or more

6. I feel comfortable using computers. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

Please answer the following questions after running the program.

7. The computer software that I am working with is on (A) IBM Hydrologic Cycle (B) APPLE Water Pollution (C) APPLE Water Cycle (D) APPLE Water & Weather Series (E) APPLE Streams and Rivers.

8. This was a high quality program compared to others you have used or seen. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

9. I enjoyed using this program. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

10. I would share this information with a friend. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

11. What grade level do you think this material is appropriate for? (A) 4th and 5th (B) 6th and 7th (C) 8th and 9th (D) 10th and 11th (E) 12th or more.

12. There was enough visual material (graphics) to help me. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

13. The length of the program is appropriate for a single lesson or class period. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

14. I was able to control the rate and sequence of presentation and review. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

15. I was able to operate the program without teacher assistance. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

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17. My mistakes were explained for me. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

18. The content is free of race, ethnic, sex and other stereotypes. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

19. This computer program is as useful as other learning materials such as books, worksheets, charts, lectures and films. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

20. The books, worksheets, charts, etc. that came with the program were helpful. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

21. I find this program "exciting." (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

22. This program should be used in sciences classes. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

23. More time should be spent learning with computer software programs. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

24. I think water education is important. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

25. I think water education should be taught in the schools. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

26. We really haven't thought about cutting down our use of water. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

27. Water reclaimed from waste is as good as any other water. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disgree

28. Mankind has a right to free and unlimited use of water. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

29. Nature has a way to solve water supply problems before they get serious. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

30. It's the people who should do something about the water problem. (A) strongly agree (B) agree (C) undecided (D) disagree (E) strongly disagree

31. The greatest amount of rain falls at... (A) higher elevations (B) lower elevations.

32. In the eastern United States most rivers flow toward the (A) Atlantic Ocean (B) Gulf of Mexico (C) Pacific Ocean (D) both A and B (E) both B and C.

33. In the western United States most rivers flow toward the (A) Atlantic Ocean (B) Pacific Ocean (C) Mississippi River (D) both A and C (E) both B and C.

34. A feature which appears at the bottom of a waterfall is a... (A) delta (B) deposit (C) pothole (D) meander

35. During heavy rainstorms, water sometimes gradually erodes the tops of waterfalls causing them to become longer. This process is called... (A) headward erosion (B) headward deposition (C) meandering (D) braiding.

36. Waterfalls usually develop in places where... (A) softrock overlays hardrock (B) hardrock alone exists (C) hardrock overlays softrock (D) softrock alone exists.

37. When a river meets an ocean or lake what is the feature that often forms? (A) seamount (B) meander (C) pothole (D) delta

38. If a stream flows through a raised sandy area what type of stream occurs? (A) waterfall (B) headward erosional stream (C) meandering stream (D) braided stream

39. A river in flat area with no mountains will tend to be a (A) braided river (B) meandering river (C) waterfall (D) headward erosional river.

40. In a meandering stream, deposition occurs on (A) the high outside bank (B) the low inside bank (C) both A and B (D) neither bank.

41. In a meandering stream, erosion takes place on (A) the high outside bank (B) the low inside bank (C) both A and B (D) neither bank.

42. A double delta may form... (A) after a flood (B) when the sea level changes (C) when a river changes course (D) all of the above.

APPENDIX G

TEACHER EVALUATION FORMS

TEACHER EVALUATION

Hydrologic Cycle

PART I

DIRECTIONS: Please write TEACHER EVALUATION where your name would be on the answer sheet and then answer the following questions and statements by marking the appropriate letter on the computer sheet. Answer questions 1-6 before previewing the program.

1. I am taking test form (A) Teacher Evaluation (B) Student Evaluation : Post Review (C) Student Evaluation : Pretest

2. I have taught science from (A) 0 to 2 years (B) 3 to 5 years (C) 6 to 8 years (D) 9 to 11 years (E) over 12 years.

3. My previous experience on a computer is (A) 0 to 20 hours (B) 21 to 40 hours (C) 41 to 60 hours (D) 61 to 80 hours (E) over 81 hours.

4. How many different educational microcomputer programs have you examined prior to this program? (A) 0 (B) 1 to 3 (C) 4 to 6 (D) 7 to 9 (E) 10 or more

5. How many programs have you used with your class prior to this evaluation? (A) 0 (B) 1 to 3 (C) 4 to 6 (D) 7 to 9 (E) 10 or more

6. I feel comfortable using computers. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

PART II

Please answer the following questions after running the program.

