AN ABSTRACT OF THE THESIS OF

Robert John Frieske for the degree of

Doctor of Philosophy in Science Education presented on

November 2, 1987.

Title: The Influence of Selected Supplementary Materials on Standardized Science Achievement Scores

Redacted for Privacy

Abstract approved: ____

Thomas P. Evans

The purposes of this study were as follows: (1) to determine if the use of selected supplementary instructional materials, in the form of either computer assisted instruction or additional readings and worksheet presentations, could influence test scores relating to science achievement for fifth grade students, and (2) to determine whether an increase in direct teacher instructional time could influence the science achievement test scores for fifth grade students.

The study used the true experimental design of pretest - posttest and control group, with alternate forms used for the pretest and posttest. The population consisted of 130 fifth grade students from the North Clackamas School

District located in Milwaukie, Oregon.

Treatment materials in the form of computer assisted instruction and reading materials with worksheets were developed for the science content area of green plants. Analysis of covariance was utilized to analyze student test scores from the science portion of the Survey of Basic Skills - Level 34 (SRA) forms P and Q. The 0.05 level was used to determine the significance of the results.

The findings revealed the following: (1) no significant difference between the standardized science achievement test scores for fifth grade students using supplementary instructional materials and students not using supplementary instructional materials; (2) no significant difference between the standardized science achievement test scores for fifth grade students using the computer as the medium for supplementary instruction and students not using the computer for supplementary instruction; (3) no significant difference between the standardized science achievement test scores for fifth grade students using written worksheets as the medium for supplementary instruction and students not using the worksheets for supplementary instruction; and (4) no significant difference between the standardized science achievement test scores for fifth grade students utilizing media for supplementary instruction and students receiving additional direct teacher instruction. It was concluded that the use of selected supplementary instructional materials, in the form of either computer assisted instruction or additional text and worksheet presentations, did not significantly increase science achievement test scores of 5th grade students.

THE INFLUENCE OF SELECTED SUPPLEMENTARY MATERIALS ON STANDARDIZED SCIENCE ACHIEVEMENT SCORES

by

Robert John Frieske

A THESIS

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Doctor of Philosophy

Completed November 2, 1987

Commencement June 1988

APPROVED:

Redacted for Privacy

Professor of Science, Mathematics, and
Computer Science Education in charge of major

Redacted for Privacy

Chairman of Science, Mathematics, and
Computer Science Education

Redacted for Privacy

Dean of Graduate School

Date thesis is presented November 2, 1987

Typed by Robert Frieske for Robert John Frieske

ACKNOWLEDGEMENTS

Sincere thanks to Dr. Thomas Evans, Dr. Margaret Niess, Dr. Howard Wilson, Dr. Jake Nice, and Dr. David Froman for serving on the doctoral committee and aiding in the preparation of the dissertation.

Special acknowledgement is given to Dr. Thomas Evans, my major professor, for his meaningful suggestions and support throughout my doctoral studies.

Especially, I want to express my gratitude to Dr. Margaret Niess for her encouragement, valuable suggestions, generosity of time, and her warm friendship.

I am grateful to Linda Faes for her help and friendship during the writing of this thesis.

A special thanks with love to my wife, Maggie, for her patience and understanding during my work at Oregon State University; and to Sam, Buffy, Chuck, Marigold, Hazel, Jasmine, and Sidney for always being there when I came home.

TABLE OF CONTENTS

LIST OF TABLES

Table		Page

THE INFLUENCE OF SELECTED SUPPLEMENTARY MATERIALS ON STANDARDIZED SCIENCE ACHIEVEMENT SCORES.

CHAPTER I

THE PROBLEM

During the last few years, American schools have been held more accountable for achievement than at any other time in history. The entire educational system has been placed under close examination. Since many conclusions dealing with the quality of education are based on examination results, the process of testing has played a major role.

The most influential types of tests are the standardized achievement tests. Standardized achievement tests are objective pencil and paper instruments that are group administered and usually machine scored. Their administration may be mandated by a state or local school district. Individual teachers generally have little control over their selection or use. The influence of standardized tests on educational programs and policies is having a greater impact due to the large number of standardized tests that are being administered in schools today.

To identify major problems in American education and recommend concrete solutions, the National Commission on Excellence in Education was formed. In A Nation at Risk, the Commission summarized the evidence found and identified academic achievement as the principal goal (National Commission on Excellence in Education, 1983). The results of testing programs served as the primary source of evidence. The Commission noted that in nineteen academic tests, American students not only failed to place first or second, but on seven tests they placed last. They reported that data also revealed a steady decline of science achievement scores by seventeen year old students on 1969, 1973, and 1977 national achievement tests. The Commission showed concern that American scholastic test scores had not only declined, but they were lower than those of other developed countries (National Commission on Excellence in Education, 1983).

Although student achievement scores have been proposed as a means of teacher evaluation (Carnegie Forum on Education and Economy, 1986), concern about classroom achievement is not limited to teachers. School administrators, school boards, and entire communities evaluate what is accomplished in the classroom by results of test scores, a student's entrance into special classes, programs or schools is determined by performance on these examinations. A test provides only a sample of student performance (Haertel, 1985). It is then important to evaluate the test itself to determine whether the test matches the curriculum or instructional objectives, and that the test results are reliable.

Some schools have moved toward encouraging direct instruction in test taking skills. Rewarding teachers, schools, or districts for good test scores may lead to a gradual narrowing of the curriculum to the knowledge and skills tested (Elliot and Hall, 1985; Frederiksen, 1984). But as long as these tests correspond to the new instructional goals and new content, they can provide reliable information for students, teachers, administrators, and parents about the success of the educational system.

Numerous factors influence student achievement. Many of these, such as pupil and community characteristics, are beyond a teacher's direct control (Medley, 1977). The quality of the facilities, instructional materials, and time available for instruction also have an influence on student achievement (Wiley and Harnischfeger, 1974). The time available for instruction may be a function of the length of the school year, school day, instructional period, or the teacher - student ratio. Because definite content areas are covered on the standardized achievement tests, it is possible to focus instruction on certain aspects of the curriculum as it relates to the achievement tests, and also to increase the amount of instructional time given to a content area.

As pointed out by Holsinger (1982), in examining data gathered from the International Studies of Educational Achievement (IEA) (Wolf, 1979),:

> ... if national educational planners and policy makers wished to do one thing which would have a high probability of improving national averages in a certain subject, they should give that subject strong emphasis in the curriculum and encourage teachers to devote as much time as possible to it in the classroom. If they would do that they could reasonably expect to observe measurable improvements in test scores.

Studies have shown that higher student achievement results if schools can increase the amount of time teachers spend engaging students in learning. In other words, committing a larger portion of the school day to uninterrupted effective teaching increases student achievement (Cooley and Leinhardt, 1980; Rutter, Maughan, Mortimore, and Ouston, 1979).

The current instructional day is already filled with curriculum demands from a widening array of subject matters. Floden, Porter, Schmidt, Freeman, and Schwille (1980) contend that the formal curriculum cannot fare well when teachers must resolve competing demands on the time allotted to instruction.

Since evidence supports a strong positive relationship between instructional time and test scores, an important goal in improving the quality of education is to find a means to provide additional instructional time without requiring additional teacher time.

Need for the Study

Increasing student learning is a major educational goal, and one way it can be measured is by achievement test scores. An increase in student achievement can be brought about by an increase in uninterrupted effective teaching (Cooley and Leinhardt, 1980). However, the school curriculum is filled and adjustments to the school day to allow for additional direct teacher instruction does not appear to be a possibility.

It might be possible to increase instructional time by utilizing media to provide supplementary instruction. Currently, there is not a body of research that considers utilizing media for supplementary instruction that has controlled the media as the only variable in the instructional process. There is, likewise, little research that looks specifically at either increasing science achievement test scores or at fifth grade students. Avenues that allow for additional student instruction but do not require additional teacher time need to be examined.

Statement of the Problem

The purposes of this study are as follows: (1) to determine if the use of selected supplementary instructional materials, in the form of either computer assisted instruction or additional readings and worksheet presentations, could influence test scores relating to science achievement for fifth grade students, and (2) to determine whether an increase in direct teacher instructional time could influence the science achievement test scores for fifth grade students.

Theoretical Framework

The theoretical framework under which this study was conducted includes the following arguments:

1. Research studies have demonstrated significant relationships between the amount of academic learning time and student academic achievement.

2. Studies have shown that an increase in teacher instruction time results in higher student achievement.

3. The current instructional teacher day is filled which results in limited time for additional teacher instruction.

4. In the classroom, the instructional process often takes place utilizing media. It then becomes important to determine which media will provide the best achievement growth.

5. Studies have shown that the greatest gains from the use of the computer occur when it is integrated thoughtfully into an on-going curriculum. It is then to be determined whether the computer can supply the additional student instruction to increase student achievement.

If research has shown that supplemental instruction can increase learning, then it should be possible to utilize existing media to provide this additional learning and not require additional direct teacher instruction time. With care and consideration given to both content consistency and available media, it should be possible to increase achievement test scores.

A more extensive review of the literature is found in Chapter 2.

Research Hypotheses

1. There is a significant difference between the standardized science achievement test scores for fifth grade students using supplementary instructional materials and students not using supplementary

instructional materials.

2. There is a significant difference between the standardized science achievement test scores for fifth grade students using the computer as the medium for supplementary instruction and students not using the computer for supplementary instruction.

3. There is a significant difference between the standardized science achievement test scores for fifth grade students using written worksheets as the medium for supplementary instruction and students not using the worksheets for supplementary instruction.

4. There is a significant difference between the standardized science achievement test scores for fifth grade students utilizing media for supplementary instruction and students receiving additional direct teacher instruction.

Assumptions

1. It is assumed that The Survey of Basic Skills - Level 34 (SRA) provides a valid and reliable measure of student achievement.

2. It is assumed that the students taking part in the study will work on task when presented with the computer and reading tasks.

3. It is assumed that the teachers taking part in the study will present classroom instruction in the same manner, with respect to time allotted and material covered, as they would if not taking part in the study.

Limitations

1. The study is limited to fifth grade students in the North Clackamas School District.

2. The study is limited to the basic science concepts covered in the Silver Burdett Science Series, Grade Five, in the content area of green plants.

3. The study is limited by media consisting of either computer assisted instruction or additional readings.

4. The study is limited by the small number of questions available on the pretest and posttest that pertained to the subject area and were used as the basis for the item pool.

Delimitations

1. Test results will not be used to evaluate the teachers participating in the study.

2. Individual student data will not be released without the classroom teachers permission.

Definition of Terms

The following definitions are relevant to this study. Other terms or phrases used in this report are considered self-explanatory.

1. Achievement. The quality and quantity of a student's work during a given time period. In this study it is limited to a test score on the science section of the *Survey of Basic Skills* - Level 34 (SRA).

2. Achievement Test. A test designed to measure the amount of knowledge and/or skill a person has acquired, usually as a result of classroom instruction.

3. Instructional Time. The number of minutes instructional materials are available.

4. Item. A single question or exercise in a test.

5. Media. The carrier of a message of communication. In this study it is limited to the use of the computer and/or worksheets to deliver instruction.

6. Supplementary Instruction. Material presented in addition to direct teacher instruction or the basal textbook and its related materials.

7. Teacher Instructional Time. The number of minutes a teacher is actually providing direct instruction.

Overview of the Study

For this study, data will be gathered from fifth grade students in the North Clackamas School District. For the analysis, student scores on the science portion of the Survey of Basic Skills - Level 34 form P and Q will be used.

Treatment materials will be developed by the researcher with the content validity determined by a panel of judges. Analysis of covariance will be used to analyze data obtained from students taking the Survey of Basic Skills - Level 34.

Organization of the Remainder of the Study

The remainder of the study is organized in the following manner. Chapter 2 presents a review of research and other related literature. Details of the process of developing the treatments, procedures used to gather data and a description of the design are presented in Chapter 3. Chapter 4 reports the findings of the analysis of the data. Chapter 5 presents the summary and conclusions for the study.

CHAPTER II

REVIEW OF RELATED LITERATURE

This chapter reviews the research and literature pertaining to the influence of academic learning time on student achievement, the influence of media on learning, and the use of the computer as media.

Influence of Academic Learning Time on Student Achievement

Research has shown that achievement depends on the emphasis given to specific material in school through the curriculum, which in turn is contingent upon the time available or allocated to a subject area (Holsinger, 1982). The amount of time students are actively engaged in learning activities contributes strongly to their achievement (Rutter, Maughan, Mortimore, and Ouston, 1979).

Research studies have consistently demonstrated significant relationships between the amount of academic learning time and student academic achievement (Anderson, 1976; Bloom, 1974). Fisher, Berliner, Filby, Marliave, Cahen, Dishaw, and Moore (1978a) found that academic learning time was a significant predictor of academic achievement in mathematics and reading for elementary grade students. Walberg, Schiller, and Haertel (1979), after reviewing some 15 correlational studies of academic learning time, found that all reported statistically significant relationships between academic learning time and student cognitive achievement.

Regardless of the type of task or management system used by the teacher, a major intervening variable between teacher instructional behavior and student achievement appears to be academic learning time. Academic learning time is the amount of time students spend engaged in academic tasks that are performed to a given level of mastery (Fisher, Berliner, Filby, Marliave, Cahen, Dishaw, & Moore, 1978b).

Teachers are charged with the task of maximizing a student's academic learning time. The carrying out of this task offers important opportunities for improving educational quality and effectiveness within a given amount of time. Maximizing a student's academic learning time takes on significance because, of the many factors affecting the education process, time is one of the few factors under a teacher's direct control (Bloom, 1980).

Holsinger (1982) found that the amount of classroom time devoted to instructional purposes is a major contributor to the amount of subject matter students actually learn, as measured by their performances on standardized achievement tests. When examining the International Studies of Educational Achievement (IEA) data, Holsinger could find no other characteristic of the school systems of the different countries which showed the same strength of association with standardized test scores as did the sheer time devoted to instruction. "In the case of science, it was the time allotted to the different sciences that affected individual specialization scores" (Holsinger, 1982). Not surprisingly, when children master material that they are tested on, they score higher on the test (Cooley and Leinhardt, 1980).

Simply providing more instructional time may do little to increase academic achievement. How time is used is more important than the actual amount of time provided (Brown and Saks, 1983). Current research has tended to shift away from time per se to various measures of academic learning time (Fisher, Berliner, Filby, Marliave, Cahen, Dishaw, & Moore, 1978b). These more refined measures account for greater variance in student achievement than do studies considering additional time alone as a predictor variable (Good, 1982).

Influence of Media on Learning

In the classroom, the instructional process often takes place utilizing media. As defined by Lumsdaine (1963), media are simple delivery devices.

Studies dealing with the influence of media on learning have long been a part of educational research. Most media research is based on the assumption that learning will be enhanced with the proper mix of medium, student, subject matter content and learning task. Many of the models base their prescriptions on presumed learning benefits from media (Jamison, Suppes and Welles, 1974).

Some cautions must be considered when doing media studies. Only the media being compared can be different; all other aspects of the treatments, including the subject matter content and method of instruction, must be identical. Mielke (1968) suggests that if there is evidence for one medium over another, then the active ingredient might be some uncontrolled aspect of the content or instructional strategy rather than the medium.

In a meta-analysis by Kulik, Kulik, and Cohen (1980) the findings showed the most common sources of confounding in media research to be the uncontrolled effects of a) instructional method or content difference between treatments that were compared and b) a novelty effect for newer media, which tended to disappear over time.

It was noted that the positive effect for media more or less disappears when the same instructor produces all treatments (Kulik, Kulik, and Cohen, 1980). Different teams of instructional designers or different teachers can give different content and instructional methods to the treatments being compared. When different instructional designers are involved, it is not known whether to attribute the advantage to the medium or to the differences between content and method and the media being compared. It is important that the content be consistent for each of the media and that the treatments be developed by the same designer(s).

Many attempts to improve school effectiveness involve the introduction of a new technique or curriculum. The effects of such innovations, once they are actually implemented, can show positive results, regardless of the practice or program involved. These conditions are likely to result in an "experimental" or "Hawthorne" effect where teachers, parents, and students are aware that they are involved in something special and that it is expected to work. Therefore, it is important to select subjects that have had previous experience with each of the media being presented so that the "Hawthorne" effect can be decreased.

