Development of a Computer-Adapted Form of the Scientific Literacy Test

Douglas M. Allred
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DEVELOPMENT OF A COMPUTER-ADAPTED FORM
OF THE SCIENTIFIC LITERACY TEST

by

Douglas M. Allred

A thesis submitted in partial fulfillment
of the requirement for the degree

of

MASTER OF SCIENCE

in

Elementary Education

Approved:

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Major Professor                   Department Head

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Committee Member                  Dean of Graduate Studies

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Committee Member

UTAH STATE UNIVERSITY
Logan, Utah
1989
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ABSTRACT

Development of a Computer-Adapted Form
of the Scientific Literacy Test

by

Douglas M. Allred, Master of Science
Utah State University, 1989

The purpose of this study is to computer-adapt the Scientific Literacy Test. The challenges in doing so were: (1) developing a programming procedure that would make it possible to present complex graphics on an Apple IIe while administering the computerized Scientific Literacy Test, (2) designing equivalent graphic test-items, and (3) developing a program that a majority of students favor.

Factors that may affect student performance on computer-administered tests are reviewed, the program developed to present complex graphics is listed, assessment of test-item equivalency and student attitude are discussed, and suggestions regarding further development of the product are proposed.

(175 pages)
CHAPTER I
BACKGROUND

Source of Product Conceptualization

The Elementary Teacher Education Program at Utah State University consists of five major areas: self, others, disciplines, implementation, and association. The acronym SODIA is used to identify the program.

The third area, disciplines, is designed to give students knowledge and teaching experience in the various subject areas taught in the elementary school. The science methods course, part of the disciplines component, was redesigned in 1987. The new course includes 10 program goals (Daugs, 1986). Program goal 2.0, "To provide a means of determining student level of scientific literacy" (Daugs, 1986 p. 17) is of special interest to this project.

Currently, scientific literacy is assessed through a paper-and-pencil Scientific Literacy Test (Appendix A). Subgoals 2.1, 2.2, and 2.3 suggest that the test be administered by computer. However, available software programs designed to adapt paper-and-pencil tests for computer administration are not capable of accommodating some of the components of the Scientific Literacy Test. This study was designed, therefore, to investigate the
possibility of developing a computer-adapted form of the Scientific Literacy Test.

The Problem

Transferring information from paper to computer has become a common practice. Thus, adapting the Scientific Literacy Test for computer administration may appear to be a routine task. However, the test's complex drawings and the limited graphic capabilities of the Apple IIe computer present a hindrance in doing so. Furthermore, there is no published information on programs and procedures for achieving the desired product.

The Purposes

The primary purpose of this study was to develop a procedure which would make it possible to present complex graphics within the framework of the computerized Scientific Literacy Test.

The three secondary purposes of this study were:

1. To design a questionnaire that measures student attitude toward (a) science and computers in general, (b) specific aspects of the computer-administered test, and (c) the computerized test as compared to the paper version of the test.

2. To conduct a preliminary field test in order to (a) assess graphic test-item equivalency between computer and paper test
administration, (b) assess student attitude toward the product, and (c) provide information for product improvement.

3. To conduct a follow-up field test to assess specific-item equivalency following any revisions stemming from the preliminary field-test results.

The Questions

The critical question in this study was whether or not a specific graphics routine could be programmed and effectively incorporated into the computer-adapted Scientific Literacy Test. The success of this task would be determined by the answers to the following questions.

1. Can reasonable graphic test-item equivalency be achieved between the computer generated graphics and the diagrams used in the original Scientific Literacy Test?

2. Will student response indicate a favorable attitude toward the computerized test?

Research Approach

The form of research used to address the questions mentioned above is called educational research and development, usually referred to as the R & D cycle, and "appears to be the most promising strategy we now have for improving education" (Borg &
Gall, 1983, p. 772). The R & D cycle, however, does have some limiting factors. Because the process is often time-consuming and expensive (Borg & Gall, 1983), this study was restricted to selected parts of the R & D cycle: a review of literature, computer adaptation of the Scientific Literacy Test, development of a procedure within the computer program, administration of a preliminary field test, revisions, and administration of a follow-up field test.
CHAPTER II
REVIEW OF LITERATURE

Introduction

The review of literature focuses on
1. the leading software application for designing Apple IIe microcomputer graphics,
2. the factors which may affect the computer-adapted Scientific Literacy Test's usefulness,
3. the commitment of education to computer technology, and
4. a rationale for using computers in testing.