7. The computer software that I am working with is on (A) IBM Hydrologic Cycle (B) APPLE Water Pollution (C) APPLE Water Cycle (D) APPLE Water & Weather Series (E) APPLE Streams and Rivers

8. This was a high quality program compared to others you have used or seen. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

9. High school students will enjoy this program. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

10. High school students will want to share this information with a friend. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

11. What grade level do you think this material is appropriate for? (A) 4th and 5th (B) 6th and 7th (C) 8th and 9th (D) 10th and 11th (E) 12th or more.

12. The program had enough visual material (graphics) to help the student. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

13. The length of the program is appropriate for a single lesson or class period. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

14. The students can control the rate and sequence of presentation and review. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

15. The students will be able to operate the program without teacher assistance. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

16. The students will easily understand the directions. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

17. The students will find the feedback adequate when a mistake is made. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

18. The content is free of race, ethnic, sex and other stereotypes. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

19. This computer program is as useful as other teaching materials such as books, worksheets, charts, lectures and films. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

20. The books, worksheets, charts, etc. that came with the program were helpful. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

21. Students will find this program "exciting." (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

22. This program should be used in sciences classes. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

23. More time should be spent teaching with computer software programs. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

24. I think water education is important. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

25. I think water education should be taught in the schools. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

PART III

DIRECTIONS: Please answer the guestion "What percent of high school students will answer each question correctly before and after using the program?" by using the following:

(A) 90 to 100%
(B) 75 to 89%
(C) 60 to 74%
(D) 31 to 59%
(E) 30 to 0%

What is the source of energy for the hydrologic cycle? (A) Gravity (B) Radioactivity (C) The sun (D) Water (E) Mountain building

26. _____% Before
27. _____% After

Which of the following is not a part of the hydrologic cycle? (A) Lithosphere (B) Biosphere (C) Atmosphere (D) Oceans (E) Mantle

28. _____% Before
29. _____% After

What is the process that passes water through the pores of plants? (A) Evaporation (B) Percolation (C) Outgassing (D) Transpiration (E) None of these

30. _____% Before
31. _____% After

What is the entrance of water into the soil called? (A) Porosity (B) Capillarity (C) Infiltration (D) Permeability

32. _____% Before
33. _____% After

Approximately how much of the earth's total water supply is found in the ocean? (A) 30% (B) 50% (C) 75% (D) 97%

34. _____% Before
35. _____% After

Which of the following makes up about 2% of the total earth's water supply? (A) Freshwater lakes (B) Rivers (C) The soil (D) Glaciers and icepacks (E) Ground water

36. _____% Before
37. _____% After

Which of the following contains more water than all of the world's rivers? (A) Glaciers and icepacks (B) The ground (C) Lakes (D) All of the above

38. _____% Before
39. _____% After

What happens whenever water changes from the gaseous state to the liquid state? (A) Heat is released. (B) Heat is absorbed. (C) Water is evaporated. (D) Only B and C occur.

40. _____% Before
41. _____% After

How does water make its way from the ocean to land areas? (A) By evaporation and runoff (B) By ground water runoff and surface runoff (C) By evaporation, condensation, and precipitation (D) By evapotranspiration and precipitation

42. _____% Before
43. _____% After

What happens to most of the water that falls as rain? (A) It stays in the soil. (B) It runs off the land in streams. (C) It returns to the atmosphere by evapotranspiration. (D) It sinks into the ground water zone.

44. _____% Before
45. _____% After

What is the source of water for the underground zone? (A) Lakes (B) Precipitation (C) Rivers (D) Springs

46. _____% Before
47. _____% After

What is the average annual rainfall over the continental United States? (A) 10 inches (B) 20 inches (C) 30 inches (D) 40 inches (E) 50 inches

48. _____% Before
49. _____% After

From where does metropolitan Los Angeles obtain its water? (A) Northern California (B) The Colorado River (C) Owens Valley and Mono Lake Basin (D) Ground water (E) All of the above

50. _____% Before
51. _____% After

Which section of California receives the most rainfall? (A) The southern third (B) The Central Valley (C) The northern third