There are various forms of media available for use in the elementary classroom. Teachers are able to select a specific medium to enhance a content area or to allow for a varied instructional pace. However, Clark (1983) believes it is not media, but rather, other variables such as the instructional method used that encourage learning. He suggests that there are no learning benefits to be gained from employing different media in instruction, regardless of their obviously attractive features or advertised superiority. In his meta-analysis, Clark cites numerous media comparison studies which have attributed positive learning effects to one medium over another, when the real independent variables are not the media themselves but rather the specific instructional design characteristics of the media. Clark presents evidence for the generalization that there are no learning benefits to be gained from employing any specific medium to deliver instruction. However, he does not argue whether or not learning takes place via media but rather notes that one media presentation may not be better than another. Also, few of the studies he examined dealt with either science related topics or with elementary age students.

Overview of Computer Assisted Instruction (CAI)

A short time ago, the use of computers in education would have been important to relatively few persons involved in research and development activities. Educational computing seemed far-removed from the real world of practice. Now computer support is available to even the smallest of schools, school districts, colleges, and other organizations.

One of the earlier and most prominent applications within the area of computer-based education was computer assisted instruction (CAI). Splittgerber (1979) defined CAI as a teaching process directly involving the computer in the presentation of instructional materials in an interactive mode to provide and control the learning environment for each individualized student.

Among the first users of CAI were members of the computer industry who, in the early 1960s, used computer-based instruction to train their own personnel (Suppes and Macken, 1978). Coincidentally, educators' interest focused on programmed instruction as a means toward individualized instruction. Educational CAI was an almost natural combination of emerging computer technology and the programmed instruction movement (Schoen and Hunt, 1977). The availability of federal funds to education in the early 1960s provided an additional stimulus that was needed to promote educational CAI development (Atkinson and Wilson, 1969).

Following the lead of IBM, computer corporations ventured into the field of instructional computing throughout the 1960s. Notable among these were Digital Equipment, Control Data, and Hewlett-Packard. Numerous enterprises were undertaken in conjunction with major university educational research and development specialists. Frequently funded by the National Science Foundation or the United States Office of Education, these cooperative endeavors combined the corporate contribution of technical hardware/software expertise with the philosophical expertise of the educational theorist relative to learner control and instructional hierarchies. Paramount among the significant CAI models to emerge from these efforts was the Stanford Project (Suppes, Jerman, and Brian, 1968).

Initiated under the direction of Patrick Suppes at the Institute for Mathematical Studies in the Social Sciences at Stanford University, the Stanford computer assisted instruction project was among the earliest CAI endeavors in the area of public school education. Begun in 1963, its original aim centered on the development of a small tutorial system intended to provide instruction in elementary mathematics and language arts. By the end of the second year of operation, approximately 400 students had received daily instruction under computer control (Suppes, Jerman, and Brian, 1968).

Concurrently, a second CAI system, known as the Stanford Drill-and-Practice System, was designed by the Stanford group. During the 1967-1968 school year, approximately 3,000 students received daily lessons in initial reading, arithmetic, and spelling (Suppes and Morningstar, 1972).

The PLATO (Programmed Logic for Automatic Teaching Operations) system originated in 1960 in the Coordinated Science Laboratory at the University of Illinois. Over the course of a seven-year developmental phase, the feasibility of effectively utilizing this computer-based teaching system toward the goal of automating individual instruction was explored. During this time, over 300 programs were written for the system to demonstrate its flexibility for teaching as well as for educational research (Lyman, 1972).

The University of Pittsburgh has been active in the field of CAI since the early 1970s in the form of its Project Solo. The project attempted to test the feasibility of deliberately reorganizing a segment of secondary school mathematics around computer-based laboratories intended to preserve the best features of both student-controlled computing and modern math curricula and to integrate mathematics and other disciplines (Dwyer, 1974).

The TURTLE CAI project, developed in the early 1970s at the Massachusetts Institute of Technology under the direction of Seymour Papert, deserves mention in that it was characterized by a unique philosophy which stressed creative functions as opposed to rote aspects of subject matter. The basic tenet of Papert's approach centered on belief in the need to provide learning environments in which students can experientially deal with mental models (Molnar, 1978). MIT LOGO developed out of this project. Over the past decade, thousands of children have used LOGO and its physical incarnation, the "turtle" (Abelson and DiSessa, 1981).

All of these projects, in one way or another, were attempts to show how computers could be used as a learning tool for the student. In a sense, they were all reactions or alternatives to the original philosophy of CAI in which computers were used to deliver instruction.

From the body of CAI studies and research there are some generalized conclusions that can be drawn regarding the effectiveness of CAI in the learning process:

1. The use of CAI either improved learning or showed no difference when compared to traditional classroom approaches (Kearsley, 1976). In other words, achievement was never less using CAI.

2. The effect on achievement occurred regardless of the type of CAI used, the type of computer system, the age range of the students, or the type of instrument used to make the measurements (Hallworth and Brebner, 1980).

3. When CAI and traditional instruction are compared, equal or better achievement using CAI is obtained in less time (Deignan and Duncan, 1978).

4. Foreign languages and science are two areas in which CAI programs consistently have been shown to be effective in

increasing student achievement (Dence, 1980).

Use of the Computer as Media

It is important to determine which media will provide the best instructional results, and to note the cost and availability of each. The choice of vehicle might influence the cost or extent of distributing instruction. Lumsdaine (1963) noted that media might reduce the cost of instruction when many students are serviced. This would come about since the cost of perfecting the instrument could be prorated in terms of a denominator representing a large student population.

The computer is one medium that has drawn a great deal of attention and has been the focus of numerous studies. Computer assisted instruction (CAI) research generally has shown that the use of the computer for delivering instruction results in positive student gains. Recent research has shown that students learn more when using computers than when using conventional classroom instruction (Bracey, 1982). Unfortunately, the cost of this delivery can be quite high.

Computers offer a wide range of instructional modes: tutorials, drill and practice, instructional gaming, simulations, problem solving, instructional management, and instructional support and testing (Price, 1982). This wide range of instructional modes allows teachers more flexibility in incorporating the computer into their own teaching style.

CAI does offer some advantages over traditional methods of instruction. The computer, through CAI programs, can keep the student actively involved and allow the student to progress at his/her own pace. Answers can be judged promptly and responded to with helpful feedback.

The overall analysis and synthesis of many studies points to a significant enhancement of learning in instructional environments supplemented by CAI. Kulik, Bangert, and Williams (1983) analyzed 51 independent studies and found that when CAI was used in instruction, student scores on final examinations were raised. Fisher (1984) found CAI to be particularly effective in raising achievement under certain conditions, one of which is the area of science.

The greatest gains from the use of the computer seem to occur when it is integrated thoughtfully into the on-going curriculum and not used as a replacement for existing courses. Jamison, Suppes, and Wells (1974) concluded that when CAI was used as a supplement to traditional instruction at the elementary level, classroom achievement was improved.

Summary

Research has shown that supplemental instruction can increase learning. However, existing research has been shown to be limited. There is not a body of research that considers utilizing media for supplementary instruction that has controlled the media as the only variable in the instructional process. Likewise, there is little research that looks specifically at either increasing science achievement test scores or at fifth grade students. Avenues that allow for additional student instruction but do not require additional teacher time need to be examined.

It should then be possible to utilize existing media to provide this additional learning and not require additional direct teacher instruction time. With care and consideration given to both content consistency and available media, it should be possible to increase achievement test scores.

CHAPTER III

RESEARCH PROCEDURES

This chapter describes the research process and the procedures used in the study. The chapter encompasses the following: (1) design of the study, (2) description of the subjects studied, (3) instruments, (4) treatments, (5) collection of the data, and (6) design of the statistical analysis of the research data.

Design of the Study

The study used the true experimental design of Pretest-Posttest and Control Group (Campbell and Stanley, 1963). Alternate forms were used for the pretest and posttest.

Students from five, fifth grade classes were randomly placed within each class into one of four groups. All students were given a pretest consisting of the science battery of the *Survey of Basic Skills* - Level 34 (SRA) in the form of version P. Time limits and directions for teacher administration of the test as set forth in the test guidelines were used. The test was administered by other building teachers who served as neutral parties.

During the same two week period, all five classroom teachers presented standard instruction of Chapter I, Activities of Green Plants, from the Silver Burdett Science Series, Grade Five. This textbook served as the basal text for each class. The standard instruction presented by the five different teachers utilized each teacher's own teaching style. Each teacher kept a daily record of instructional time to the nearest five minute interval (see Appendix H). Standardizing of the weeks in which lessons were taught and the duration of the instruction hoped to decrease any possible effects of outside history.

In addition to the standard instruction, each student was exposed to an additional activity. The form of this supplementary instruction or activity depended upon the treatment group to which each student had been randomly assigned. The treatments consisted of:

A) supplementary instruction on green plants using CAI (computer assisted instruction);

B) supplementary instruction via additional reading which was the script version of treatment A;

C) supplementary direct instruction via the classroom teacher which encompasses the script version of treatment A; and

D) completion of a plant related art project which did not use content covered in Treatment A. This group served as the control group.

A panel of four judges were used to determine the content validity of the supplementary treatments. The judges were teachers who had been, or currently were, fifth grade teachers. They were familiar with both the subject material and the curriculum guidelines. The judges were not the same teachers who presented classroom instruction for this study. A checklist was developed by the researcher to aid in the validation process (see Appendices E, F and G). Validation for each question was said to have occurred when there was an 80% minimum agreement that the question from the Survey of Basic Skills test, in versions P and Q, dealing with plant life was covered in Treatments A, B, and C. These same judges were used to validate, by the same technique, that the same question material from the Survey of Basic Skills dealing with plant life was also covered in the basal textbook. The judges also noted whether each question on the science section of the Survey of Basic Skills test did indeed relate to district fifth grade science goals.

The materials for treatments A, B, and C were developed by the researcher. The goals and objectives that were validated by the panel were used as the basis for the CAI text. All the goals and objectives were encompassed in the writing. The treatments were developed so that the same information was presented. An attempt was made to keep those features that are unique to each medium at a minimum. The same panel of judges was used to verify that the identical script had been used in all three treatments and that instructional material had received the same emphasis in each treatment.

All supplementary instruction was completed by the students during the final week of the two week time period. No additional teacher instruction or influence was required when the treatments were provided, as they were self-guided supplementary instruction. However, treatments were completed in the classroom under teacher supervision. The researcher made first hand observations of the entire study process with special emphasis in viewing the treatment process.

At the conclusion of the two week period, a posttest was administered using the science battery from the Survey of Basic Skills - Level 34 (SRA) using version Q. The test was administered by other teachers serving as neutral parties following the guidelines for test administration as established by SRA. The use of alternate forms of the Survey of Basic Skills test served to eliminate the problems of question recall because of the short time interval between test administrations.

The test results were used to determine if the use of supplementary material, or an increase in teacher instruction time, increased test scores by examining the pretest and posttest scores for each of the treatment groups. Differences in test score results between the students using the various treatments (A, B and C) were examined. In addition, the results were examined to note whether there was a difference between the classes, each of which differed in the total minutes of teacher instructional time, and between each of the teachers, whose own unique teaching style might have influenced the effectiveness of a particular medium.

The Population

The population for this study consisted of 130 fifth grade students from the North Clackamas School District located in Milwaukie, Oregon. The students were from five classrooms located in three different schools. According to the Director of Planning and Administrative Services of the North Clackamas School District, these schools represented a wide social and economic base and the students possessed a wide range of academic ability. The students in all five classes had previous experience using each of the media.

The distribution of the student population is shown in Table 1.

Table 1

Distribution of Student Population

class number	building	students
1	A	24
2	A	22
3	A	24
4	B	30
5	C	30
total		130

The Instruments

Two tests, a pretest and a posttest, were administered to each student participating in the study. The science section of the Survey of Basic Skills - Level 34 (SRA) versions P and Q were administered. When testing the alternate forms (versions P and Q) Level 34, SRA obtained a reliability coefficient of .74 using 670 fifth graders. When testing the internal validity of Level 34 (versions P and Q), SRA obtained reliability coefficients of .82 and .80 (KR-20) respectively using 989 fifth graders for each study. SRA made two types of validity studies: (1) correlations of the test with course grades and (2) correlations of the test with other achievement batteries. Correlations between test scores and course grades ranged from .43 to .79. Correlations of test scores with those from other test batteries correlated in the .80s and .90s.

The item pool for this study was selected from those questions that dealt with plants. Each test consisted of 34 multiple choice questions. Those questions identified in version P as dealing with plants were as follows:

Question Number	
13	bean growing
14	bean growing
22	algae - green plants - oxygen
29	plant plankton - sunlight
31	plants and animals
32	plants and animals
33	plants and animals
34	plants and animals

Those questions identified in version Q as dealing with plants were as follows:

<u>Question Number</u>

12 bean growing

13 bean growing

11 green plants - animals - oxygen

23 green plants - fungi

The content validity of the treatments was established by a panel of four judges. The judges were teachers who had been, or currently were, fifth grade teachers, and were familiar with both the subject material and the curriculum guidelines. The judges were not the same teachers who presented classroom instruction for this study. A checklist was developed to aid in the validation process. Validation for each question was said to have occurred when there was an 80% minimum agreement that the question from the *Survey of Basic Skills* test (versions P and Q) dealing with plant life was covered in Treatments A, B, and C (see Appendices E, F and G). Establishing that the question material from the *Survey of Basic Skills* dealing with plant life was also covered in the basal text was done by the same teacher judges.

The panel of judges agreed that the questions on the science section of the Survey of Basic Skills test related to the district fifth grade science goals. The panel agreed that the questions from the Survey of Basic Skills test (versions P and Q) dealing with plant life were covered in Treatments A, B, and C. The panel could not agree that questions 18 and 19 (version Q) were valid, even though they dealt with plants, they were determined not to relate to any plant content. The panel agreed that the remaining question material from the Survey of Basic Skills dealing with plant life was covered in the basal textbook.

The Treatments

The CAI program (see Appendix C), treatment A, was developed by the researcher for the Apple computer and written in BASIC. The text for the CAI program was written using objectives from Chapter I, Activities of Green Plants, Silver Burdett Science Series, Grade Five (see Appendix E).

The additional reading material (see Appendix D), treatment B was the script version of the CAI program in treatment A.

The material covered by the teacher during the additional direct instruction, treatment C, was written by the researcher, using the same instructional goals used in the development of treatment A.

Collection of Data

Permission for collecting the data was obtained from the Director of Planning and Administrative Services of the North Clackamas School District. Arrangements for administering the *Survey of Basic Skills* test was made with each of the classroom teachers. The completed student tests were collected by a neutral party and scored by the researcher.

Administration of the Survey of Basic Skills

The science section of the *Survey of Basic Skills* test version P was administered to the student population at the beginning of the second week in January 1987 in their regular classroom by neutral parties. The posttest, in the form of the science section of the *Survey of Basic Skills* test version Q, was administered to the student population at the end of the last week in January 1987. Both tests were given in the morning, using the 25 minute test time limit and following the guidelines for test administration as established by SRA.

Administration of the Treatments

The classroom teacher offered direct class instruction using the basal textbook and related materials during the first week. During the second week the class time was divided into two time blocks. The first consisted of direct teacher instruction which was followed by the time block allowing for student work time. The students worked on the treatment activity depending on the treatment group to which the student had been assigned.

Statistical Design

The study was designed to determine whether or not the use of supplementary material would increase test scores. The study also was designed to determine if an increase in direct teacher instructional time would increase test scores. The statistical hypotheses to determine the differences in the use of supplementary instructional materials and an increase in teacher instructional time were tested using analysis of covariance with the pretest scores used as the covariate.