Apple IIe Graphics

Dazzle Draw (Snider, 1984a), a software program, provides the means for designing graphics that are unsurpassed by all other software programs available for the Apple IIe computer (Williams, 1985). Most of the reviews of Dazzle Draw are merely descriptions of the program's capabilities (Bumgarner, 1985; Field, 1985; and Schiff, 1985). In only one review are educational applications for this software program identified (Wheeler, 1986). In that review, Wheeler (1986) suggested that Dazzle Draw be utilized in secondary-level art and computer classes.
Unfortunately, the idea and process of integrating Dazzle Draw graphics for computer-program applications is not addressed.

**Factors Affecting Usefulness of Computerized Tests**

Student academic performance is enhanced through the use of computers in the classroom. This belief exists in spite of the indications from research that "... there are no learning benefits to be gained from employing different media in instruction regardless of the obviously attractive features or advertised superiority" (Clark, 1983, p. 450).

During the 1950s radio was a popular teaching tool and in the 1960s television was utilized. Many studies were conducted to measure student performance comparing the new media with traditional forms of instruction. Some of these studies showed a performance gain attributed with the new media (Clark & Clark, 1984). However, in a meta-analysis of the media's influence on learning, Clark (1983) concluded that the medium per se is not the discriminating variable.

**Instructional Design and Human Factors**

If the medium is not the discriminating variable, what factors were associated with gains in performance? Clark and Clark (1984) suggested two possibilities: instructional design and human factors. Programs that use new media often apply greater
effort to creating effective instructional design. This idea was supported by Reif (1987) and applied to current educational applications for computers. Also, Clark and Clark (1984) identified a human factor; that being the novelty of the new media may cause subjects to invest more interest and energy in their work, thus resulting in increased learning.

Computer Experience

Lee (1986) investigated other human factors and suggested that experience with computers affects student performance. She conducted research in which the subjects' computer experience was compared with their performance on a computer-administered arithmetic reasoning test. A statistically significant difference in scores was found between individuals with computer experience and those with no computer experience. In both groups, subjects completed a computer course, used a word processor, or typed data into a computer. The only discriminating factor was the extent to which the subjects had participated in any of these activities.

Another study conducted by Wise, Boettcher, Harvey, and Plake (1987) found no statistically significant difference in performance between subjects with computer experience and those with none. This study was similar to Lee's (1986) in number of subjects, testing instruments, environments, and procedures. The major differences between the two were the subjects' academic status and the criteria used to categorize
subjects' computer experience. Lee's (1986) subjects were all undergraduates while Wise and his associates (1987) used subjects who were advanced undergraduates or graduate students. This might be a discriminating factor associated with the results. This possibility is supported by Sorensen (1985).

A more distinctive difference between the two studies may have been in the criteria used to determine computer experience. Lee (1986) based her experience scale on type and degree of activity conducted on the computer. Wise et al. (1987) simply asked their subjects to state the total number of hours they had spent working on a computer, then divided the responses into two levels: no experience and experience. This difference in population makes it difficult to compare and generalize findings. Additional research needs to be conducted that identifies how and what kind of computer experience affects student performance.

**Attitude Toward Computers**

Loyd and Loyd (1985) investigated attitude as another human factor. The authors concluded that individual attitudes toward computers may enhance or impede learning. Bowen (1984) found that students' attitudes about computers were congruent with the degree of success they had experienced in a testing situation. Student performance on a computer, therefore, might also be compounded by computer-testing experience.

Computer anxiety is a generally accepted human factor, but the basis for acceptance is often anecdotal data (Jonassen,
Computer anxiety, also referred to as computerphobia, is defined as the fear an individual feels when using or considering the use of a computer (Maurer & Simonson, 1984). Fear, according to Rubin (1983), is a real possibility for a student taking a computerized test. The student may be concerned about pressing the wrong key, failing the exam, misinterpreting instructions, or accidentally breaking the computer. Such problems can be compounded and cause the individual to feel powerless. This powerless feeling can cause a discrepancy in student performance (Lawton & Gerschner, 1982).