52. _____% Before
53. _____% After

Which section of the United States receives the most rainfall? (A) The western states (B) The eastern states

54. _____% Before
55. _____% After

Which section of the United States consumes the most water? (A) The West (B) The East

56. _____% Before
57. _____% After

Which of the following consumes water that is withdrawn? (A) Irrigation (B) Public Water Supply (C) Hydropower (D) Industrial cooling

58. _____% Before
59. _____% After

Which of the following withdraws the most water? (A) Public water supply (B) Industry (C) Irrigation (D) Recreation

60. _____% Before
61. _____% After

What is the amount of per capita domestic (in-home) water use in the United States? (A) 2000 gallons a day (B) 90 gallons a day (C) 300 gallons a day (D) 1000 gallons a day

62. _____% Before
63. _____% After

Which of the following has occurred in this century, partly as a result of human activities? (A) Glaciers have expanded. (B) Sea level has risen. (C) More water sink into the ground wate zone. (D) All of the above have occurred.

64. _____% Before
65. _____% After

HYDROLOGIC CYCLE

Answers to the questions of PART III are listed below.

Question #26.	C	Question #46.	B
#28.	E	#48.	C
#30.	D	#50.	E
#32.	C	#52.	C
#34.	D	#54.	B
#36.	D	#56.	A
#38.	D	#58.	A
#40.	A	#60.	B
#42.	C	#62.	B
#44.	C	#64.	B

TEACHER EVALUATION

Water Pollution

PART I

DIRECTIONS: Please write TEACHER EVALUATION where your name would be on the answer sheet and then answer the following questions and statements by marking the appropriate letter on the computer sheet. Answer questions 1-6 before previewing the program.

1. I am taking test form (A) Teacher Evaluation (B) Student Evaluation : Post Review (C) Student Evaluation : Pretest

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5. How many programs have you used with your class prior to this evaluation? (A) 0 (B) 1 to 3 (C) 4 to 6 (D) 7 to 9 (E) 10 or more

6. I feel comfortable using computers. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

PART II

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DIRECTIONS: Please answer the question "What percent of high school students will answer each question correctly before and after using the program?" by using the following:

(A) 90 to 100%
(B) 75 to 89%
(C) 60 to 74%
(D) 31 to 59%
(E) 30 to 0%

As the temperature of a body of water decreases the dissolved oxygen levels (A) decrease (B) increase (C) remain the same (D) decrease then increase.

26. _____% Before
27. _____% After

Before stocking a lake with game fish, what is the most important factor to check? (A) Dissolved oxygen content (B) Water temperature (C) Rate of flow (D) Type of waste being dumped

28. _____% Before
29. _____% After

As the flow rate of a body of water decreases the dissolved oxygen levels (A) decrease (B) increase (C) remain the same (D) increase and then decrease.

30. _____% Before
31. _____% After

BOD is an abbreviation for (A) beneficial organic decay (B) biochemical oxygen demand (C) biological organic decomposition (D) benethic oxidation and decay.

32. _____% Before
33. _____% After

All of the following are true about water except it (A) is found in all living things (B) can contain dissolved gases and minerals (C) is most dense at 0 degrees Celsius (D) can be treated to remove harmful matter.

34. _____% Before
35. _____% After

As the concentration of organic wastes in a body of water increases the BOD (A) decreases (b) increases (C) stays the same (D) increases then levels oFf.

36. _____% Before
37. _____% After

Which body of water has the highest BOD? (A) 1 degree Celsius lake with 5 ppm of secondary treated industrial waste (B) 1 degree Celsius slow river with 5ppm of primary treated sewage (C) 20 degree Celsius fast river with 13ppm of untreated industrial waste (D) 20 degree Celsius pond with 15ppm of untreated sewage

38. _____% Before
39. _____% After

Organisms that decompose wastes even after the dissolved oxygen level drops to 0 are (A) Anaerobic (can do without oxygen) (B) Aerobic (need oxygen) (C) undergoing respiratory distress (D) in need of secondary treatment.

40. _____% Before
41. _____% After

Most game fish die in bodies of water with dissolved oxygen levels of less than (A) 3 ppm (parts per million) (B) 5 ppm (C) 10 ppm (D) 14 ppm.