The null hypotheses for determining the differences in test scores were as follows:

1. There is no significant difference between the standardized science achievement test scores for fifth grade students using supplementary instructional materials and students not using supplementary instructional materials.

$$\mu 1 = \mu 2$$

2. There is no significant difference between the standardized science achievement test scores for fifth grade students using the computer for supplementary instruction and students not using the computer for supplementary instruction.

$$\mu 1 = \mu 2$$

3. There is no significant difference between the standardized science achievement test scores for fifth grade students using written worksheets for supplementary instruction and students not using the worksheets for supplementary instruction.

$$\mu 1 = \mu 2$$

4. There is no significant difference between the standardized science achievement test scores for fifth grade students utilizing media for supplementary instruction and students receiving additional direct teacher instruction.

$$\mu 1 = \mu 2$$

The mathematical model which is appropriate for testing of hypotheses using analysis of covariance is shown below:

$$Y_{ij} = \mu + \alpha_i + \beta (X_{ij} - \bar{X}) + \varepsilon_{ij}$$

where μ represents the overall mean;

α_i represents the effect of the treatment;

$\beta(X_{ij} - \bar{X})$ represents the adjustment of the postmeasure;

and ε_{ij} is a residual variable.

Table 2 shows the analysis of covariance layout for determining if there is a difference in the use of supplementary instructional materials for increasing test scores or in the use of additional teacher instructional time for increasing test scores.

Table 2

Analysis of Covariance Layout

Source of Variation	df	SS	MS	F
Groups	X1	X4	X4/X1	MSG/MSE
Error	X2	X5	X5/X2	
Corrected Total	X3	X6		

An F-ratio was computed, and the 0.05 level of significance was used to ascertain the differences in the use of supplementary instructional materials for increasing test scores or in the use of additional teacher instructional time for increasing test scores for the analysis of covariance layout in Table 2.

CHAPTER IV

FINDINGS OF THE STUDY

The purposes of this study were as follows: (1) to determine if the use of selected supplementary instructional materials, in the form of either computer assisted instruction or additional readings and worksheet presentations, could influence the test scores relating to science achievement for fifth grade students, and (2) to determine whether an increase in direct teacher instructional time could influence the science achievement test scores for fifth grade students.

The pretest consisting of the science portion of the Survey of Basic Skills version P was administered to 132 fifth grade students in the North Clackamas School District. One hundred thirty students were given the posttest consisting of the science portion of the Survey of Basic Skills version Q. Of the original 132 students, two were not given the posttest for reasons of illness and change of schools.

Table 3 reports the class mean scores.

Table 3

Class Mean Scores

Class Number	Number of Students	Pretest Plant Mean	Posttest Plant Mean
1	24	4.54	2.45
2	22	4.90	2.59
3	24	4.87	2.95
4	30	4.53	2.36
5	30	4.56	2.53
Total	130	4.66	2.56

The mean scores for classes range from 4.53 to 4.90 out of a possible 8.00 on the pretest and from 2.36 to 2.95 out of a possible 4.00 on the posttest. The pretest and posttest mean scores appears to have decreased but the difference is due to the varied number of questions pertaining to plants on test versions P and Q. When compared to the total mean scores of 4.66 on the pretest and 2.56 on the posttest, these scores indicate no great achievement differences concerning the subject area of green plants in any particular class.

The group mean scores for the treatments are presented in Table 4. See Appendix I for the group mean scores for each individual treatment.

Table 4

Group Mean Scores

Treatment	Number of Students	Pretest Plant Mean	Posttest Plant Mean
A (CAI)	33	4.90	2.63
B (Reading Material)	33	4.60	2.60
C (Direct Instruction)	31	4.48	2.45
D (Control Group)	33	4.66	2.51
Total	130	4.66	2.56

The mean score for treatment A (CAI) was 4.90 out of a possible 8.00 on the pretest and 2.63 out of a possible 4.00 on the posttest. The mean score for treatment B (additional reading material) was 4.60 out of a possible 8.00 on the pretest and 2.60 out of a possible 4.00 on the posttest. The mean score for treatment C (additional direct instruction) was 4.48 out of a possible 8.00 on the pretest and 2.45 out of a possible 4.00 on the posttest. The mean score for treatment D (control group) was 4.66 out of a possible 8.00 on the pretest and 2.51 out of a possible 4.00 on the posttest. These can be compared to the total class mean scores of 4.66 on the pretest and 2.56 on the posttest.

It can be observed that the treatment groups range in number of students from 31 to 33 and that the treatment mean scores range from 4.48 to 4.90 on the pretest and from 2.45 to 2.66 on the posttest.

Statistical Analysis of Hypotheses

The statistical hypotheses of whether the use of selected supplementary instructional materials or an increase in direct teacher instructional time could influence the science achievement for fifth grade students were tested using analysis of covariance. In situations where the P value was larger than 0.05, the null hypotheses was accepted. Where the P value was found to be smaller than 0.05, the null hypotheses was rejected.

The null hypotheses for determining whether the use of selected supplementary instructional materials or an increase in direct teacher instructional time could influence the science achievement were as follows:

1. There is no significant difference between the standardized science achievement test scores for fifth grade students using selected supplementary instructional materials and students not using supplementary instructional materials.

2. There is no significant difference between the standardized science achievement test scores for fifth grade students using the computer for supplementary instruction and students not using the computer for supplementary instruction.

3. There is no significant difference between the standardized science achievement test scores for fifth grade students using written worksheets for supplementary instruction and students not using the worksheets for supplementary instruction.

4. There is no significant difference between the standardized science achievement test scores for fifth grade students utilizing selected media for supplementary instruction and students receiving additional direct teacher instruction.

The results for the testing of hypothesis Number one are presented in Table 5.

Table 5

Differences Between Student Scores on Achievement Using Supplementary Instructional Materials (Treatments A, B, and C) and Not Using Supplementary Instructional Materials (Treatment D)

Source of Variation	df	SS	MS	F	P
Groups	1	0.1264	0.1264	0.11	0.7413
Error	127	146.5515	1.1539		
Corrected Total	128	146.6779			

Table 5 shows an F ratio of 0.11 with a P value of 0.7413. Since the P value is greater than the expected level of significance ($\alpha = .05$) the null hypothesis was accepted. Hence, there was no significant difference between science achievement test scores for fifth grade students using selected supplementary instructional materials and students not using supplementary instructional materials.

The results for the testing of hypothesis Number two are presented in Table 6.

Table 6

Differences Between Student Scores on Achievement Using the Computer for Supplementary Instruction (Treatment A) and Not Using Supplementary Instruction (Treatment D)

Source of Variation	df	SS	MS	F	P
Groups	1	0.0482	0.0482	0.04	0.8475
Error	63	81.5015	1.2937		
Corrected Total	64	81.5497			

Table 6 shows an F ratio of 0.04 with a P value of 0.8475. Since the P value is greater than the expected level of significance ($\alpha = .05$) the null hypothesis was accepted. Hence, there was no significant differences between science achievement test scores for fifth grade students using the computer for supplementary instruction and students not using the computer for supplementary instruction.

The results for the testing of hypothesis Number three are presented in Table 7.

Table 7

Differences Between Student Scores on Achievement Using Written Worksheets for Supplementary Instruction (Treatment B) and Not Using Supplementary Instruction (Treatment D)

Source of Variation	df	SS	MS	F	P
Groups	1	0.4627	0.4627	0.41	0.5264
Error	63	71.8388	1.1403		
Corrected Total	64	72.3015			

Table 7 shows an F ratio of 0.41 with a P value of 0.5264. Since the P value is greater than the expected level of significance (α = .05) the null hypothesis was accepted. Hence, there was no significant difference between science achievement test scores for fifth grade students using written worksheets for supplementary instruction and students not using the worksheets for supplementary instruction.

The results for the testing of hypothesis Number four are presented in Table 8.

Table 8

Differences Between Student Scores on Achievement Using Selected Media for Supplementary Instruction (Treatments A and B) and Additional Teacher Supplementary Instruction (Treatment C)

Source of Variation	df	SS	MS	F	P
Groups	1	0.3586	0.3586	0.35	0.5581
Error	94	97.5769	1.0381		
Corrected Total	95	97.9355			

Table 8 shows an F ratio of 0.35 with a P value of 0.5581. Since the P value is greater than the expected level of significance ($\alpha = .05$) the null hypothesis was accepted. Hence, there was no significant difference between science achievement test scores for fifth grade students utilizing selected media for supplementary instruction and students receiving additional direct teacher instruction.

Amount of Direct Teacher Instruction

Table 9 shows the number of minutes of direct teacher instructional time given to the entire class by each classroom teacher. The figures shown were self-reported by each teacher.

Table 9

Total Minutes of Direct Teacher Instruction
Given to the Entire Classroom

Teacher Number	Total Minutes Direct Classroom Instruction
1	235
2	205
3	170
4	52
5	235

Possible differences in teaching styles can be seen in the total number of minutes that direct classroom instruction was offered. Approximately 270 minutes of classroom time was allotted for student learning time by each teacher. Teachers numbers one and five each spent 235 minutes out of a possible 270 minutes in direct class instruction. Whereas, teacher number four spent only 52 minutes out of a possible 270 minutes in direct class instruction. Observation of the classrooms by the researcher showed that the teaching style of teacher number four relied to a great extent on students working individually with the teacher acting as a resource should questions arise.

Statistical Analysis of Additional Teacher Instruction

The results for the testing of additional direct teacher instructional time are presented in Table 10.

Table 10

Differences Between Student Scores on Achievement Using Additional Teacher Supplementary Instruction (Treatment C) and No Additional Teacher Supplementary Instruction (Treatment D)

Source of Variation	df	SS	MS	F	P
Groups	1	0.0163	0.0163	0.01	0.9161
Error	62	88.7570	1.4550		
Corrected Total	63	88.7733			

Table 10 shows an F ratio of 0.01 with a P value of 0.9161. Since the P value is greater than the expected level of significance (α = .05) there was no significant difference between student scores using additional teacher supplementary instruction and students not using additional teacher supplementary instruction.

<u>Statistical Analysis of Differences Between Classrooms</u>

Tables 11 - 15 show the results of student scores in each classroom as compared to student scores in all other classrooms.

Table 11

Differences Between Student Achievement
Scores of Class Number One and All Other Classrooms

Source of Variation	df	SS	MS	F	P
Groups	1	0.1872	0.1872	0.16	0.6877
Error	127	146.4906	1.1535		
Corrected Total	128	146.6778			

Table 12

Differences Between Student Achievement
Scores of Class Number Two and All Other Classrooms

Source of Variation	df	SS	MS	F	P
Groups	1	0.0364	0.0364	0.03	0.8593
Error	127	146.6414	1.1547		
Corrected Total	128	146.6778			

Table 13

Differences Between Student Achievement
Scores of Class Number Three and All Other Classrooms

Source of Variation	df	SS	MS	F	P
Groups	1	3.3910	3.3910	3.01	0.0854
Error	127	143.2868	1.1282		
Corrected Total	128	146.6778			

Table 14

Differences Between Student Achievement
Scores of Class Number Four and All Other Classrooms

Source of Variation	df	SS	MS	F	P
Groups	1	1.1206	1.1206	0.98	0.3246
Error	127	145.5572	1.1461		
Corrected Total	128	146.6778			

Table 15

Differences Between Student Achievement
Scores of Class Number Five and All Other Classrooms

Source of Variation	df	SS	MS	F	P
Groups	1	0.0046	0.0046	0.00	0.9500
Error	127	146.6733	1.1549		
Corrected Total	128	146.6779			

The results from Tables 11-15 show that none of the P values obtained were less than the expected level of significance (α = .05). Hence, there was no significant differences between the student achievement scores of any of the classes compared to student achievement scores in all other classrooms. However, the P value obtained for class number three was much closer to the 0.05 level than any other class.

In conclusion, the results revealed the following:

1. There was no significant difference between the standardized science achievement test scores for fifth grade students using selected supplementary instructional materials and students not using supplementary instructional materials.

2. There was no significant difference between the standardized science achievement test scores for fifth grade students using the computer for supplementary instruction and students not using the computer for supplementary instruction.

3. There was no significant difference between the standardized science achievement test scores for fifth grade students using written worksheets for supplementary instruction and students not using the worksheets for supplementary instruction.

4. There was no significant difference between the standardized science achievement test scores for fifth grade students utilizing selected media for supplementary instruction and students receiving additional direct teacher instruction.

5. There was no significant difference between the scores of any of the classes compared to all other classes.

CHAPTER V

SUMMARY AND CONCLUSIONS

Increasing student learning is a major educational goal. One way it can be measured is by achievement test scores. Research has shown that an increase in test scores can result from an increase in student learning time (Anderson, 1976; Bloom, 1974). However, the school curriculum is filled, and adjustments to the school day to allow for additional direct teacher instruction does not appear to be feasible. It should be possible to increase the student instructional time by utilizing media to provide supplementary instruction. Currently, there is not a body of research that considers utilizing media for supplementary instruction that has controlled for the media as the only variable in the instructional process. There is, likewise, little research that looks specifically at either increasing science achievement test scores or at fifth grade students. Other avenues that allow for additional student instruction but do not require additional teacher time need to be examined.

This chapter presents the following: (1) a summary of the study, which includes the statement of the problem and procedures, (2) conclusions, (3) discussion of the results, and (4) suggestions for further study.

Restatement of the Problem

The purposes of this study were as follows: (1) to determine if the use of selected supplementary instructional materials, in the form of either computer assisted instruction or additional text and worksheet presentations, could influence the science achievement for fifth grade students, and (2) to determine whether an increase in direct teacher instructional time could influence the science achievement for fifth grade students.

Specifically, the following null hypotheses were investigated:

1. There is no significant difference between the standardized science achievement test scores for fifth grade students using selected supplementary instructional materials and students not using supplementary instructional materials.

2. There is no significant difference between the standardized science achievement test scores for fifth grade students using the computer for supplementary instruction and students not using the computer for supplementary

instruction.

3. There is no significant difference between the standardized science achievement test scores for fifth grade students using written worksheets for supplementary instruction and students not using the worksheets for supplementary instruction.

4. There is no significant difference between the standardized science achievement test scores for fifth grade students utilizing selected media for supplementary instruction and students receiving additional direct teacher instruction.

Research Procedures

The Population

The population for this study consisted of 130 fifth grade students from the North Clackamas School District located in Milwaukie, Oregon. The students were from five classrooms located in three different schools. These schools represent a wide social and economic base and the students possess a wide range of academic ability. The students in all five classes had previous experience using each of the media.

Design of the Study

The study used the true experimental design of Pretest-Posttest and Control Group (Campbell and Stanley, 1963). Alternate forms were used for the pretest and posttest.

Students from five fifth grade classes were randomly placed within each class into one of four treatment groups. All students were given a pretest consisting of the science battery of the Survey of Basic Skills - Level 34 (SRA) in the form of version P.

During the same two week period, all five classroom teachers presented standard instruction of Chapter I, Activities of Green Plants, from the Silver Burdett Science Series, Grade Five.

In addition to the standard instruction, each student was exposed to an additional activity. The form of this supplementary instruction or activity depended upon the treatment group to which each student had been randomly assigned. The treatments consisted of:

A) supplementary instruction on green plants during the second week using CAI (computer assisted instruction);

B) supplementary instruction during the second week via additional reading, which was the script version of treatment A;

C) supplementary direct instruction during the second week via the classroom teacher, which encompassed the script version of treatment A; and

D) completion of a plant related art project during the second week which served as the control group.

Before the treatments were applied, a panel of four judges were used to determine the content validity of the supplementary treatments and determined that the same information was presented in treatments A, B, and C.

At the conclusion of the two week period, a posttest was administered using the science battery from the Survey of Basic Skills - Level 34 (SRA) using version Q. The test results were used to determine if the use of supplementary materials, or an increase in teacher instruction time, increased test scores by examining the pretest and posttest scores for each of the treatment groups. The difference in test score results between the various treatments (A, B and C) were examined. In addition, the test scores were examined to note whether there was a difference between the classes, each of which differed in the total amount of direct instructional time, and between each of the teachers, whose own unique teaching style might have influenced the effectiveness of a particular medium.

The Instruments

Two tests, a pretest and a posttest, were administered to each student participating in the study. The science section of the Survey of Basic Skills - Level 34 (SRA) versions P and Q were administered. Each test consisted of 34 multiple choice questions. The item pool for this study was selected from among those 34 questions that dealt with plants.

Administration of the Survey of Basic Skills

The science section of the Survey of Basic Skills test version P was administered to the student population at the beginning of the second week in January 1987 in their regular classroom by neutral parties. The posttest in the form of the science section of the Survey of Basic Skills test version Q was administered to the student population at the end of the last week in January 1987. Both tests were given in the morning using the 25 minute test time limit and following the guidelines for test administration as established by SRA.