In more recent studies (Jonassen, 1986b; Wise et al., 1987), researchers pointed out that the high degree of variation within groups identified as having computer anxiety indicated the presence of individual differences and possibly individual causes. Thus the cause of computer anxiety and its effect on student performance is still not clear.

**Reading Performance Scores**

Another factor that may cause a discrepancy in performance is unique to computer-administered tests. Heppner, Anderson, Farstrup, and Weiderman (1985) found that reading-performance scores were significantly better for printed-form tests than for computer-display tests. Heppner and his associates (1985) utilized a timed test that required extensive reading in order to answer questions. The first passage and questions were divided into two screens. Heppner et al. (1985) suggested that multiple
screens for reviewing text, screen resolution, key pressing, and
time limitations might have caused the discrepancy between
subjects' performance on printed and computer reading tests.

Jonassen (1986a) conducted similar research measuring the
effects of microcomputer screen displays. Subjects were
required to identify a specific figure within a pattern presented
on a computer monitor and on paper. Subjects scored
significantly higher on the paper version of the test. Research
conducted by Jacobs, Byrd, and High (1985) supports Jonassen's
finding.

Educational Commitment to Computer Technology

During this decade, our nation's public schools have witnessed
a computer revolution. Public education has made large financial
commitments and major curriculum adaptations to implement
computers. This commitment was demonstrated by the fact that
in 1981, 18 percent of our schools utilized computers. Three
years later, this figure increased to 85.1 percent (Statistical
Abstract of the United States, 1986).

The public school system's commitment to finance the
implementation of computers is evident. Electronic Learning, in
its "1986 Annual Survey of the States" (Reinhold, 1986), reported
an estimated $680 million spent on computers for educational
purposes. In addition, a majority of the states said that they
would budget more money in 1987 for computer-related items.
The commitment to integrate computers into the school curriculum is apparent. The trend of encouraging schools to use computers in the classroom gained strength between 1983, when a few states simply recommended such action, and 1986, when 11 states required schools to integrate computers into the curriculum. Students in 12 states were required to take some kind of computer course, while six states required students to pass a computer-competency test.

At the university level, no states required computer instruction for teacher certification in 1982. By 1986, 7 states had required students to take computer coursework in order to be certified. An additional 14 states had officially recommended such action. For teachers who were already certified, 40 states provided the necessary inservice training.

Finally, the number of state-level computer coordinators has increased from 26 in 1983 to 44 in 1986. The evidence strongly suggests that the education system is committed to the utilization of computer technology.

**Rationale for Using Computers to Administer Tests**

Using computers to administer tests has been an increasingly popular practice (Hunt, 1982; Sampson, 1983; Ward, 1984). This can be attributed to the increasing availability of computer technology (Ward, 1984). Computer-assisted testing has many advantages over the standard paper-and-pencil form of
administering tests. Following are brief discussions of points which promote computer testing.

1. Adaptive testing is a process in which an examinee is asked a question and, depending upon the response, the next problem is selected for the examinee from a large item pool. This process insures that the subject is asked questions that are neither too difficult nor too easy. The computer limits test questions to those most appropriate for the individual. Thus, unnecessary questions are avoided and test completion time is reduced (Millman, 1984; Sampson, 1983; Ward, 1984).

2. An advantage of computers is the speed at which information can be processed (Sampson, 1983). That is, test results can be reported immediately and students can be given remedial assignments, professional counseling, and other information based on their test results. Faculty and administrators can capitalize on computer capabilities when scoring student assignments and exams by preprogramming decisions, such as grades or educational plans. The possibilities are numerous.

3. Specially designed input and output computer devices enable individuals with physical limitations to take tests that they may not be capable of taking in a paper-and-pencil version (Sampson, 1983; Ward, 1984).

4. Computers can be programmed to incorporate video simulations and sound effects for more realistic presentation of information (Clark, 1983; Reif, 1987).
5. An examinee’s response time in answering questions can be measured and branching decisions made based on student responses indicating, for example, fatigue, which can then be used to program the computer to a rest period (Sampson, 1983).