42. _____% Before
43. _____% After

Secondary treatment of wastes before dumping into waterways is more desirable than just primary treatment because (A) it kills harmful microorganisms (B) it keeps the BOD low (C) none of the above (D) both A and B

44. _____% Before
45. _____% After

WATER POLLUTION

Answers to the questions of PART III are listed below.

Question #26.	B	Question #36.	B
#28.	A	#38.	D
#30.	A	#40.	A
#32.	B	#42.	B
#34.	C	#44.	D

TEACHER EVALUATION

The Water Cycle

PART I

DIRECTIONS: Please write TEACHER EVALUATION where your name would be on the answer sheet and then answer the following questions and statements by marking the appropriate letter on the computer sheet. Answer questions 1-6 before previewing the program.

1. I am taking test form (A) Teacher Evaluation (B) Student Evaluation : Post Review (C) Student Evaluation : Pretest

2. I have taught science from (A) 0 to 2 years (B) 3 to 5 years (C) 6 to 8 years (D) 9 to 11 years (E) over 12 years.

3. My previous experience on a computer is (A) 0 to 20 hours (B) 21 to 40 hours (C) 41 to 60 hours (D) 61 to 80 hours (E) over 81 hours.

4. How many different educational microcomputer programs have you examined prior to this program? (A) 0 (B) 1 to 3 (C) 4 to 6 (D) 7 to 9 (E) 10 or more

5. How many programs have you used with your class prior to this evaluation? (A) 0 (B) 1 to 3 (C) 4 to 6 (D) 7 to 9 (E) 10 or more

6. I feel comfortable using computers. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

PART II

Please answer the following questions after running the program.

7. The computer software that I am working with is on (A) IBM Hydrologic Cycle (B) APPLE Water Pollution (C) APPLE Water Cycle (D) APPLE Water & Weather Series (E) APPLE Streams and Rivers

8. This was a high quality program compared to others you have used or seen. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

9. High school students will enjoy this program. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

10. High school students will want to share this information with a friend. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

11. What grade level do you think this material is appropriate for? (A) 4th and 5th (B) 6th and 7th (C) 8th and 9th (D) 10th and 11th (E) 12th or more.

12. The program had enough visual material (graphics) to help the student. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

13. The length of the program is appropriate for a single lesson or class period. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

14. The students can control the rate and sequence of presentation and review. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

15. The students will be able to operate the program without teacher assistance. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

16. The students will easily understand the directions. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

17. The students will find the feedback adequate when a mistake is made. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

18. The content is free of race, ethnic, sex and other stereotypes. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

19. This computer program is as useful as other teaching materials such as books, worksheets, charts, lectures and films. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

20. The books, worksheets, charts, etc. that came with the program were helpful. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

21. Students will find this program "exciting." (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

22. This program should be used in sciences classes. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

23. More time should be spent teaching with computer software programs. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

24. I think water education is important. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

25. I think water education should be taught in the schools. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

PART III

DIRECTIONS: Please answer the question "What percent of high school students will answer each question correctly before and after using the program?" by using the following:

(A) 90 to 100%
(B) 75 to 89%
(C) 60 to 74%
(D) 31 to 59%
(E) 30 to 0%

When the rate of condensation is equal to the rate of evaporation, the air is said to be... (A) supersturated (B) supercooled (C) saturated (D) unsaturated

26. _____% Before
27. _____% After

Evaporation takes place most slowly when the air is... (A) humid (B) dry (C) saturated (D) hot.

28. _____% Before
29. _____% After

As the temperature decreases, the amount of dew... (A) varies (B) increases (C) stays the same (D) decreases.

30. _____% Before
31. _____% After

You have a glass filled with ice-cold soda pop. Moisture will appear most quickly on a day which is... (A) warm and dry (B) cold and dry (C) warm and humid (D) cold and humid.

32. _____% Before
33. _____% After

As the amount of cloud cover increases, the rate of evaporation from the earth's surface will...
(A) increase (B) decrease (C) stay the same (D) vary.

34. _____% Before
35. _____% After

Which in not an example of evaporation? (A) gaseous water forming from liguid water (B) cooling of your skin after a swim (C) water boiling (D) cloud formation from water vapor

36. _____% Before
37. _____% After

The ability of the atmosphere to hold water vapor is determined by its... (A) humidity (B) oxygen content (C) pressure (D) temperature.