Statistical Design

The study was designed to determine if the use of supplementary material would increase student achievement test scores. The study also was designed to determine if an increase in direct teacher instructional time would increase student achievement test scores.

The statistical hypotheses to evaluate the effectiveness of various supplementary instructional materials and to determine the effect of an increase in teacher instructional time were tested using analysis of covariance with the pretest scores used as the covariate. An F-ratio was computed and the 0.05 level of significance was used.

Conclusions

The results of the analyses were as follows:

1. There was no significant difference found between the standardized science achievement test scores for fifth grade students using selected supplementary instructional materials and students not using supplementary instructional materials.

2. There was no significant difference found between the standardized science achievement test scores for fifth grade students using the computer for supplementary instruction and students not using the computer for supplementary instruction.

3. There was no significant difference found between the standardized science achievement test scores for fifth grade students using written worksheets for supplementary instruction and students not using the worksheets for supplementary instruction.

4. There was no significant difference found between the standardized science achievement test scores for fifth grade students utilizing selected media for supplementary instruction and students receiving additional direct teacher instruction.

5. There was no significant difference found between the scores of any individual class when compared to all the other classes.

From these findings it can be concluded that the use of selected supplementary instructional materials, in the form of either computer assisted instruction or additional text and worksheet presentations, did not significantly increase science achievement test scores of 5th grade students.

Discussion of the Findings

This study was intended to determine whether the use of selected supplementary instructional materials, in the form of either computer assisted instruction or additional text and worksheet presentations, could influence the science achievement for fifth grade students and also evaluate the effect of an increase in direct teacher instructional time on science achievement test scores for fifth grade students.

Because definite content areas are covered on standardized achievement tests, it is possible to focus instruction on certain aspects of the curriculum as it relates to those achievement tests. However, it was difficult to find a subject area with sufficient numbers of corresponding questions on alternate forms of the Survey of Basic Skills test that pertained to areas covered in classroom texts. This lack of a large item pool was disturbing in the light of the emphasis given to subject areas by the textbook publishers and those considered important by the test publishers. The subject area of green plants offered the most correlation between textbook and test in grades four, five and six, although the item pool remained small.

The location of the questions on the actual test also posed a problem. Some of the questions under examination by this study were found at the end of the pretest. There were some students, especially in the control group, that did not finish the test and therefore did not answer these items. Since it is not known whether the students could correctly answer these items, it is not possible to properly evaluate their performance on the posttest.

The study found no significant differences in test scores between student groups using either computer assisted instruction, additional text and worksheet presentations, or increased direct teacher instruction. Since Wiley and Harnischfeger (1974) found that the quality and time for instruction have an influence on student achievement, the teachers participating in this study were asked to present the classroom material with the same amount of emphasis and allocate the same amount of class time that the subject would normally receive. However, conversations with the teachers indicated that they may have allocated more class time than in previous years, since they wished to cover all the textbook material in depth.

Studies have shown that if schools can increase the amount of time teachers spend engaging students in learning, higher achievement results. In other words, committing a larger portion of the school day to uninterrupted effective teaching increases student achievement (Cooley and

Leinhardt, 1980; Rutter, Maughan, Mortimore, and Ouston, 1779).

Considering the impact of committing a larger portion of teaching time, and noting that the items under consideration on the Survey of Basic Skills test were shown to correlate to the student textbook, it is possible that the supplementary materials would not show as great an impact since all students would have been taught the material to a higher degree. If, under normal circumstances, the classroom teacher spent less time and emphasis on textbook material instruction then the supplementary materials might tend to have a greater effect. It can be noted that even additional teacher instruction (Treatment C) did not show significant gains. Also to be considered is whether the item pool questions from the Survey of Basic Skills test were able to discriminate whether significant increased learning had taken place. It can be noted that the classroom receiving the least amount of direct teacher instruction showed the smallest increase in pretest/posttest scores.

When undertaking this study, it was noted that since the item pool was small it might not be possible to find significant differences. The teachers providing the instruction were not aware of the test questions. However, the material from which the questions were drawn was found in the basal text as verified by the panel of judges. The teachers would have emphasized that material deemed important. Even though alternate forms were used for the pretest and posttest, the taking of the pretest provided instruction as to the test format and would be responsible for some of the gains on the posttest for all groups. Also, since two test versions were used for the pretest and posttest, it is not known if the students might have scored exceptionally high on the pretest items making it difficult to show significant growth on the posttest.

As Mielke (1968) pointed out, there are some cautions that must be considered when doing media studies. Only the media being considered can be different, and all other aspects of the treatments, including the subject matter content and method of instruction, must be identical. With this consideration, the researcher designed and wrote the CAI program, as well as the additional reading and worksheet materials. Therefore, this study is limited to those particular programs. CAI programs or worksheet materials with a different presentation format may have had a varied effect on student outcomes.

Even though there was no significant difference found between treatments, observations and interviews with students taking part in the study indicated that they enjoyed the computer and art activities more than the additional teacher instruction and supplementary worksheet activities.

When comparing each class against all other classes in the study, it was noted that the P value obtained for class number three was much closer to the 0.05 level than that of any other class. Looking at the individual test scores it was noted that these students scored much better as a group on both tests. However, the high scores were evenly divided among the four treatment groups.

There is a limited amount of direct instructional time available to the classroom teacher. Finding no significant difference between treatments indicates that the use of supplementary activities could replace some of that direct instructional time and not cause any significant loss in student gains. Teachers could then use this available time for additional student contact time and/or work on additional material preparation.

Suggestions for Further Study

The following are suggested for further study:

1. The present study demonstrated that the use of selected supplementary instructional materials, in the form of either computer assisted instruction or additional text and worksheet instruction, did not significantly increase

student test scores in the fifth grade science area covering green plants. More research is needed to determine if the same is true with other science subject areas or with other grade levels.

2. The present study was not able to demonstrate that an increase in direct teacher instructional time was able to significantly increase student test scores in the fifth grade science area of green plants. More research is needed to determine if the same is true with other science subject areas or with other grade levels.

3. This study is specific only to the particular supplementary instructional computer program and worksheets used. More research is needed using other formats of CAI programs and supplemental readings.

4. The use of alternate test forms did not allow for determining if specific material had been mastered. A study should be undertaken using a test-retest format so that specific test responses can be compared.

5. There was difficulty in finding subject areas with sufficient numbers of questions on the alternate forms of the Survey of Basic Skills test. Other achievement tests might be examined to determine if a larger item pool might be obtained.

6. It might be of interest to see if there is a difference in the long term retention of the material presented by each treatment. The same student population could be retested at a later date.

7. The teachers in this study may have presented the basal text information in greater depth during large group instruction, which would tend to reduce the effects of any supplementary treatment. This study should be repeated after establishing a more accurate allocation of direct instructional time.

8. The materials created by the researcher (computer program and written materials with worksheets), could be used again with another student population to determine if the findings are consistent. It might be of value to increase the number of test pool items.

BIBLIOGRAPHY

Abelson, H., and DiSessa, A. Turtle Geometry: The Computer as a Medium for Exploring Mathematics. Cambridge, MA: MIT Press, 1981.

Anderson, L. W. An Empirical Investigation of Individual Differences in Time to Learn. Journal of Educational Psychology, 68, 226-233, 1976.

Atkinson, R. C., and Wilson, H. A. Computer-Assisted Instruction: A Book of Readings. New York: Academic Press, 1969.

Bloom, B. S. Time and Learning. American Psychologist, 29, 682-688, 1974.

Bloom, B. S. The New Direction in Educational Research: Alterable Variables. Phi Delta Kappan, 61, 382-385, 1980.

Bracey, G. W. Computers in Education: What the Research Shows. Electronic Learning, November/December, 1982.

Bridges, E. M. Managing the Incompetent Teacher. School Management Digest Series, Number 29. Eugene, OR: University of Oregon, College of Education, 1984.

Brophy, J. E. Teacher Behavior and Its Effects. Journal of Educational Psychology, 71 (6), 733-750,1979.

Brown, B. W., and Saks, D. H. The Microeconomics of Schooling: How Does the Allocation of Time Affect Learning and What Does It Reveal About Teacher Preferences? Nashville, TN: Vanderbilt University, Vanderbilt Institute for Public Policy Studies, 1983.

Campbell, D. T., Stanley, J. C. Experimental and Quasi-Experimental Designs For Research. Houghton Mifflin Company, 1963.

Carnegie Forum on Education and Economy. A Nation Prepared: Teachers for the 21st Century. Hyattsville, MD, 1986.

Clark, R. E. Reconsidering Research on Learning From Media. Review of Educational Research, 53 (4), 445-459, 1983.

Cooley, W. W. and Leinhardt, G. The Instructional Dimensions Study. Educational Evaluation and Policy Analysis, 2 (1), 7-25, 1980.

Courtney, E. W. Techniques of Research. Corvallis, Oregon: Division of Continuing Education, 1982.

Courtney, E. W. Analysis. Corvallis, Oregon: Division of Continuing Education, 1983.

Deignan, G. M., and Duncan, R. D. CAI in Three Medical Training Courses: It Was Effective! Behavior Research Methods and Instrumentation, 10 (2), 228-230,1978.

Dwyer, T. A. Heuristic Strategies for Using Computers to Enrich Education. International Journal of Man-Machine Studies, 6, 1-16, 1974.

Dence, M. Toward Defining a Role for CAI: A Review. Educational Technology, 20 (11), 50-54, 1980.

Elliot, E. J., and Hall, R. Indicators of Performance: Measuring the Educators. Educational Measurement: Issues and Practice, 4 (2), 6-9, 1985.

Fisher, C. W., Berliner, D. C., Filby, N. N., Marliave, R., Cahen, L. S., Dishaw, M. W., and Moore, J. E. BTES Beginning Teacher Evaluation Study, Technical Report Series, Report VII-1. San Francisco, CA: Far West Laboratory, 1978a.

Fisher, C. W., Berliner, D. C., Filby, N. N., Marliave, R., Cahen, L. S., Dishaw, M. W., and Moore, J. E. Teaching and Learning in Elementary Schools: A Summary of the Beginning Teacher Evaluation Study. San Francisco, CA: Far West Laboratory, 1978b.

Fisher, G. Where CAI is Effective: A Summary of the Report. Electronic Learning, November/December, 1983.

Floden, R. E., Porter, A. C., Schmidt, W. H., Freeman, D. J., and Schwille, J. R. Responses to Curriculum Pressures: A Policy-capturing Study of Teacher Decisions About Content:. East Lansing: Michigan State University, Institute for Research on Teaching, 1980.

Frederiksen, N. The Real Test Bias. Influences of Testing on Teaching and Learning. American Psychologist, 39, 193-202, 1984.

George, P. Coaching for Tests: A Critical Look at the Issues. Curriculum Review, September/October, 1985.

Good, T. L. What is Learned in Schools: Responding to School Demands in Grades K - 6. Paper prepared for the Commission on Excellence in Education, Washington, D.C., 1982.

Haertel, E. H. Construct Validity and Criterion-referenced Testing. Review of Educational Research, 55, 23-46, 1985.

Hald, A. Statistical Tables and Formulas. Wiley Publications in Statistics, 1965.

Hallworth, H. J., and Brebner, A. Computer Assisted Instruction in Schools: Achievements, Present Developments and Projections for the Future. Calgary: Faculty of Education Computer Applications Unit, 1980.

Holmes Group, The. Tomorrow's Teachers: A Report of the Holmes Group. East Lansing, MI, 1986.

Holsinger, D. B. Time, Content and Expectations As Predictors of School Achievement in the USA and Other Developed Countries: A Review of IEA Evidence. Paper presented to the National Commission on Excellence in Education. New York: The State University of New York at Albany, The Center for Educational Research and Policy Studies, 1982.

Huitson, A. The Analysis of Variance. Charles Griffin & Company Limited, 1966.

Jamison, D., Suppes, P., and Welles, S. The Effectiveness of Alternative Instructional Media: A Survey:. Review of Educational Research, 44, 1-68, 1974.

Kearsley, G. P. Some 'Facts' About CAI: Trends 1970-1976. Journal of Educational Data Processing, 13 (3), 1-11, 1976.

Kulik, J. A., Bangert, R. L., and Williams, G. W. Effects of Computer-based Teaching on Secondary School Students. Journal of Educational Psychology, 75 (1), 19-26, 1983.

Kulik, J. A., Kulik, C. C., and Cohen, P. Effectiveness of Computer-Based College Teaching: A Meta-analysis of Findings. Review of Educational Research, 50 (4), 525-544, 1980.

Lumsdaine, A. Instruments and Media of Instruction. Handbook of Research on Teaching. Chicago: Rand McNally, 1963.

Lyman, E. R. A Summary of PLATO Curriculum and Research Materials. Ubana, IL: 1972.

Medley, D. M. Teacher Competence and Teacher Effectiveness. A Review of Process-Product Research. Washington, D.C.: American Association of Colleges for Teacher Education, 1977.

Mielke, K. Questioning the Questions of ETV Research. Educational Broadcasting Review, 2, 6-15, 1968.

Molnar, A. R. The Next Great Crisis in American Education: Computer Literacy. AEDS Journal, 12, 11-19, 1978.

National Commission on Excellence in Education. A Nation at Risk: The Imperative for Educational Reform. Washington, D.C.: U.S. Government Printing Office, 1983.

National Geographic Society. Complex Plants. National Geographic Society, 1974.

National Geographic Society. Green Life. National Geographic Society, 1974.

National Geographic Society. Simple Plants. National Geographic Society, 1974.

Price, R. V. Selecting Educational Computer Software. Educational Resources and Techniques, Spring/Summer, 1982.

Rutter, M., Maughan, B., Mortimore, P. and Ouston, J. Fifteen Thousand Hours: Secondary Schools and Their Effects on Children. Cambridge, MA: Harvard University Press, 1979.

Schoen, H. L., and Hunt, T. C. The Effect of Technology on Instruction: The Literature of the Last 20 Years. AEDS Journal, 10, 62-82, 1977.

Science Research Associates. Survey of Basic Skills Achievement Test Series, level 34, version P, 1985.

Science Research Associates. Survey of Basic Skills Achievement Test Series, level 34, version Q, 1985.

Silver Burdett Elementary Science Program. Silver Burdett Science, Grade Five. Silver Burdett Company, 1985.

Splittgerber, F. L. Computer-Based Instruction: A Revolution in the Making. Educational Technology, 19 (1), 20-26, 1979.

Suppes, P., Jerman, M., and Brian, D. Computer-Assisted Instruction: The 1965-66 Stanford Arithmetic Program. New York: Academic Press, 1968.

Suppes, P., and Macken, E. The Historical Path from Research and Development to Operational Use of CAI. Educational Technology, 18, 9-12, 1978.

Suppes, P., and Morningstar, M. Computer-Assisted Instruction at Stanford, 1966-68: Data, Models, and Evaluation of the Arithmetic Programs. New York: Academic Press, 1972.

Walberg, H. J., Schiller, D., and Haertel, G. D. The Quiet Revolution in Educational Research. Phi Delta Kappan, 61 (3), 179-183, 1979.

Wiley, D. E., and Harnischfeger, A. Explosion of a Myth: Quantity of Schooling and Exposure to Instruction, Major Educational Vehicles. Educational Researcher, 4 (3), 7-11, 1974.

Wolf, R. M. Achievement in America. Educational Environments and Effects. Berkeley, CA: McCutchan, 1979.

APPENDICES

APPENDIX A

SURVEY OF BASIC SKILLS - TEST P

Survey of Basic Skills, Level 34 - Version P

SAMPLE

S1. The brain is located in a human being's

A. chest
B. head
C. neck
D. leg

Directions: Look at the pictures of the four birds and choose the best answer for each question that follows.

1. The best swimmer is probably

A. bird 1
B. bird 2
C. bird 3
D. bird 4

2. The best runner is probably

A. bird 1
B. bird 2
C. bird 3
D. bird 4

Directions: Choose the best answer for each of the following questions.