**Summary of Literature Review**

There is evidence of the degree of commitment to utilizing computers in the educational setting. Test administration is one use for computers. However, certain variables can distort student performance statistics. These variables include novelty of the computer; instructional design of the software; graphic resolution and readability of the monitor screen; and the user’s attitude, anxiety, and previous computer experience.
CHAPTER III
METHODOLOGY

Introduction

In this chapter, the following items are addressed:

1. A description of the research and development approach is provided.
2. The program procedure for adapting the Scientific Literacy Test’s drawings for the Apple IIe computer is explained in the context of programming the test for computer administration.
3. The development of the questionnaire, interview, and method of observation are discussed.
4. The preliminary field test procedures and results are reported.
5. Product revisions are identified.
6. Follow-up field-test procedures and results are reported.

Research and Development Approach

Portions of the research and development cycle described by Borg and Gall (1983) were implemented.

1. Planning. The sequence of major activities was as follows:
   A. Development of a computer program capable of presenting the complex drawings of the Scientific
Literacy Test.

B. Adaption of the Scientific Literacy Test for use on the Apple IIe computer.

C. Identification and preparation of an accessible population to be administered the exam.

D. Preparation of questionnaire and interview formats.

E. Administration of the preliminary field test.

F. Analysis of student performance, questionnaire and interview responses, and observations.

G. Revisions of the product based upon preliminary field test results.

H. Administration of a follow-up field test.

I. Analysis and evaluation of results from follow-up field test and report.

2. Development. Preliminary forms of three products were developed.

A. A computerized form of the Scientific Literacy Test was designed to match the original version of the test as closely as technologically possible and to identify potential problems that are unique to computerized tests.

B. A questionnaire was designed to measure student attitude toward the computerized product.

C. An interview was designed to identify the aspects of the computerized test that needed revision.

3. Preliminary field testing. Twelve students, from an accessible population of 51 subjects enrolled in a science
methods course for elementary educators, were randomly selected. The design of the field test was:

\[ R \times Q \times Y \] (Group A had six subjects)
\[ R \times Y \times Q \] (Group B had six subjects)

- \( R \) = random selection and assignment
- \( X \) = computer-administered test
- \( Y \) = paper-and-pencil-administered test
- \( Q \) = questionnaire and interview

The testing procedure controlled for order effect (Borg & Gall, 1983) by first administering the paper version of the test to Group A and the computerized version to Group B. After completing the first (either \( X \) or \( Y \)) test, each group was administered the version of the test that they had not taken. This counterbalance design eliminates the possible confounding of order effects with treatment effects.

4. Product revision. The product revision was based upon qualitative results obtained from the questionnaire, interview, and the instructor's observations during the administration of the computerized test and from quantitative results from the subjects' scores on computer graphic-related questions.

5. Follow-up field test. The remaining students enrolled in the elementary education science methods courses were given a revised, abridged version of the computerized test and an abridged form of the original Scientific Literacy Test. This was due to test-administration time limitations and the students' familiarity with the original version of the test. The follow-up
field test design was:

R X Y Group A had six subjects.
R Y X Group B had six subjects.
R = random assignment
X = computer-administered test
Y = paper-and-pencil-administered test

The testing procedure controlled for order effect in the same manner as for the preliminary test.

Programming of the Computer Adapted Test

Programming the Scientific Literacy Test for computer administration required the majority of the resources expended in this study. The program, written in Applesoft BASIC, is designed to run on Apple IIe microcomputers with extended 80-column cards and color monitors. The 80-column card provides the auxiliary memory that is needed to display the graphic-related test items. The graphics are presented in color to facilitate identification of the features that constitute the drawings.

Two goals were identified for the development of a successful computerized form of the Scientific Literacy Test. These were: (a) match the original version of the test (excluding the color) as closely as technologically possible, and (b) identify, from the literature, variables that promote successful computer test administration.
Matching the Original Test

Two aspects of the paper-and-pencil test, the text and the graphics, were matched on the computer as closely as technologically possible. Matching the multiple-choice questions was simple. Each computer text question is word-for-word identical to the paper version. The computerized test differs in the use of small and large lettering, the location of the carriage return in sentences, and the inclusion of computer operational instructions.

Matching the graphic portions of the original test on the computer was the major success of this project. Because of the complexity and value of this procedure, a step-by-step explanation of how this was accomplished is provided.

1. The graphics were designed using Dazzle Draw (Snider, 1984a), developed by Broderbund Software, and Graphics Tablet, made by Apple Computer Inc.