38. _____% Before
39. _____% After

If the amount of moisture in the air increases while the temperature remains the same, the realitive humidity will... (A) decrease (B) vary upwards or downwards (C) increase (D) remain constant.

40. _____% Before
41. _____% After

Where would you normally find the greatest difference in temperature readings between the wet and dry-bulb thermometers of a psychomemeter? (A) the seashore (B) an inland city (C) a tropical rain forest (D) the desert

42. _____% Before
43. _____% After

The liquid inside a wet-bulb thermometer is...
(A) cobalt chloride (B) water (C) alcohol (D) mercury

44. _____% Before
45. _____% After

Dew point is measured in... (A) liters (B) grams (C) percent (D) degrees.

46. _____% Before
47. _____% After

The air contains the smallest amount of water vapor during... (A) Fall (B) Spring (C) Summer (D) Winter.

48. _____% Before
49. _____% After

A humid day is one which is... (A) is hot (B) has a lot of moisture in the air (C) is foggy (D) is rainy.

50. _____% Before
51. _____% After

Snow crystals have... (A) 10 sides (B) 8 sides (C) 6 sides (D) 4 sides.

52. _____% Before
53. _____% After

The process of changing gaseous water to liquid water is called... (A) precipitation (B) condensation (C) sublimation (D) evaporation.

54. _____% Before
55. _____% After

Most high clouds are made of... (A) condensation nuclei (B) water droplets (C) ice crystals (D) water vapor.

56. _____% Before
57. _____% After

Approximately how many cloud droplets are equal to the size of a raindrop? (A) 1 thousand (B) 1 hundred (C) 10 (D) 1 million

58. _____% Before
59. _____% After

One centimeter of rain is equivalent to about... (A) 100 centimeters of snow (B) 10 centimeters of snow (C) 1 centimeter of snow (D) 2 centimeters of snow.

60. _____% Before
61. _____% After

If the temperature remains at zero degrees C. or below from the clouds all the way down to the ground, any precipitation will be in the form of... (A) sleet (B) glaze (C) wet snow (D) dry snow.

62. _____% Before
63. _____% After

Which represents the correct order of cloud formation? The moist air... (A) evaporates - rises - cools to dew point - condenses (B) cools to dew point - rises - evaporates - condenses (C) rises - cools to dew point - evaporates - condenses (D) evaporates - cools to dew point - rises - condenses.

64. _____% Before
65. _____% After

THE WATER CYCLE

Answers to the questions of PART III are listed below.

Question #26.	B	Question #46.	C
#28.	C	#48.	C
#30.	C	#50.	D
#32.	A	#52.	B
#34.	B	#54.	B
#36.	B	#56.	A
#38.	B	#58.	A
#40.	A	#60.	C
#42.	C	#62.	A
#44.	A	#64.	A

TEACHER EVALUATION

Water & Weather Series

PART I

DIRECTIONS: Please write TEACHER EVALUATION where your name would be on the answer sheet and then answer the following questions and statements by marking the appropriate letter on the computer sheet. Answer questions 1-6 before previewing the program.

1. I am taking test form (A) Teacher Evaluation (B) Student Evaluation : Post Review (C) Student Evaluation : Pretest

2. I have taught science from (A) 0 to 2 years (B) 3 to 5 years (C) 6 to 8 years (D) 9 to 11 years (E) over 12 years.

3. My previous experience on a computer is (A) 0 to 20 hours (B) 21 to 40 hours (C) 41 to 60 hours (D) 61 to 80 hours (E) over 81 hours.

4. How many different educational microcomputer programs have you examined prior to this program? (A) 0 (B) 1 to 3 (C) 4 to 6 (D) 7 to 9 (E) 10 or more

5. How many programs have you used with your class prior to this evaluation? (A) 0 (B) 1 to 3 (C) 4 to 6 (D) 7 to 9 (E) 10 or more

6. I feel comfortable using computers. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

PART II

Please answer the following questions after running the program.

7. The computer software that I am working with is on (A) IBM Hydrologic Cycle (B) APPLE Water Pollution (C) APPLE Water Cycle (D) APPLE Water & Weather Series (E) APPLE Streams and Rivers

8. This was a high quality program compared to others you have used or seen. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

9. High school students will enjoy this program. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

10. High school students will want to share this information with a friend. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

11. What grade level do you think this material is appropriate for? (A) 4th and 5th (B) 6th and 7th (C) 8th and 9th (D) 10th and 11th (E) 12th or more.