3. Sound and light bounce off surfaces. What name do scientists use to talk about this kind of bouncing?
   A. Conduction
   B. Induction
   C. Reflection
   D. Refraction

4. The sun is an example of
   A. a star
   B. a planet
   C. a satellite
   D. a constellation

5. What is a microscope slide?
   A. A knob to move the lens up and down
   B. A small piece of glass that holds the sample
   C. A round piece of steel that holds the lens
   D. A U-shaped piece of plastic at the base

6. Every year the Mississippi River deposits soil in the place where it empties into the Gulf of Mexico. This example shows that
   A. flowing water carries soil from place to place
   B. rocks can dissolve in water
   C. sea water is denser than fresh water
   D. the earth's land area keeps growing

Directions: Read this paragraph and study the drawing. Then choose the best answer for each question that follows.

Four students are standing around a bucket of very hot water. Each student holds one end of a stick of the same length and thickness, but one stick is made of iron, one of wood, one of plastic, and one of rubber. The students place the other end of their sticks in the hot water at the same time.

7. Whether a student feels warmth in his or her stick depends on
   A. the shape of the stick
   B. how dense the stick is
   C. what the stick is made of
   D. what the stick weighs

8. The first person who will feel his or her stick getting hot will be the student holding
   A. the wooden stick
   B. the plastic stick
   C. the rubber stick
   D. the iron stick

9. If the sticks are placed in ice water instead of hot hater, the first student who will feel his or her stick getting cold will be the student holding
   A. the rubber stick
   B. the iron stick
   C. the wooden stick
   D. the plastic stick

Directions: Choose the best answer for each of the following questions.

10. Which of these animals that live in water has lungs and breathes air?
    A. A tadpole
    B. A salmon
    C. A herring
    D. A whale

11. The process of changing from a liquid to a gas is called
    A. evaporation
    B. distillation
    C. condensation
    D. precipitation

12. No one has ever seen a live dinosaur. What evidence shows that they really lived?
    A. Dinosaur fossils have been preserved in rocks.
    B. Drawings of dinosaurs have appeared in caves.
    C. Whole dinosaurs have been found frozen in glaciers.
    D. Creatures like dinosaurs are a part of many legends.

Directions: Read this paragraph and study the drawings. Then choose the best answer for each question that follows.

Ten beans are soaked in water for one day. Then the beans are placed on wet cotton in a dish. The drawings show how the beans looked on the three days they were observed.

13. A bean that took longer than any of the others to sprout was
    A. bean 1
    B. bean 2
    C. bean 3
    D. bean 4

14. Which of these is the most likely explanation for the differences between the beans on day 2?
    A. Some beans do not grow in water.
    B. Sometimes beans do not sprout.
    C. The beans are different ages.
    D. Beans sprout at different rates.

<u>Directions:</u> Choose the best answer for each of the following questions.

15. A mixture of liquid X and liquid Y always turns blue when flour is added. The best way to find out whether one liquid alone is causing the effect is to
    A. put liquid X in one test tube, liquid Y in another, and water in a third, add flour to each test tube and compare results
    B. put liquid X in one test tube with flour, liquid Y in another with sugar, and compare results
    C. put liquid X in one test tube with flour, put the same amounts of liquid X and flour again in another test tube, and compare results
    D. put liquid X and liquid Y in one test tube, put the same amounts of X and Y in another test tube with flour, and compare results

16. A chemical change occurs when
    A. baking soda is mixed with vinegar
    B. sugar is mixed with water
    C. baking soda is mixed with salt
    D. sugar is mixed with sand

17. What is the atmosphere of the moon mostly made of?
    A. Water vapor
    B. Carbon dioxide
    C. Nitrogen
    D. The moon has no atmosphere.

Directions: Mary took a census of the sex, hair color, and eye color of each student in her class. Study the table she made from the results and choose the best answer for each question that follows.

18. How many students with brown eyes have black hair?
    A. 3
    B. 6
    C. 9
    D. 11

19. How many of the students in Mary's class have blue eyes?
    A. 5
    B. 8
    C. 13
    D. 26

20. Which of these statements is supported by the data in Mary's table?
    A. More than half the students with brown hair have brown eyes.
    B. More than half the students with brown eyes have black hair.
    C. More than half the students with blond hair have brown eyes.
    D. More than half the students with blue eyes have blond hair.

Directions: Choose the best answer for each of the following questions.

21. When a board is sawed, the cut end of the wood feels very warm. The heat probably comes from
    A. an electric charge that built up when the saw rubbed the board
    B. particles of wood that were made to move more slowly by the vibration of the saw
    C. the friction of the saw rubbing against the wood
    D. sunlight reflected off the metal onto the wood

22. Algae are green plants. This means that in sunlight algae give off
    A. poisons
    B. carbon dioxide
    C. carbon monoxide
    D. oxygen

23. You can see the colors of the spectrum when you look at a diamond in the sunlight. This shows that sunlight
    A. is different from the light of an electric bulb
    B. can be broken into many different colors
    C. travels only in straight lines
    D. is absorbed by the carbon in the diamond

24. Which of the following lists the main parts of the earth in order, from the center to the surface?
    A. Core, crust, mantle
    B. Core, mantle, crust
    C. Mantle, core, crust
    D. Mantle, crust, core

Directions: Read this paragraph and study the table. Then choose the best answer for each question that follows.

Chris collected 1 liter of water from a river each season for one year. He took the water from the same spot every time. He weighed the solid matter in the water and made a table of his findings.

25. When did the water contain the most solid matter?
    A. Spring
    B. Summer
    C. Fall
    D. Winter

26. When was the water in the river flowing the fastest?
    A. Spring
    B. Summer
    C. Fall
    D. Winter

27. What is the name for the solid matter that Chris found in the water?
    A. Conglomerate
    B. Erosion
    C. Precipitate
    D. Sediment

Directions: Choose the best answer for each of the following questions.

28. How is a liquid different from a solid in its physical properties?
    A. The mass of a solid is greater than the mass of a liquid.
    B. The mass of a liquid is greater than the mass of a solid.
    C. Solids have a definite shape, and liquids take the shape of their containers.
    D. Liquids have a definite shape, and solids take the shape of their containers.

29. Plankton are one-celled plants and animals that live in the sea. The plant-plankton are seldom found more than a few inches below the water surface. Why?
    A. There is no carbon dioxide in the sea.
    B. There is too little sunlight deeper in the sea.
    C. Plant-plankton are eaten only by fish that live deeper in the sea.
    D. There is no food for the plankton to eat deeper in the sea.

30. Saliva, pepsin, and lactase are
    A. minerals
    B. enzymes
    C. carbohydrates
    D. fats

<u>Directions:</u> Darnell made the airtight aquarium below for his science class to study how water plants and animals live together. He put in the aquarium everything that was needed for the plants and animals to live and grow. Study Darnell's aquarium and choose the best answer for each question that follows.

31. If all the oxygen in the aquarium were suddenly removed, which would die first?
    A. The fish
    B. The algae
    C. The large water plant
    D. All would die at about the same time.

32. Which of these things in the aquarium is NOT an organism?
    A. The fish
    B. The plants
    C. The snails
    D. The rocks

33. The plant is the
    A. consumer
    B. producer
    C. predator
    D. prey

34. The only thing that enters Darnell's aquarium from the outside is
    A. carbon dioxide
    B. food
    C. energy
    D. oxygen

APPENDIX B

SURVEY OF BASIC SKILLS - TEST Q

<u>Survey of Basic Skills</u>, Level 34 - Version Q

SAMPLE

S1. The brain is located in a human being's
- A. chest
- B. head
- C. neck
- D. leg

Directions: The diagram shows some of the parts of the human body. Look at it and choose the best answer for each question that follows.

1. Which part of the body shown in the diagram grinds food into smaller pieces?
   - A. The saliva glands
   - B. The esophagus
   - C. The teeth
   - D. The liver

2. What system does the diagram show?
   - A. The respiratory system
   - B. The digestive system
   - C. The circulatory system
   - D. The skeletal system

3. Which part of the diagram shows the small intestine?
   A. Part 2
   B. Part 3
   C. Part 4
   D. Part 5

Directions: Choose the best answer for each of the following questions.

4. The attraction between the earth and objects on the surface of the earth is the result of
   A. magnetism
   B. gravity
   C. acceleration
   D. friction
5. A scientist discovers a substance that kills insects. The very next thing the scientist should do is
   A. see if the substance is dangerous to other living things
   B. agree to sell the substance to farmers
   C. destroy the substance because it might kill other living things
   D. try to make the substance even more effective

6. In which kind of telescope is light focused by a mirror?
   A. All telescopes
   B. Refractor telescopes
   C. Reflector telescopes
   D. No telescopes

Directions: Read this paragraph and study the graph. Then choose the best answer for each question that follows.

A science teacher showed her class how temperature changed when ice was heated until it melted and then boiled. A thermometer was frozen in a jar of water and the jar was then heated over a burner. The teacher showed the class how to read the temperature and put the temperature onto a graph like this one:

7. What is the temperature at time C?
    A. -10 C
    B. 0 C
    C. +10 C
    D. +20 C

8. At which time was all the ice melted?
    A. Time A
    B. Time B
    C. Time C
    D. Time D

Directions: Choose the best answer for each of the following questions.

9. Which of these diagrams shows a light beam being reflected?

10. In general, the best way to lose weight is to
    A. exercise more and eat foods with more vitamins
    B. eat foods with fewer calories and more protein
    C. exercise more and eat foods with fewer calories
    D. eat foods with fewer vitamins and more protein

11. An important difference between green plants and animals is that green plants
    A. store energy, but animals do not
    B. give off oxygen, but animals do not
    C. need minerals, but animals do not
    D. live many years, but animals do not

Directions: Read this paragraph and study the drawing. Then choose the best answer for each question that follows.

Ten beans are soaked in water for one day. Then the beans are placed on wet cotton in a dish. The drawings show how the beans looked on the three days they were observed.

12. None of the beans would have sprouted without
    A. water
    B. minerals
    C. light
    D. soil

13. The first sprouts on any of the beans appeared
    A. before noon on day 1
    B. between noon on day 1 and noon on day 2
    C. between noon on day 2 and noon on day 3
    D. after noon on day 3

Directions: Choose the best answer for each of the following questions.

14. Juan wanted to move a 100-kilogram rock in an empty lot. He planned to use a long pole and a log cut in half to help. The picture shows how he set them up on his first try.

    If Juan cannot push hard enough to get the rock to move with the log at point C, he should try again after
    A. getting a thicker log to put under the pole
    B. getting a thinner log to put under the pole
    C. moving the log farther from the rock
    D. moving the log closer to the rock

15. Bicycle tires become warm while you are riding because of
    A. friction
    B. electricity
    C. a chemical change
    D. a physical change

16. Which of the following is a star?
    A. The sun
    B. Orion
    C. The moon
    D. Venus

17. An iodine solution can be used as a test for
    A. sugar
    B. starch
    C. protein
    D. fat

Directions: Read this paragraph and study the table. Then choose the best answer for each question that follows.

Lottie filled three pots exactly alike with the same amount of three different soils. She planted a bean in each pot and gave all three the same amount of water and light. She measured each bean plant once a week, and this is what she found:

18. When does Lottie first observe that the bean plants are NOT the same height?
    A. Week 4
    B. Week 5
    C. Week 6
    D. Week 7

19. Which of these would be the best statement for Lottie to make about the way bean plants grow on the basis of her observations?
    A. Bean plants grow tallest in clay alone.
    B. Bean plants grow tallest in sand alone.
    C. Bean plants grow tallest in a mixture of clay and sand.
    D. The kind of soil makes no difference in the way bean plants grow.

Directions: Choose the best answer for each of the following questions.

20. Which of these sources of energy does NOT decrease in supply as people use it?
    A. Coal
    B. Uranium
    C. Plutonium
    D. Wind

21. Which of the following would be LEAST useful to astronauts on the moon?
    A. A hammer
    B. A rope
    C. Matches
    D. Star maps

22. When two experiments are the same and both are done carefully, the results of the two should agree generally with
    A. the scientist's predictions
    B. each other
    C. all other experiments
    D. proven theories

23. A major difference between green plants and fungi is that green plants
    A. make their own food, but fungi do not
    B. get food from other living things, but fungi do not
    C. have cells, but fungi do not
    D. have spores, but fungi do not

Directions: This is an example of a food chain. Study it and choose the best answer for each question that follows. Answer as if the food chain shows everything these animals eat.

24. If all the hawks died, what would happen FIRST?
    A. The number of snakes would increase.
    B. The number of snakes would decrease.
    C. The number of frogs would increase.
    D. The number of frogs would decrease.

25. Suppose all the snakes died. Which of the following would be most likely to decrease in number?
    A. Clover
    B. Grasshoppers
    C. Frogs
    D. Hawks

26. The arrows in the diagram show the direction of
    A. heat flow through the chain
    B. carbon dioxide flow through the chain
    C. energy flow through the chain
    D. oxygen flow through the chain

27. All the other members of this food chain would decrease in number if an accident killed all
    A. the clover
    B. the grasshoppers
    C. the frogs
    D. the hawks

Directions: Choose the best answer for each of the following questions.

28. Fossils are almost never found in rock formed from lava. Why?
    A. Lava contains bacteria that cause decay.
    B. Animals run away when a volcano erupts.
    C. Lava would trap air with the plant or animal, and it would decay.
    D. Heat from the lava would burn up the plant or animal.

29. A sound is most likely to reflect from a wall that is
    - A. hard and smooth
    - B. hard and rough
    - C. soft and smooth
    - D. soft and rough

30. Carla takes a half-filled bottle of ice water from the refrigerator on a hot, humid day. The bottle has a cork in it. After a while, she notices a puddle under it. What happened?
    - A. Water came through the glass.
    - B. Water vapor from the air condensed onto the cold glass.
    - C. Water leaked through a hole in the cork.
    - D. Water evaporated from the air onto the cold glass.

31. What is the name of the stage of a butterfly's life when it is a caterpillar?
    - A. Parasite
    - B. Pupa
    - C. Nymph
    - D. Larva

<u>Directions:</u> Look at this picture of a mountain, a V-shaped valley, a river, and a lake. Then choose the best answer for each question that follows.

32. How was the valley probably formed?
    - A. The river deposited sediments.
    - B. Ice wore away the rock.
    - C. The river wore away the rock.
    - D. The mountain formed around the river.