2. After a graphic was designed, the information was stored in binary code. A brief subroutine was required for the picture to be called up within a program written in BASIC. This machine language subroutine was typed in BASIC as follows:

CALL-151
300:A0 00 A2 20 A9 40 84 06 86 07 84 08 85 09
30E:8D 01 C0 8D 0D C0 8D 5E C0
317:B1 06 8D 55 C0 91 06 8D 54 C0 B1 08 91 6
325:C8 D0 EF E6 07 E6 09 CA D0 E8
32F:8D 50 C0 8D 52 C0 8D 54 C0 8D 57 C0 60
3D0G
(Snider, 1984b)
This routine was saved by entering:

BSAVE DHIRES.MOVER,A$300,L$SF

4. The routine listed in step 3 could be called up at the beginning of each file that employed graphics by using the statement:

10 D$=CHR$(4)
12 PRINT CHR$(4);"BLOAD DHIRES.MOVER"

5. Using this procedure displayed half of a graphic on the Apple Ile computer monitor. In order to present the entire graphic, it was necessary to utilize the auxiliary memory along with the main memory. This was accomplished by using the following commands:

First, the picture was called up with the commands:
4210 PRINT D$;"BLOAD NUMBER 42,A$2000"
4215 CALL 768
Then the TEXT was switched to the GRAPHICS mode.
10151 POKE 49153,0
10155 POKE 49239,0
10160 POKE 49237,0
10165 POKE 49232,0
"INPUT Q$" statement allows the picture to be viewed before the graphics mode switches back to the text mode. The sequencing of the first four POKE statements can be altered or deleted with the same result—a full picture. The finalized sequence of POKE commands is based on directions given by Applesoft Computer Inc. (Applesoft Computer, Inc., 1985).

6. An exception to the above POKE commands is necessary to call up the first graphics in the program. In this case, it must be entered as follows:

```
100 POKE 49153,0
110 POKE 49239,0
Then the graphics are loaded using the following commands:

120 PRINT D$"BLOAD ABC,A$2000"
130 CALL 768
(In this case, "ABC" represents the name of the first picture.) Followed by the usual sequence of POKE commands.
```

```
140 POKE 49153,0
150 POKE 49239,0
160 POKE 49237,0
170 POKE 49232,0
180 INPUT Q$
```
190 POKE 49233,0
200 POKE 49164,0

7. These commands solved the problem of presenting complex graphics. However, it created an additional challenge. When the graphics were loaded into main memory, a large amount of space used for storing test questions was eliminated. Thus, the eighty-item exam was unexpectedly cut to nine questions.

In order to solve this dilemma, the test was divided into twelve separate files. The files were then connected by using the statement:

4398 PRINT CHR$(4);"CHAIN PART5"

(In this case,"PART5" was the name of the next file to be connected with the present text file.)

This allows the test to run smoothly and keep a tally of student responses. The only noticeable effect is the two-to-three second delay needed to load a graphic or new file.

Variables That Promote Successful Computerized Testing

The second procedure in developing the software program was the identification of variables that may affect student performance on a computer-administered test.

According to Sampson (1983), computer programs must be designed to account for human factors. One possible problem is a misunderstanding of the instructions for operating the computer.
This concern was addressed by developing two practice questions shown in Appendix B. The first question demonstrates the procedure for answering text-only questions. The second questions shows the procedure for responding to graphic-related questions. Students must correctly complete the practice questions before they can begin the Scientific Literacy Test. They have the option of reviewing the practice questions as many times as they choose before starting the Scientific Literacy Test.

Another variable to consider is that a student might accidentally press a wrong key. A two-fold protection against such mishaps was developed. The first safeguard occurs when students type their initial response. The response appears on the screen for them to check. If they want to change the response, they can do so by pressing the left arrow key and entering another answer before pressing RETURN to finalize the decision. This procedure is explained at the start of the exam. The second safeguard occurs after a student selects an answer and presses "RETURN." If the response is anything other than one of the letters "A," "B," "C," "D," or "P," then the computer displays a that explains the error. The subject is then allowed to enter an appropriate response.