12. The program had enough visual material (graphics) to help the student. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

13. The length of the program is appropriate for a single lesson or class period. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

14. The students can control the rate and sequence of presentation and review. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

15. The students will be able to operate the program without teacher assistance. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

16. The students will easily understand the directions. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

17. The students will find the feedback adequate when a mistake is made. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

18. The content is free of race, ethnic, sex and other stereotypes. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

19. This computer program is as useful as other teaching materials such as books, worksheets, charts, lectures and films. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

20. The books, worksheets, charts, etc. that came with the program were helpful. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

21. Students will find this program "exciting." (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

22. This program should be used in sciences classes. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

23. More time should be spent teaching with computer software programs. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

24. I think water education is important. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

25. I think water education should be taught in the schools. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

PART III

DIRECTIONS: Please answer the question "What percent of high school students will answer each question correctly before and after using the program?" by using the following:

(A) 90 to 100%
(B) 75 to 89%
(C) 60 to 74%
(D) 31 to 59%
(E) 30 to 0%

What is water? (A) H2 (B) H2O (C) H2SO4 (D) H2O2

26. _____% Before
27. _____% After

At what temperature (Degrees Celsius) does water freeze? (A) -32 (B) 10 (C) 0 (D) 32

28. _____% Before
29. _____% After

Water boils at what temperature (Degrees Celsius)? (A) 98.6 (B) 212 (C) 100 (D) 220

30. _____% Before
31. _____% After

Is a summer sea breeze cooler than a land breeze? (A) yes (B) no

32. _____% Before
33. _____% After

What part (%) of sunlight is reflected back to space by the air and clouds? (A) 50% (B) 30% (C) 20% (D) 10%

34. _____% Before
35. _____% After

What is a monsoon? (A) a heavy rain (B) an onshore wind (C) a strong dry wind (D) a big storm

36. _____% Before
37. _____% After

What part (%) of rainfall is evaporated from the soil and plants? (A) 5% (B) 64% (C) 79% (D) 31%

38. _____% Before
39. _____% After

What part (%) of rainfall runs off directly to the rivers? (A) 25% (B) 5% (C) 10% (D) 52%

40. _____% Before
41. _____% After

If the Antartic Ice Cap melts the sea will rise by... (A) 3 meters (B) 1 meter (C) 30 to 60 meters (D) 5 to 6 meters

42. _____% Before
43. _____% After

When air rises... (A) it becomes cooler. (B) it doesn't change temperature. (C) it becomes warmer. (D) it becomes drier.

44. _____% Before
45. _____% After

Air currents travel from... (A) low pressure to high pressure. (B) not at all (C) high pressure to low pressure. (D) north to south.

46. _____% Before
47. _____% After

Does air heat up faster over... (A) a bog. (B) the water. (C) the soil. (D) Air heats up equally over all areas.

48. _____% Before
49. _____% After

Would air pressure be higher over... (A) a mountain top (B) a warm part of the surface (C) pressure isn't changed by temperature (D) A cool part of the surface

50. _____% Before
51. _____% After

Does water evaporate faster at... (A) room temperature (B) high temperatures (C) low temperatures (D) temperature does not matter

52. _____% Before
53. _____% After

Which affects evaporation? (A) heat (B) both light and heat (C) light (D) pressure

54. _____% Before
55. _____% After

Can water evaporate at a temperature below its boiling point? (A) yes (B) no

56. _____% Before
57. _____% After

Energy from the sun causes seawater... (A) to become saltier (B) solar energy does not effect the sea (C) to become less salty (D) to sink

58. _____% Before
59. _____% After

If the same amount of heat escapes as is absorbed--the temperature... (A) rises (B) falls (C) remains the same (D) rises then falls

60. _____% Before
61. _____% After

In the northern hemisphere an anticyclone rotates... (A) clockwise (B) they don's rotate at all (C) counterclockwise (D) north to south

62. _____% Before
63. _____% After

Typical thunderstorms have... (A) wind, rain, and clouds (B) heavy rains (C) clouds (D) strong winds

64. _____% Before
65. _____% After

WATER & WEATHER SERIES

Answers to the questions of PART III are listed below.