33. The valley would probably be a good place to look for fossils if some of the rock that is showing is
    A. granite
    B. sedimentary
    C. marble
    D. metamorphic

34. The oldest rocks are probably at the bottom of the valley because
    A. new rock layers are usually formed by lava
    B. older rock layers contain the largest sediments
    C. new rock layers form on top of older rock layers
    D. older rock layers are heavier and usually sink

APPENDIX C

TREATMENT A - BASIC PROGRAM

TREATMENT A - APPLESOFT BASIC CODE

```
1 REM 1000 TITLE
2 REM 2000 INTRO
3 REM 3000 TEXT
4 REM 6000 CORRECT ANSWER
5 REM 6500 WRONG ANSWER
6 REM 6600 REVIEW FRAME
7 REM 7000 REVIEW MATERIAL
8 REM 10000 SPACEBAR ROUTINE
10 TEXT : HOME : SPEED = 255
20 REM TITLE
30 GOSUB 1000
40 REM INTRO
50 GOSUB 2000
60 REM PLANT TEXT
70 GOSUB 3000
80 REM REPLAY PROGRAM
90 GOSUB 5930
100 HOME : END
1000 REM TITLE SCREEN
1010 RETURN
2000 REM INTRO
2010 VTAB(4) : PRINT "In this lesson you will learn about
     green plants."
2020 GOSUB 10000
2030 RETURN
3000 REM PLANT TEXT
3010 HOME : PRINT "All living things are divided into two
     large groups. These two groups are called the animal
     kingdom and the plant kingdom."
3020 GOSUB 10000
3030 VTAB (8) : HTAB (1) : PRINT "Usually it is easy to
     distinguish a plant from an animal. For example, a tree
     is a plant and a dog is an animal."
3040 GOSUB 10000
3045 VTAB (14): HTAB (1) : PRINT "Plants and animals do have
     striking differences. Plants alone are the food makers
     of the world.";
3050 PRINT "Animals eat plants and other animals, but they
     cannot make food for themselves. Yet, they are also
     alike in many ways."
3060 GOSUB 10000
3070 HOME : PRINT "All living things have many traits in
     common. All living things grow. They all maintain
     themselves or keep themselves alive. All living things
     reproduce."
3080 GOSUB 10000
```

```
3090 VTAB (8) : HTAB (1) : PRINT "The smallest whole part of
     a living thing is the cell. Cells are the building
     blocks of living things. All living organisms, both
     plants and animals, are composed of cells."
3100 GOSUB 10000
3110 VTAB (16) : HTAB (1) : PRINT "Some plants and animals
     consist of only a single cell. These single celled
     plants and animals are the simplest form of life on
     earth. Most familiar plants and animals are made up of
     many cells."
3120 GOSUB 10000
3130 HOME : PRINT : PRINT "Let's see what you remember."
3140 GOSUB 10000
3150 HOME : VTAB (2) : HTAB (4) : PRINT : PRINT "All living
     things"
3160 VTAB (8) : HTAB (12) : INVERSE : PRINT "1" : NORMAL :
     PRINT ". produce food."
3170 VTAB (11) : HTAB (12) : INVERSE : PRINT "2" : NORMAL :
     PRINT ". breathe oxygen."
3180 VTAB (14) : HTAB (12) : INVERSE : PRINT "3" : NORMAL :
     PRINT ". grow."
3190 VTAB (18) : HTAB (12) : GET A$
3200 IF A$ = CHR$ (49) THEN GOSUB 6500 : GOTO 7010
3210 IF A$ = CHR$ (50) THEN GOSUB 6500 : GOTO 7010
3220 IF A$ = CHR$ (51) THEN GOSUB 6000 : GOTO 3240
3230 GOTO 3190
3240 GOSUB 10000
3250 HOME : VTAB (2) : HTAB (4) : PRINT : PRINT "The
     smallest whole part of a living thing is the"
3260 VTAB (8) : HTAB (12) : INVERSE : PRINT "1" : NORMAL :
     PRINT ". cell."
3270 VTAB (11) : HTAB (12) : INVERSE : PRINT "2" : NORMAL :
     PRINT ". head."
3280 VTAB (14) : HTAB (12) : INVERSE : PRINT "3" : NORMAL :
     PRINT ". nucleus."
3290 VTAB (18) : HTAB (12) : GET A$
3300 IF A$ = CHR$ (49) THEN GOSUB 6000 : GOTO 3340
3310 IF A$ = CHR$ (50) THEN GOSUB 6500 : GOTO 7050
3320 IF A$ = CHR$ (51) THEN GOSUB 6500 : GOTO 7050
3330 GOTO 3290
3340 GOSUB 10000
3350 HOME : VTAB (2) : HTAB (4) : PRINT : PRINT "All living
     organisms are composed of"
3360 VTAB (8) : HTAB (12) : INVERSE : PRINT "1" : NORMAL :
     PRINT ". blood."
3370 VTAB (11) : HTAB (12) : INVERSE : PRINT "2" : NORMAL :
     PRINT ". cells."
3380 VTAB (14) : HTAB (12) : INVERSE : PRINT "3" : NORMAL :
     PRINT ". muscle."
3390 VTAB (18) : HTAB (12) : GET A$
```

```
3400 IF A$ = CHR$ (49) THEN GOSUB 6500 : GOTO 7080
3410 IF A$ = CHR$ (50) THEN GOSUB 6000 : GOTO 3440
3420 IF A$ = CHR$ (51) THEN GOSUB 6500 : GOTO 7090
3430 GOTO 3390
3440 GOSUB 10000
3450 REM KINDS OF PLANTS
3460 HOME : HTAB (1) : PRINT "There are many kinds of
     plants. Some plants are large, such as the giant
     sequoia tree of California which can grow to a height
     of more than three hundred feet.";
3470 PRINT "Some plants are small. Bacteria, which are
     one-celled plants are so tiny they can be seen only
     through a microscope."
3475 GOSUB 10000
3480 VTAB (12) : HTAB (1) : PRINT "Scientists group, or
     classify, plants. They study plants and group them
     according to similarities and differences. To group a
     plant it must be observed carefully.";
3490 PRINT "All the parts are examined and it is noted how
     the parts are put together."
3500 GOSUB 10000
3510 HOME : PRINT "One group contains algae, fungi, and
     lichens. These plants do not have roots, stems, flowers
     or leaves."
3515 GOSUB 10000
3520 VTAB (7) : HTAB (1) : PRINT "There are many kinds of
     algae. Seaweeds and many freshwater plants are algae.
     The familiar green scum on the surface of ponds is
     algae.";
3530 PRINT "Many algae can be seen only through a
     microscope. But others are large and are visible to the
     unaided eye."
3540 GOSUB 10000
3550 HOME : PRINT "Bacteria are among the most common fungi.
     They are too small to be seen by the eyes alone. A
     microscope is needed to bring them into view.";
3560 PRINT "Many fungus plants are molds, which grow in
     dark, moist places. Molds grow on foods, wood, paper,
     leather, and many other materials.";
3570 PRINT "The fungi differ from other plants in an
     important way. They cannot make food for themselves. To
     get their nourishment many fungi attach themselves to
     green plants."
3575 GOSUB 10000
3580 VTAB (16) : HTAB (1) : PRINT "Lichens are a combination
     of algae and fungi. The algae in lichens make food for
     both themselves and the fungi."
3590 GOSUB 10000
3600 HOME : PRINT "Another group includes mosses and
     liverworts. Liverworts are small green plants. They
```

```
     grow in damp, shady places.";
3605 PRINT "They cling to rocks, soil, and tree trunks. It
     is believed that liverworts were the first land
     plants."
3607 GOSUB 10000
3610 VTAB (10) : HTAB (1) : PRINT "The mosses probably
     developed from liverworts. They have many traits of the
     liverwort but they are more advanced in their
     development and ways of living. Each moss plant has
     a stem, leaves, and thread-like roots.";
3620 PRINT "Few plants are more widely scattered than
     mosses. They grow throughout the world and are even
     found in the Arctic and Antarctic. They are mostly land
     plants, but some grow in water. Mosses grow in cool,
     moist places."
3630 GOSUB 10000
3640 HOME : PRINT "Ferns belong to another group. Ferns have
     a long history. These plants once formed most of the
     earth's vegetation. Ferns do not have flowers, seeds,
     or fruits.";
3650 PRINT "They reproduce by means of spores. The spores
     are found underneath the fern leaf. You can recognize
     them by noticing the brown spots. Ferns grow best in
     moist, shady places."
3655 GOSUB 10000
3660 VTAB (12) : HTAB (1) : PRINT "The next big group of
     plant life consists of those plants that have seeds.
     Some seed producing plants have seeds that are enclosed
     in a kind of case.";
3670 PRINT "Familiar garden flowers all have covered seeds.
     In some trees the seed case, along with the seed, is a
     fruit such as an apple or a walnut. Some trees that
     have green needles all year round have their seeds in
     cones."
3680 GOSUB 10000
3690 HOME : PRINT : PRINT "Let's see what you remember."
3700 GOSUB 10000
3710 HOME : VTAB (2) : HTAB (4) : PRINT : PRINT "Fungi
     differ from other plants in that they"
3720 VTAB (8) : HTAB (12) : INVERSE : PRINT "1" : NORMAL :
     PRINT ". only have leaves."
3730 VTAB (11) : HTAB (12) : INVERSE : PRINT "2" : NORMAL :
     PRINT ". can not make food for themselves."
3740 VTAB (14) : HTAB (12) : INVERSE : PRINT "3" : NORMAL :
     PRINT ". are too small to be seen."
3750 VTAB (18) : HTAB (12) : GET A$
3760 IF A$ = CHR$ (49) THEN GOSUB 6500 : GOTO 7120
3770 IF A$ = CHR$ (50) THEN GOSUB 6000 : GOTO 3800
3780 IF A$ = CHR$ (51) THEN GOSUB 6500 : GOTO 7120
3790 GOTO 3750
```

```
3800 GOSUB 10000
3810 HOME : VTAB (2) : HTAB (4) : PRINT : PRINT "Few plants
     are more widely scattered than"
3820 VTAB (8) : HTAB (12) : INVERSE : PRINT "1" : NORMAL :
     PRINT ". lichens."
3830 VTAB (11) : HTAB (12) : INVERSE : PRINT "2" : NORMAL :
     PRINT ". liverworts."
3840 VTAB (14) : HTAB (12) : INVERSE : PRINT "3" : NORMAL :
     PRINT ". mosses."
3850 VTAB (18) : HTAB (12) : GET A$
3860 IF A$ = CHR$ (49) THEN GOSUB 6500 : GOTO 7160
3870 IF A$ = CHR$ (50) THEN GOSUB 6500 : GOTO 7160
3880 IF A$ = CHR$ (51) THEN GOSUB 6000 : GOTO 3900
3890 GOTO 3850
3900 GOSUB 10000
3910 HOME : VTAB (2) : HTAB (4) : PRINT : PRINT "Ferns
     reproduce by means of"
3920 VTAB (8) : HTAB (12) : INVERSE : PRINT "1" : NORMAL :
     PRINT ". spores."
3930 VTAB (11) : HTAB (12) : INVERSE : PRINT "2" : NORMAL :
     PRINT ". seeds."
3940 VTAB (14) : HTAB (12) : INVERSE : PRINT "3" : NORMAL :
     PRINT ". flowers."
3950 VTAB (18) : HTAB (12) : GET A$
3960 IF A$ = CHR$ (49) THEN GOSUB 6000 : GOTO 3995
3970 IF A$ = CHR$ (50) THEN GOSUB 6000 : GOTO 7200
3980 IF A$ = CHR$ (51) THEN GOSUB 6500 : GOTO 7200
3990 GOTO 3950
3995 GOSUB 10000
4000 REM ROOTS OF PLANTS
4010 HOME : PRINT "The root is usually the underground part
     of a plant. Roots hold the plant in position. The roots
     absorb water from the soil. They also absorb dissolved
     minerals."
4020 GOSUB 10000
4030 VTAB (9) : HTAB (1) : PRINT "There are different kinds
     of roots in plants. Some are large or long in
     appearance like those of carrots, beets, and turnips.
     Others, like grasses, spread out in all directions."
4040 GOSUB 10000
4050 VTAB (17) : HTAB (1) : PRINT "Some roots are close to
     the ground and hardly break the surface. Other roots
     grow down into the soil fifteen feet or more."
4060 GOSUB 10000
4070 HOME : PRINT "If seeds are set in a moist, warm
     location they will germinate or sprout. Seeds often
     germinate at different rates. When a seed does
     germinate the first part to appear is the root."
4080 GOSUB 10000
4090 VTAB (9) : HTAB (1) : PRINT "For a long time it was
```

```
     thought that roots grow downward because of the plant's
     need of moisture. Plants do need moisture and the roots
     absorb moisture."
4100 GOSUB 10000
4110 VTAB (17) : HTAB (1) : PRINT "But, this need for
     moisture is not a true explanation of why roots grow
     downward. It has been found that roots grow downward
     because of gravity."
4120 GOSUB 10000
4125 HOME : PRINT "If a plant is placed on its side certain
     chemicals in the plant will cause the stem to bend
     upward near their tips. Gravity will cause the roots to
     grow downward."
4126 GOSUB 10000
4127 HOME : PRINT "The tip of the root is considered the
     root system's sense of touch. It seeks the right kind
     of moisture, the most desirable temperature, and the
     proper food.";
4128 PRINT "It may guide the root system around obstacles.
     The root tip is protected by a thimble-like cap.
     Without this protection it could hardly endure all the
     things it runs into."
4129 GOSUB 10000
4130 VTAB (12) : HTAB (1) : PRINT "The life of a plant is
     measured by the length of time its roots live and work.
     Annuals have root systems that last for only one year.
     Biennials live for two years, and perennials live for
     many years."
4131 GOSUB 10000
4135 HOME : PRINT : PRINT "Let's see what you remember."
4140 GOSUB 10000
4150 HOME : VTAB (2) : HTAB (4) : PRINT : PRINT "In order to
     sprout seeds need"
4160 VTAB (8) : HTAB (12) : INVERSE : PRINT "1" : NORMAL :
     PRINT ". light."
4170 VTAB (11) : HTAB (12) : INVERSE : PRINT "2" : NORMAL :
     PRINT ". soil."
4180 VTAB (14) : HTAB (12) : INVERSE : PRINT "3" : NORMAL :
     PRINT ". water."
4190 VTAB (18) : HTAB (12) : GET A$
4200 IF A$ = CHR$ (49) THEN GOSUB 6500 : GOTO 7250
4210 IF A$ = CHR$ (50) THEN GOSUB 6500 : GOTO 7250
4220 IF A$ = CHR$ (51) THEN GOSUB 6000 : GOTO 4240
4230 GOTO 4190
4240 GOSUB 10000
4250 HOME : VTAB (2) : HTAB (4) : PRINT : PRINT "Seeds
     sprout"
4260 VTAB (8) : HTAB (12) : INVERSE : PRINT "1" : NORMAL :
     PRINT ". at different rates."
4270 VTAB (11) : HTAB (12) : INVERSE : PRINT "2" : NORMAL :
```

```
     PRINT ". at the same time."
4280 VTAB (14) : HTAB (12) : INVERSE : PRINT "3" : NORMAL :
     PRINT ". every five minutes."
4290 VTAB (18) : HTAB (12) : GET A$
4300 IF A$ = CHR$ (49) THEN GOSUB 6000 : GOTO 4340
4310 IF A$ = CHR$ (50) THEN GOSUB 6500 : GOTO 7300
4320 IF A$ = CHR$ (51) THEN GOSUB 6500 : GOTO 7300_
4330 GOTO 4290
4340 GOSUB 10000
4350 HOME : VTAB (2) : HTAB (4) : PRINT : PRINT "Roots grow
     downward because of"
4360 VTAB (8) : HTAB (12) : INVERSE : PRINT "1" : NORMAL :
     PRINT ". a lack of light."
4370 VTAB (11) : HTAB (12) : INVERSE : PRINT "2" : NORMAL :
     PRINT ". gravity."
4380 VTAB (14) : HTAB (12) : INVERSE : PRINT "3" : NORMAL :
     PRINT ". moisture."
4390 VTAB (18) : HTAB (12) : GET A$
4400 IF A$ = CHR$ (49) THEN GOSUB 6500 : GOTO 7350
4410 IF A$ = CHR$ (50) THEN GOSUB 6000 : GOTO 4400
4420 IF A$ = CHR$ (51) THEN GOSUB 6500 : GOTO 7350
4430 GOTO 4390
4440 GOSUB 10000
4450 REM THE STEM
4460 HOME : HTAB (1) : "The stem is an important part of the
     plant. It connects the leaves to the root system. The
     stem is a pipeline that transports food and raw
     materials."
4470 GOSUB 10000
4480 VTAB (8) : HTAB (1) : PRINT "The root system absorbs
     water and minerals from the soil. These raw materials
     travel through the stem to the leaves.";
4490 PRINT "All the food for the plant is manufactured in
     the leaves. The food then travels back through the stem
     to the roots."
4500 GOSUB 10000
4510 HOME : PRINT "The stem helps the leaves absorb light.
     It holds the leaves in place and keeps them turned
     toward the light.";
4515 PRINT "If the leaves somehow fall into a shadow the
     stem then bends or moves to get the leaves back into
     the light."
4517 GOSUB 10000
4520 HOME : PRINT "The stems of some plants are underground.
     These underground stems serve the plants by storing
     food. The potato and onion that you eat are actually
     underground stems.";
4530 PRINT "Some cactuses have fleshy stems that absorb
     great quantities of water during occasional rainfalls.
     The stems store the water for use during dry times."
```

```
4540 GOSUB 10000
4690 HOME : PRINT : PRINT "Let's see what you remember."
4700 GOSUB 10000
4710 HOME : VTAB (2) : HTAB (4) : PRINT : PRINT "The stem
     helps the plant by"
4720 VTAB (8) : HTAB (12) : INVERSE : PRINT "1" : NORMAL :
     PRINT ". holding the plant in position."
4730 VTAB (11) : HTAB (12) : INVERSE : PRINT "2" : NORMAL :
     PRINT ". transporting food and raw materials."
4740 VTAB (14) : HTAB (12) : INVERSE : PRINT "3" : NORMAL :
     PRINT ". absorbing water from the soil."
4750 VTAB (18) : HTAB (12) : GET A$
4760 IF A$ = CHR$ (49) THEN GOSUB 6500 : GOTO 7400
4770 IF A$ = CHR$ (50) THEN GOSUB 6000 : GOTO 4800
4780 IF A$ = CHR$ (51) THEN GOSUB 6500 : GOTO 7400
4790 GOTO 4750
4800 GOSUB 10000
4810 HOME : VTAB (2) : HTAB (4) : PRINT : PRINT "Underground
     stems serve the plant by"
4820 VTAB (8) : HTAB (12) : INVERSE : PRINT "1" : NORMAL :
     PRINT ". keeping the soil from moving away."
4830 VTAB (11) : HTAB (12) : INVERSE : PRINT "2" : NORMAL :
     PRINT ". making homes for animals."
4840 VTAB (14) : HTAB (12) : INVERSE : PRINT "3" : NORMAL :
     PRINT ". storing food."
4850 VTAB (18) : HTAB (12) : GET A$
4860 IF A$ = CHR$ (49) THEN GOSUB 6500 : GOTO 7450
4870 IF A$ = CHR$ (50) THEN GOSUB 6500 : GOTO 7450
4880 IF A$ = CHR$ (51) THEN GOSUB 6000 : GOTO 4900
4890 GOTO 4850
4900 GOSUB 10000
5000 REM THE LEAVES
5010 HOME : PRINT "Leaves of plants perform an important
     function. They are the part of the plant that
     manufactures food."
5020 GOSUB 10000
5030 VTAB (7) : HTAB (1) : PRINT "The veins in the leaves
     are tubes that carry water and minerals into the leaf.
     The vein pattern differs in various leaves. Often there
     is a major vein found in the center of the leaf."
5040 GOSUB 10000
5045 VTAB (16) : HTAB (1) : PRINT "Chemical energy is stored
     in food. Every living thing must have this energy to
     remain alive. A green plant is the only living thing
     that produces its own food."
5060 GOSUB 10000
5070 HOME : PRINT "The leaves of green plants make food
     through a process known as photosynthesis. The word
     photosynthesis means 'putting together with the help of
     light'."
```

```
5080 GOSUB 10000
5090 VTAB (8) : HTAB (1) : PRINT "To make food, a leaf puts
     water and carbon dioxide together. But it can put these
     things together only with the help of light. It needs
     the energy that light provides."
5100 GOSUB 10000
5110 VTAB (16) : HTAB (1) : PRINT "The leaf changes light
     energy into chemical energy. A substance known as
     chlorophyll brings about this change in energy. Every
     green leaf contains chlorophyll."
5111 GOSUB 10000
5112 HOME : PRINT " The leaf gets water through the roots
     and stem of the plant. It draws in carbon dioxide from
     the air. With the help of light and chlorophyll, the
     leaf combines the water and carbon dioxide to make
     sugar."
5113 GOSUB 10000
5114 VTAB (10) : HTAB (1) : PRINT "If a plant doesn't need
     all the sugar it produces, then it changes the sugar
     into starch. It stores this starch in the stem for
     later use, such as a potato or beet does."
5115 GOSUB 10000
5116 VTAB (18) : HTAB (1) : PRINT "With sugar and starch,
     the plants have food. The plants, in turn, provide food
     for animals. All animals, including human beings, are
     dependent on plants."
5117 GOSUB 10000
5120 HOME : PRINT "As it makes sugar, the leaf gives off
     oxygen. Scientists say that oxygen is a by-product of
     photosynthesis."
5122 GOSUB 10000
5124 VTAB (8) : HTAB (1) : PRINT "But this by-product is not
     wasted. It is returned to the air that animals breathe
     to stay alive. Plants take in carbon dioxide and give
     off oxygen."
5126 GOSUB 10000
5130 HOME : PRINT : PRINT "Let's see what you remember."
5140 GOSUB 10000
5150 HOME : VTAB (2) : HTAB (4) : PRINT : PRINT "The leaves
     of green plants make food through a process known as"
5160 VTAB (8) : HTAB (12) : INVERSE : PRINT "1" : NORMAL :
     PRINT ". condensation."
5170 VTAB (11) : HTAB (12) : INVERSE : PRINT "2" : NORMAL :
     PRINT ". photography."
5180 VTAB (14) : HTAB (12) : INVERSE : PRINT "3" : NORMAL :
     PRINT ". photosynthesis."
5190 VTAB (18) : HTAB (12) : GET A$
5200 IF A$ = CHR$ (49) THEN GOSUB 6500 : GOTO 7500
5210 IF A$ = CHR$ (50) THEN GOSUB 6500 : GOTO 7500
5220 IF A$ = CHR$ (51) THEN GOSUB 6000 : GOTO 5240
```

```
5230 GOTO 5190
5240 GOSUB 10000
5250 HOME : VTAB (2) : HTAB (4) : PRINT : PRINT "From the
     air a leaf draws in"
5260 VTAB (8) : HTAB (12) : INVERSE : PRINT "1" : NORMAL :
     PRINT ". carbon dioxide."
5270 VTAB (11) : HTAB (12) : INVERSE : PRINT "2" : NORMAL :
     PRINT ". oxygen."
5280 VTAB (14) : HTAB (12) : INVERSE : PRINT "3" : NORMAL :
     PRINT ". chlorine."
5290 VTAB (18) : HTAB (12) : GET A$
5300 IF A$ = CHR$ (49) THEN GOSUB 6000 : GOTO 5340
5310 IF A$ = CHR$ (50) THEN GOSUB 6500 : GOTO 7550
5320 IF A$ = CHR$ (51) THEN GOSUB 6500 : GOTO 7550
5330 GOTO 5290
5340 GOSUB 10000
5350 HOME : VTAB (2) : HTAB (4) : PRINT : PRINT "As a leaf
     makes sugar it gives off"
5360 VTAB (8) : HTAB (12) : INVERSE : PRINT "1" : NORMAL :
     PRINT ". carbon dioxide."
5370 VTAB (11) : HTAB (12) : INVERSE : PRINT "2" : NORMAL :
     PRINT ". oxygen."
5380 VTAB (14) : HTAB (12) : INVERSE : PRINT "3" : NORMAL :
     PRINT ". chlorine."
5390 VTAB (18) : HTAB (12) : GET A$
5400 IF A$ = CHR$ (49) THEN GOSUB 6500 : GOTO 7600
5410 IF A$ = CHR$ (50) THEN GOSUB 6000 : GOTO 5400
5420 IF A$ = CHR$ (51) THEN GOSUB 6500 : GOTO 7600
5430 GOTO 5390
5440 GOSUB 10000
5450 REM FLOWERS
5460 HOME : HTAB (1) : PRINT "Flowers are important parts of
     a plant. They serve as organs of reproduction. Without
     flowers, some plants would not be able to reproduce."
5470 GOSUB 10000
5480 VTAB (8) : HTAB (1) : PRINT "The fragrance and beauty
     of flowers is not intended for humans. They are meant
     for insects. Sweet smells, bright colors, different
     sizes, different shapes, even foul odors all attract
     insects."
5500 GOSUB 10000
5510 HOME : PRINT "Insects are the plant's partners in
     forming seeds to start a new plant. Flowers produce
     pollen, which contains material necessary for
     reproduction."
5515 GOSUB 10000
5520 VTAB (8) : HTAB (1) : PRINT "As the insects seek nectar
     from the flowers, they move the pollen from one flower
     to another. This transfer of pollen is called
     pollination.";
```

```
5521 PRINT "Bees, birds, moths, flies, beetles, wind, and
     many other agents pollinate flowers."
5540 GOSUB 10000
5550 HOME : PRINT "A typical flower has a ring of leaflike
     sections around the petals. These parts are called
     sepals. Inside the sepals are the petals. The petals
     are usually brightly colored."
5555 GOSUB 10000
5560 VTAB (10) : HTAB (1) : PRINT "In the center of the
     flower are slender, stalklike parts called stamens. A
     knob at the end of each stamen is called the anther.";
5561 PRINT "The anther is the male part of the flower.
     Pollen develops within the anther."
5565 GOSUB 10000
5570 HOME : PRINT "The stamens surround the female part of
     the flower. The female part is called the pistil. It is
     in the center of the flower. Inside the pistil is the
     ovary.";
5572 PRINT "It contains the ovules that develop into seeds.
     They contain the female egg cell."
5575 GOSUB 10000
5580 VTAB (10) : HTAB (1) : PRINT "Pollination causes an
     ovule to become a seed. As the seed grows, other parts
     of the flower develop into food that surrounds the
     seed.";
5581 PRINT "The developing seed with its surrounding food
     becomes the fruit of the plant such as a watermelon."
5590 GOSUB 10000
5600 HOME : PRINT "The work of the flower is done once
     fertilization takes place. The flower withers and dies.
     Its shape, its color, its odor and all its parts have
     helped a seed to form."
5607 GOSUB 10000
5610 VTAB (10) : HTAB (1) : PRINT "Having formed a seed, the
     flower has accomplished its mission. New plants can now
     grow from seeds."
5630 GOSUB 10000
5690 HOME : PRINT : PRINT "Let's see what you remember."
5700 GOSUB 10000
5710 HOME : VTAB (2) : HTAB (4) : PRINT : PRINT "The
     transfer of pollen is called "
5720 VTAB (8) : HTAB (12) : INVERSE : PRINT "1" : NORMAL :
     PRINT ". photosynthesis."
5730 VTAB (11) : HTAB (12) : INVERSE : PRINT "2" : NORMAL :
     PRINT ". pollination."
5740 VTAB (14) : HTAB (12) : INVERSE : PRINT "3" : NORMAL :
     PRINT ". chlorophyll."
5750 VTAB (18) : HTAB (12) : GET A$
5760 IF A$ = CHR$ (49) THEN GOSUB 6500 : GOTO 7650
5770 IF A$ = CHR$ (50) THEN GOSUB 6000 : GOTO 5800
```

```
5780 IF A$ = CHR$ (51) THEN GOSUB 6500 : GOTO 7650
5790 GOTO 5750
5800 GOSUB 10000
5810 REM REVIEW
5820 HOME : PRINT "Plants and animals are living things.
     They have traits in common but also differ in some
     ways."
5830 GOSUB 10000
5840 VTAB (8) : HTAB (1) : PRINT "One thing that sets a
     plant apart from an animal is its ability to make its
     own food. Green plants, and only green plants, are the
     food makers among living things."
5850 GOSUB 10000
5860 VTAB (17) : HTAB (1) : PRINT "Green plants use light,
     chlorophyll, water, and carbon dioxide to make sugar.
     This process is photosynthesis."
5865 GOSUB 10000
5870 HOME : PRINT "There are major groups of plants. Some
     are simple plants that include algae, fungi, lichens,
     mosses and liverworts. Another group includes the
     familiar plants we see all around:";
5880 PRINT " trees, vegetables, shrubs, and garden flowers.
     Some of these have flowers and bear covered seeds or
     have their seeds in cones."
5890 GOSUB 10000
5900 HOME : PRINT "Green plants have roots, stems, and
     leaves. These parts all work together to nourish the
     plant. Roots grow downward into the soil for moisture
     and minerals.";
5910 PRINT "The roots and stems carry moisture and minerals
     to the leaves. The leaves are the food factories.
     Photosynthesis occurs in the leaves."
5920 GOSUB 10000
5925 RETURN
5930 HOME : VTAB (10) : HTAB (6) : PRINT "The end ... Thanks
     for learning!"  5940 VTAB (15) : HTAB (1) : PRINT "***
     Press 'Y' to start lesson again.";
5950 GET A$
5960 IF A$ = 'Y' THEN PRINT : GOTO 5980
5970 GOTO 5950
5980 D$ = CHR$ (4)
5990 PRINT D$ "RUN HELLO"
5995 RETURN
6000 REM CORRECT ANSWER
6010 B = INT (4 * RND (1))
6020 IF B = 0 THEN VTAB (18) : HTAB (12) : PRINT "Nice
     going."
6030 IF B = 1 THEN VTAB (18) : HTAB (12) : PRINT "Correct."
6040 IF B = 2 THEN VTAB (18) : HTAB (12) : PRINT "That's
     right!."
```

```
6050 IF B = 3 THEN VTAB (18) : HTAB (12) : PRINT
     "Outstanding!"
6060 FOR Z = 1 TO 1200 : NEXT Z
6070 RETURN
6500 REM WRONG ANSWER
6510 B = INT (3 * RND (1))
6520 IF B = 0 THEN VTAB (18) : HTAB (12) : PRINT "No. That's
     not right."
6530 IF B = 1 THEN VTAB (18) : HTAB (12) : PRINT "Sorry.
     Wrong choice."
6540 IF B = 2 THEN VTAB (18) : HTAB (12) : PRINT "Sorry.
     That's wrong."
6560 FOR Z = 1 TO 1200 : NEXT Z
6600 REM REVIEW MATERIAL SCREEN
6610 HOME : VTAB (3) : HTAB (1) : PRINT "Let's review the
     information andtry again."
6620 FOR Z = 1 TO 1200 : NEXT Z
6630 RETURN
7000 REM REVIEW MATERIAL
7010 REM QUESTION 3150
7020 HOME : VTAB (3) : PRINT "All living things have many
     traits in common. All living things grow. They all
     maintain themselves or keep themselves alive. All
     living things reproduce."
7030 GOSUB 10000
7040 GOTO 3150
7050 REM QUESTION 3250
7051 HOME : VTAB (3) : PRINT "The smallest whole part of a
     living thing is the cell. Cells are the building blocks
     of living things. All living organisms, both plants and
     animals, are composed of cells."
7060 GOSUB 10000
7070 GOTO 3250
7080 REM QUESTION 3350
7090 HOME : VTAB (3) : PRINT "The smallest whole part of a
     living thing is the cell. Cells are the building blocks
     of living things. All living organisms, both plants and
     animals, are composed of cells."
7100 GOSUB 10000
7110 GOTO 3350
7120 REM QUESTION 3710
7130 HOME : VTAB (3) : PRINT "The fungi differ from other
     plants in an important way. They cannot make food for
     themselves. To get their nourishment many fungi attach
     themselves to green plants."
7140 GOSUB 10000
7150 GOTO 3710
7160 REM QUESTION 3810
7170 HOME : VTAB (3) : PRINT "Few plants are more widely
     scattered than mosses. They grow throughout the world
```

```
     and are even found in the Arctic and Antarctic."
7180 GOSUB 10000
7190 GOTO 3810
7200 REM QUESTION 3910
7210 HOME : VTAB (3) : PRINT "Ferns reproduce by means of
     spores. The spores are found underneath the fern leaf."
7220 GOSUB 10000
7230 GOTO 3910
7250 REM QUESTION 4150
7260 HOME : VTAB (3) : PRINT "If seeds are set in a moist,
     warm location they will germinate or sprout. Seeds
     often germinate at different rates. When a seed.does
     germinate the first part to appear is the root."
7270 GOSUB 10000
7280 GOTO 4150
7300 REM QUESTION 4250
7310 HOME : VTAB (3) : PRINT "If seeds are set in a moist,
     warm location they will germinate or sprout. Seeds
     often germinate at different rates. When a seed does
     germinate the first part to appear is the root."
7320 GOSUB 10000
7330 GOTO 4250
7350 REM QUESTION 4350
7360 HOME : VTAB (3) : PRINT "It has been found that roots
     grow downward because of gravity."
7370 GOSUB 10000
7380 GOTO 4350
7400 REM QUESTION 4710
7410 HOME : VTAB (3) : PRINT "The stem is an important part
     of the plant. It connects the leaves to the root
     system. The stem is a pipeline that transports food and
     raw materials."
7420 GOSUB 10000
7430 GOTO 4710
7450 REM QUESTION 4810
7460 HOME : VTAB (3) : PRINT "The stems of some plants are
     underground. These underground stems serve the plants
     by storing food."
7470 GOSUB 10000
7480 GOTO 4810
7500 REM QUESTION 5150
7510 HOME : VTAB (3) : PRINT "The leaves of green plants
     make food through a process known as photosynthesis.
     The word photosynthesis means 'putting together with
     the help of light'."
7520 GOSUB 10000
7530 GOTO 5150
7550 REM QUESTION 5250
7560 HOME : VTAB (3) : PRINT "The leaf gets water through
     the roots and stem of the plant. It draws in carbon
```

```
     dioxide from the air."
7570 GOSUB 10000
7580 GOTO 5250
7600 REM QUESTION 5350
7610 HOME : VTAB (3) : PRINT "As it makes sugar, the leaf
     gives off oxygen. Scientists say that oxygen is a
     by-product of photosynthesis."
7620 GOSUB 10000
7630 GOTO 5350
7650 REM QUESTION 5710
7660 HOME : VTAB (3) : PRINT "As the insects seek nectar
     from the flowers, they move the pollen from one flower
     to another. This transfer of pollen is called
     pollination."
7670 GOSUB 10000
7680 GOTO 5710
10000 REM SPACEBAR ROUTINE
10010 VTAB (23) : HTAB (10) : PRINT " (SPACEBAR TO
      CONTINUE)" : VTAB (23) : HTAB (32) : GET A$ : IF A$ =
      CHR$ (32) THEN VTAB (23) : HTAB (10) :
      PRINT "                      " : RETURN
10020 IF A$ < > CHR$ (32) THEN GOTO 10010
```