Question #26.	C	Question #46.	D
#28.	C	#48.	D
#30.	B	#50.	B
#32.	C	#52.	C
#34.	B	#54.	B
#36.	D	#56.	C
#38.	D	#58.	D
#40.	C	#60.	B
#42.	D	#62.	D
#44.	D	#64.	A

TEACHER EVALUATION

Streams and Rivers

PART I

DIRECTIONS: Please write TEACHER EVALUATION where your name would be on the answer sheet and then answer the following questions and statements by marking the appropriate letter on the computer sheet. Answer questions 1-6 before previewing the program.

1. I am taking test form (A) Teacher Evaluation (B) Student Evaluation : Post Review (C) Student Evaluation : Pretest

2. I have taught science from (A) 0 to 2 years (B) 3 to 5 years (C) 6 to 8 years (D) 9 to 11 years (E) over 12 years.

3. My previous experience on a computer is (A) 0 to 20 hours (B) 21 to 40 hours (C) 41 to 60 hours (D) 61 to 80 hours (E) over 81 hours.

4. How many different educational microcomputer programs have you examined prior to this program? (A) 0 (B) 1 to 3 (C) 4 to 6 (D) 7 to 9 (E) 10 or more

5. How many programs have you used with your class prior to this evaluation? (A) 0 (B) 1 to 3 (C) 4 to 6 (D) 7 to 9 (E) 10 or more

6. I feel comfortable using computers. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

PART II

Please answer the following questions after running the program.

7. The computer software that I am working with is on (A) IBM Hydrologic Cycle (B) APPLE Water Pollution (C) APPLE Water Cycle (D) APPLE Water & Weather Series (E) APPLE Streams and Rivers

8. This was a high quality program compared to others you have used or seen. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

9. High school students will enjoy this program. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

10. High school students will want to share this information with a friend. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

11. What grade level do you think this material is appropriate for? (A) 4th and 5th (B) 6th and 7th (C) 8th and 9th (D) 10th and 11th (E) 12th or more.

12. The program had enough visual material (graphics) to help the student. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

13. The length of the program is appropriate for a single lesson or class period. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

14. The students can control the rate and sequence of presentation and review. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

15. The students will be able to operate the program without teacher assistance. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

16. The students will easily understand the directions. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

17. The students will find the feedback adequate when a mistake is made. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

18. The content is free of race, ethnic, sex and other stereotypes. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

19. This computer program is as useful as other teaching materials such as books, worksheets, charts, lectures and films. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

20. The books, worksheets, charts, etc. that came with the program were helpful. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

21. Students will find this program "exciting." (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

22. This program should be used in sciences classes. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

23. More time should be spent teaching with computer software programs. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

24. I think water education is important. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

25. I think water education should be taught in the schools. (A) strongly agree (B) agree (C) neutral (D) disagree (E) strongly disagree

PART III

DIRECTIONS: Please answer the question "What percent of high school students will answer each question correctly before and after using the program?" by using the following:

(A) 90 to 100%
(B) 75 to 89%
(C) 60 to 74%
(D) 31 to 59%
(E) 30 to 0%

The greatest amount of rain falls at... (A) higher elevations (B) lower elevations.

26. _____% Before
27. _____% After

In the eastern United States most rivers flow toward the (A) Atlantic Ocean (B) Gulf of Mexico (C) Pacific Ocean (D) both A and B (B) both B and C.

28. _____% Before
29. _____% After

In the western United States most rivers flow toward the (A) Atlantic Ocean (B) Pacific Ocean (C) Mississippi River (D) both A and C (E) both B and C.

30. _____% Before
31. _____% After

A feature which appears at the bottom of a waterfall is a... (A) delta (B) deposit (C) pothole (D) meander

32. _____% Before
33. _____% After

During heavy rainstorms, water sometimes gradually erodes the tops of waterfalls causing them to become longer. This process is called... (A) headward erosion (B) headward deposition (C) meandering (D) braiding.

34. _____% Before
35. _____% After

Waterfalls usually develop in places where... (A) softrock overlays hardrock (B) hardrock alone exists (C) hardrock overlays softrock (D) softrock alone exists.