APPENDIX D

TREATMENT B - STUDENT SCRIPT

TREATMENT B - STUDENT SCRIPT

PLANTS

All living things are divided into two large groups. These two groups are called the animal kingdom and the plant kingdom.

Usually it is easy to distinguish a plant from an animal. For example, a tree is a plant and a dog is an animal.

Plants and animals do have striking differences. Plants alone are the food makers of the world. Animals eat plants and other animals, but they cannot make food for themselves. Yet, they are also alike in many ways.

All living things have many traits in common. All living things grow. They all maintain themselves or keep themselves alive. All living things reproduce.

The smallest whole part of a living thing is the cell. Cells are the building blocks of living things. All living organisms, both plants and animals, are composed of cells.

Some plants and animals consist of only a single cell. These single celled plants and animals are the simplest form of life on earth. Most familiar plants and animals are made up of many cells.

KINDS OF PLANTS

There are many kinds of plants. Some plants are large, such as the giant sequoia tree of California which can grow to a height of more than three hundred feet. Some plants are small. Bacteria, which are one-celled plants, are so tiny they can be seen only through a microscope.

Scientists group, or classify, plants. They study plants and group them according to similarities and differences. To group a plant it must be observed carefully. All the parts are examined and it is noted how the parts are put together.

One group contains algae, fungi, and lichens. These plants do not have roots, stems, flowers or leaves.

There are many kinds of algae. Seaweeds and many freshwater plants are algae. The familiar green scum on the surface of ponds is algae. Many algae can be seen only through a microscope. But others are large and are visible to the unaided eye.

Bacteria are among the most common fungi. They are too small to be seen by the eyes alone. A microscope is needed to bring them into view. Many fungus plants are molds, which grow in dark, moist places. Molds grow on foods, wood, paper, leather, and many other materials. The fungi differ from other plants in an important way. They cannot make food for themselves. To get their nourishment many fungi attach themselves to green plants.

Lichens are a combination of algae and fungi. The algae in lichens make food for both themselves and the fungi.

Another group includes mosses and liverworts. Liverworts are small green plants. They grow in damp, shady places. They cling to rocks, soil, and tree trunks. It is believed that liverworts were the first land plants.

The mosses probably developed from liverworts. They have many traits of the liverwort but they are more advanced in their development and ways of living. Each moss plant has a stem, leaves, and thread-like roots. Few plants are more widely scattered than mosses. They grow throughout the world and are even found in the Arctic and Antarctic. They are mostly land plants, but some grow in water. Mosses grow in cool, moist places.

Ferns belong to another group. Ferns have a long history. These plants once formed most of the earth's vegetation. Ferns do not have flowers, seeds, or fruits. They reproduce by means of spores. The spores are found underneath the fern leaf. You can recognize them by noticing the brown spots. Ferns grow best in moist, shady places.

The next big group of plant life consists of those plants that have seeds. Some seed producing plants have seeds that are enclosed in a kind of case. Familiar garden flowers all have covered seeds. In some trees the seed case, along with the seed, is a fruit such as an apple or a walnut. Some trees that have green needles all year round have their seeds in cones.

ROOTS OF PLANTS

The root is usually the underground part of a plant. Roots hold the plant in position. The roots absorb water from the soil. They also absorb dissolved minerals.

There are different kinds of roots in plants. Some are large or long in appearance like those of carrots, beets, and turnips. Others, like grasses, spread out in all directions.

Some roots are close to the ground and hardly break the surface. Other roots grow down into the soil fifteen feet or more.

If seeds are set in a moist, warm location they will germinate or sprout. Seeds often germinate at different rates. When a seed does germinate the first part to appear is the root. For a long time it was thought that roots grow downward because of the plant's need of moisture. Plants do need moisture and the roots absorb moisture. But, this need for moisture is not a true explanation of why roots grow downward. It has been found that roots grow downward because of gravity. If a plant is placed on its side certain chemicals in the plant will cause the stem to bend upward near their tips. Gravity will cause the roots to grow downward.

The tip of the root is considered the root system's sense of touch. It seeks the right kind of moisture, the most desirable temperature, and the proper food. It may guide the root system around obstacles. The root tip is protected by a thimble-like cap. Without this protection it could hardly endure all the things it runs into.

The life of a plant is measured by the length of time its roots live and work. Annuals have root systems that last for only one year. Biennials live for two years, and perennials live for many years.

THE STEM

The stem is an important part of the plant. It connects the leaves to the root system. The stem is a pipeline that transports food and raw materials.

The root system absorbs water and minerals from the soil. These raw materials travel through the stem to the leaves. All the food for the plant is manufactured in the leaves. The food then travels back through the stem to the roots.

The stem helps the leaves absorb light. It holds the leaves in place and keeps them turned toward the light. If the leaves somehow fall into a shadow the stem then bends or moves to get the leaves back into the light.

The stems of some plants are underground. These underground stems serve the plants by storing food. The potato and onion that you eat are actually underground stems. Some cactuses have fleshy stems that absorb great quantities of water during occasional rainfalls. The stems store the water for use during dry times.

THE LEAVES

Leaves of plants perform an important function. They are the part of the plant that manufactures food.

The veins in the leaves are tubes that carry water and minerals into the leaf. The vein pattern differs in various leaves. Often there is a major vein found in the center of the leaf.

Chemical energy is stored in food. Every living thing must have this energy to remain alive. A green plant is the only living thing that produces its own food. The leaves of green plants make food through a process known as photosynthesis. The word photosynthesis means "putting together with the help of light."

To make food, a leaf puts water and carbon dioxide together. But it can put these things together only with the help of light. It needs the energy that light provides.

The leaf changes light energy into chemical energy. A substance known as chlorophyll brings about this change in energy. Every green leaf contains chlorophyll.

The leaf gets water through the roots and stem of the plant. It draws in carbon dioxide from the air. With the help of light and chlorophyll, the leaf combines the water and carbon dioxide to make sugar. If a plant doesn't need all the sugar it produces, then it changes the sugar into starch. It stores this starch in the stem for later use, such as a potato or beet does. With sugar and starch, the plants have food. The plants, in turn, provide food for animals. All animals, including human beings, are dependent on plants.

As it makes sugar, the leaf gives off oxygen. Scientists say that oxygen is a by-product of photosynthesis. But this by-product is not wasted. It is returned to the air that animals breathe to stay alive. Plants take in carbon dioxide and give off oxygen.

FLOWERS

Flowers are important parts of a plant. They serve as organs of reproduction. Without flowers, some plants would not be able to reproduce.

The fragrance and beauty of flowers is not intended for humans. They are meant for insects. Sweet smells, bright colors, different sizes, different shapes, even foul odors all attract insects.

Insects are the plant's partners in forming seeds to start a new plant. Flowers produce pollen, which contains material necessary for reproduction. As the insects seek nectar from the flowers, they move the pollen from one flower to another. This transfer of pollen is called pollination. Bees, birds, moths, flies, beetles, wind, and many other agents pollinate flowers.

A typical flower has a ring of leaflike sections around the petals. These parts are called sepals. Inside the sepals are the petals. The petals are usually brightly colored.

In the center of the flower are slender, stalklike parts called stamens. A knob at the end of each stamen is called the anther. The anther is the male part of the flower. Pollen develops within the anther.

The stamens surround the female part of the flower. The female part is called the pistil. It is in the center of the flower. Inside the pistil is the ovary. It contains the ovules that develop into seeds. They contain the female egg cell.

Pollination causes an ovule to become a seed. As the seed grows, other parts of the flower develop into food that surrounds the seed. The developing seed with its surrounding food becomes the fruit of the plant such as a watermelon.

The work of the flower is done once fertilization takes place. The flower withers and dies. Its shape, its color, its odor and all its parts have helped a seed to form. Having formed a seed, the flower has accomplished its mission. New plants can now grow from seeds.

REVIEW

Plants and animals are living things. They have traits in common but also differ in some ways.

One thing that sets a plant apart from an animal is its ability to make its own food. Green plants, and only green plants, are the food makers among living things. Green plants use light, chlorophyll, water, and carbon dioxide to make sugar. This process is photosynthesis.

There are major groups of plants. Some are simple plants that include algae, fungi, lichens, mosses and liverworts. Another group includes the familiar plants we see all around: trees, vegetables, shrubs, and garden flowers. Some of these have flowers and bear covered seeds or have their seeds in cones.

Green plants have roots, stems, and leaves. These parts all work together to nourish the plant. Roots grow downward into the soil for moisture and minerals. The roots and stems carry moisture and minerals to the leaves. The leaves are the food factories. Photosynthesis occurs in the leaves.

PLANT WORKSHEET

Name ______________________ Teacher __________________

Directions: Answer the questions by filling in the blanks.

PLANTS

1. All living things are divided into two large groups called the ________________ and the ________________.

2. The smallest whole part of a living thing is the ___________________.

3. All living things are composed of ___________________.

KINDS OF PLANTS

4. One group of plants do not have roots, stems, flowers or leaves. This group contains ___________________, ___________________, and ___________________.

5. ___________________ are among the most common fungi.

6. In what important way are the fungi differ from other plants?

   ____

7. Lichens are a combination of

_______________________________________.

8. Few plants are more widely scattered than

___________________.

9. Ferns do not have flowers, seeds, or fruits. They reproduce by means of ____________________.

ROOTS OF PLANTS

10. The job of the roots are to __________________________, ________________________, and ________________________.

11. Seeds will germinate or sprout if they are set

____.

12. ____________________ will cause the roots to grow downward.

THE STEM

13. The stem is a pipeline that transports

_______________________________________.

14. The stems of some underground plants serve the plants by storing ____________________.

THE LEAVES

15. The leaves are the part of the plant that manufactures ____________________.

16. A green plant is the only living thing that produces its own ____________________.

17. The leaves of green plants make food through a process known as ____________________.

18. The leaf draws in ____________________ from the air.

19. As the leaf makes sugar, it the gives off ____________________.

FLOWERS

20. The transfer of pollen from one flower to another is called ____________________.

APPENDIX E

GOALS AND OBJECTIVES FOR TREATMENTS

GOALS AND OBJECTIVES FOR TREATMENTS

Chapter Goals

_____1. Living things are alike because they are made of cells and use energy to carry out life processes.

_____2. Materials needed by green plants for food making are transported through the roots, stems, and leaves in special tubes.

_____3. Green plants make food by the process of photosynthesis.

_____4. Green plants use oxygen to release energy in food by the process of respiration.

_____5. Green plants produce new plants of the same kind by the process of reproduction.

Objectives

______1. Identify the cell as the basic unit of living things.

______2. Identify the life processes that all living things carry out to stay alive.

______3. Name three things needed by all living things to stay alive.

______4. List things needed by green plants to make food.

______5. Describe the function of roots, stems, and leaves in the transport of materials needed by green plants to make food.

______6. Describe the process of photosynthesis.

______7. Trace the movement of materials in and out of a leaf during photosynthesis.

______8. Describe the process of respiration.

_____9. Compare the process of respiration and photosynthesis.

_____10. Identify the flower as the reproductive part of a flowering plant.

_____11. Describe the parts of a flower and the role of each in reproduction.

_____12. Trace the events in the formation of a seed and its germination.

_____13. Identify the parts of a flower.

APPENDIX F

CHECKLIST FOR VALIDATION OF QUESTIONS COVERED IN TEXTBOOK

CHECKLIST FOR VALIDATION OF QUESTIONS COVERED IN TEXTBOOK

Test Q

Question		Page	
______11.		p. 17	shown in chart
______12.		p. 5	things needed
		p. 8	needed for experiment
______13.			not directly shown
		p. 8	similar observations in experiment
______18.			not directly shown
		p. 8	similar observations in experiment
______19.			not directly shown
		p. 8	similar observations in experiment
______23.	A.	p. 5	green plants make own food
	B.	p. 5	getting food
	C.	p. 4	cell basic unit of living things
	D.	p. 18	not shown part of plant or flower

Test P

Question		Page	
______13.		p. 23	stages of germination
		p. 8	similar observations in experiment
______14.		p. 8	similar observations in experiment
______22.		p. 17	chart
		p. 15	shown in equation
______29.		p. 6	needs of green plants
		p. 10	light needed to make food
		p. 11	how green plants get things to make food
		p. 14	need for sunlight
______31.	A.	p. 17	fish use oxygen
	B.C.	p. 6,10	plants produce oxygen
		p. 14,15	plants produce oxygen
______32.	A.B. C.	p. 4,5	living things composed of cells
______33.		p. 6	chart - plants make food
______34.		p. 11	light is energy
		p. 10	light is energy

APPENDIX G

CHECKLIST FOR VALIDATION OF QUESTIONS COVERED IN ADDITIONAL READING MATERIALS

CHECKLIST FOR VALIDATION OF QUESTIONS COVERED IN ADDITIONAL READING MATERIALS

Test Q

Question

_____	11.	plants give off oxygen animals breathe in oxygen
_____	12.	seeds need water to germinate
_____	13.	root appearing shows germination
_____	18.	not directly shown
_____	19.	not directly shown
_____	23.	fungi cannot make food for themselves

Test P

Question

_____13. root appears when germinating

_____14. seeds often germinate at different rates

_____22. plants give off oxygen

_____29. A. must be CO_2 since plants live there
B. plants need the energy that light provides
C. no information
D. must be CO_2 since plants live there

_____31. A. animals breathe oxygen
B. algae are plants and plants take in CO_2
C. plants take in CO_2

_____32. all living organisms composed of cells

_____33. plants make own food

_____34. light is energy

APPENDIX H

TEACHER TIME RECORDING SHEET

TEACHER TIME RECORDING SHEET

SCIENCE -- Teacher Instructional Time

Class Number ______________________

Activities of Green Plants

(Please record time each day to the nearest five minutes.)

Monday, Jan. 12 ____________

Tuesday, Jan. 13 ____________

Wednesday, Jan. 14 ____________

Thursday, Jan. 15 ____________

Friday, Jan. 16 ____________

Monday, Jan. 19 ____________

Tuesday, Jan. 20 ____________

Wednesday, Jan. 21 ____________

Thursday, Jan. 22 ____________

Friday, Jan. 23 ____________

APPENDIX I

GROUP MEAN SCORES FOR EACH TREATMENT

Group Mean Scores for Treatment A

(CAI)

Class Number	Number of Students	Pretest Plant Mean	Posttest Plant Mean
1	7	4.57	2.85
2	6	4.50	2.66
3	6	5.66	2.83
4	7	4.42	2.14
5	7	5.42	2.71
Total	33	4.90	2.63

Group Mean Scores for Treatment B

(Additional Reading Materials)

Class Number	Number of Students	Pretest Plant Mean	Posttest Plant Mean
1	6	4.66	3.00
2	5	4.60	2.40
3	6	5.33	2.66
4	8	4.50	2.75
5	8	4.12	2.50
Total	33	4.60	2.66

Group Mean Scores for Treatment C

(Additional Direct Instruction)

Class Number	Number of Students	Pretest Plant Mean	Posttest Plant Mean
1	5	4.80	1.60
2	5	6.20	3.00
3	6	3.50	3.33
4	7	4.28	1.57
5	8	4.12	2.75
Total	31	4.48	2.45

Group Mean Scores for Treatment D

(Control Group)

Class Number	Number of Students	Pretest Plant Mean	Posttest Plant Mean
1	6	4.16	2.16
2	6	4.50	2.33
3	6	5.00	3.00
4	8	4.87	2.87
5	7	4.71	2.14
Total	33	4.66	2.51