36. _____% Before
37. _____% After

When a river meets an ocean or lake what is the feature that often forms? (A) seamount (B) meander (C) pothole (D) delta

38. _____% Before
39. _____% After

If a stream flows through a raised sandy area what type of stream occurs? (A) waterfall (B) headward erosional stream (C) meandering stream (D) braided stream

40. _____% Before
41. _____% After

A river in flat area with no mountains will tend to be a (A) braided river (B) meandering river (C) waterfall (D) headward erosional river.

42. _____% Before
43. _____% After

In a meandering stream, deposition occurs on (A) the high outside bank (B) the low inside bank (C) both A and B (D) neither bank.

44. _____% Before
45. _____% After

In a meandering stream, erosion takes place on (A) the high outside bank (B) the low inside bank (C) both A and B (D) neither bank.

46. _____% Before
47. _____% After

A double delta may form... (A) after a flood (B) when the sea level changes (C) when a river changes course (D) all of the above.

48. _____% Before
49. _____% After

STREAMS AND RIVERS

Answers to the questions of PART III are listed below.

Question #26.	A	Question #38.	D
#28.	D	#40.	D
#30.	E	#42.	B
#32.	C	#44.	B
#34.	A	#46.	A
#36.	C	#48.	B

APPENDIX H

BACKGROUND FOR THE TEACHER

For The Teacher

Background Information

Teachers have suggested that computer software should be evaluated within the context of its use, i.e., in real classrooms with real teachers and students. This evaluation by inservice professionals and their students seldom takes place! Thank you for your important contribution in this software evaluation.

The purpose of this study is to determine if software programs in water education for high school students (1) are motivating, (2) influence attitude toward water, (3) increase water knowledge, and (4) are viewed the same by students and teachers. The results will be shared with teachers participating. The computer response sheets and evaluation forms can be anonymous.

Contents of the Envelope and How To Use It.

Contents:

1. Software Package with written material
2. Teacher Evaluations
3. Student Evaluation : Pretests
4. Student Evaluation : Post Reviews
5. Computer Response Sheets
6. Pencils - #2 Lead
7. Self-addressed Envelopes

Step One--Teacher Evaluation

Each program has its own separate teacher evaluation form. Please review the water education software yourself and then answer the questionaire labeled TEACHER EVALUATION.

Step Two--Student Evaluation

Each program has two different student evaluation forms labeled STUDENT EVALUATION : POST REVIEW and STUDENT EVALUATION : PRETEST. Please divide your students randomly into two groups. The students in one group are given the Student Evaluation : Pretest while the students in the other group first review the water software and then answer the Student Evaluation : Post Review. If you are limited in time or have limited computer hardware, please select a cross-section sample of as many students as possible. For any one student the maximum time to preview the software and to answer the evaluation form is 2 class periods. Evaluation questions may be used more than once if necessary. The written material that comes with the software package should be used by the students to help them. Please give the students one of the complementary pencils for use on the computer response sheet.

Step Three--Return Materials

When the evaluation is completed, please return the computer answer sheets in the self-addressed envelopes to the following address:

Dr. Terence J. Mills
Oklahoma State University
Curriculum and Instruction
306-G Gunderson
Stillwater, OK 74078

It would be very helpful if the completed printed material and the software package are returned within two weeks. If time permits, please give the envelope, software, and any unused evaluation forms and answer sheets to another participating teacher at your school. Thanks again for your time and contribution.

VITA

Mark David Schallhorn

Candidate for the Degree of

Master of Science

Thesis: AN ASSESSMENT OF MICROCOMPUTER WATER INFORMATION DISSEMINATION SOFTWARE

Major Field: Environmental Science

Biographical:

Personal Data: Born in Milwaukee, Wisconsin, October 12, 1962, the son of Mary Maples and David Schallhorn.

Education: Graduated from Moore High School, Moore, Oklahoma in May, 1981; received Associate of Science Degree in Biology from Oklahoma City Community College in 1983; attended the University of Oklahoma in the Summer of 1983; received Bachelor of Science degree in Wildlife Ecology Management from Oklahoma State University in 1985; completed requirements for Master of Science degree at Oklahoma State University in December, 1986.

Professional Experience: Graduate Assistant, Department of Education, Oklahoma State University, June, 1985, to July, 1986.

Professional Organizations: Member of the Wildlife Society, Phi Kappa Phi, Association of Interpretive Naturalists, and Western Interpreters Association.