Anxiety is the final human factor identified by Sampson (1983) and recognized in the research (Maurer & Simonson, 1984; Reif, 1987) as a variable that might affect student performance. A lengthy lag time between a student's typed response and the computer's reply can promote anxiety. Unfortunately, our
software program has about 30 incidents of lag time. These incidents, two-to-three seconds long, occur when a computer graphic or new file is called up. In each incident an explanation for the abatement or a brief description of what is about to happen is provided on the computer monitor. The subjects are always provided information during any delay between test questions and graphic presentations. In addition, an instructor is present during the administration of the computer adapted test to provide assistance at students request.

The Completed Product

The computer-adapted Scientific Literacy Test uses four, 5 1/4 inch, floppy disks and consists of 13 text files and 20 graphic files. To start-up the computerized test, a ProDOS system is required. The exam begins with instructions and two practice questions, followed by the 80 item Scientific Literacy Test, and concluded by a prompt for students to enter their name, the date, and the course number. Then the test results are printed on the screen and reported in the same manner as the paper-and-pencil test. The number correct in each of the six categories is given and a statement identifying content area requiring student remediation.
Questionnaire Design

A secondary purpose of the study was to design a questionnaire that measures student attitude toward:

1. Specific aspects of the computerized test.
2. The computerized test as compared to the paper-and-pencil form.

Aspects of the Computerized Test

Nine characteristics unique to the administration of the computer test were identified. These are:

1. The two practice questions.
2. The computer displayed graphics.
3. The separate screen presentations of an item's computer drawing and its question.
4. The lag time required for graphics to be presented.
5. The lag time required to load a text file.
6. The brief comments printed on the screen during lag times.
7. The safeguards programmed to help students who accidentally press an incorrect key.
8. Removing and inserting the four floppy disks.
9. General directions in operating the computer throughout the exam.
Following is a description of how student attitude toward each of these characteristics was measured.

**Practice questions.** Instructions to operate the computer were incorporated in the two practice questions. To measure student attitude toward the effectiveness of this feature, questionnaire item 3 reads: "The two practice questions helped me understand how to respond to the test questions" Refer to Appendix C throughout the following discussion on the development of questionnaire items.

**Computer graphics.** Several questionnaire items addressed graphic-related concerns. In one case, students' general impression of the computer graphics was measured. For example, Questionnaire item 4 reads, "The pictures were easy to use". Information about specific aspects of a drawing were collected during the interview that immediately followed the questionnaire.

**Presenting test items on separate screens.** Some of the graphics fill the entire screen such that the respective question cannot be included. The student reads the question, presses the RETURN key, and views the picture. To measure student attitude toward this feature, questionnaire item 9 read, "Sometimes the picture was so large that the question could not be written along side of it. How did you feel about removing the picture in order to read the question?"

**Loading graphics files.** Anytime a computer drawing is displayed, a 2 to 3 second delay or lag time occurs. In the questionnaire, subjects were asked "How did you feel about
pausing for the picture to be displayed on the screen?"

Loading text files. Lag time also takes place when a text file is called up from the floppy disk. Questionnaire item 12 reads, "How did you feel about waiting for the computer to load more questions?"

Lag time comments. A brief message is displayed in order to reduce student anxiety during incidents of lag time. The message describes what the computer is doing or what item appears next. In this way, students were always presented information during each lag time. This aspect was addressed in questionnaire item 5 - "I liked the various brief comments made while the computer organized pictures or more questions."

Safeguards. Two protections are available for students who accidentally pressed the wrong key. To measure the effectiveness of these precautions, students responded to item 13, "I felt comfortable knowing that if I pressed the wrong key, I could go back and change it".

Floppy disks. The computerized test uses four floppy disks. Three times during the test, students were directed to remove a floppy disk and insert the next one. Questionnaire item 14 reads, "How did you feel about removing and inserting the four floppy disks?"

General directions. Student attitude toward any directions given on the computer was measured by questionnaire item 15, "Any directions given were easy to follow."
Student Attitude Toward Form of Test Administration

Four questionnaire items address student attitude toward characteristics of the computerized test in comparison to the paper-and-pencil exam. Following is a brief discussion about each of these four items.

Item 6 determines student preference between media used to administer the test. The statement reads: "I would prefer to take this test on a computer rather than in paper-and-pencil form."

Item 7 measures student preference of media used to display graphics by stating, "I like the computer's color picture over a paper's black and white drawing."

The computer reports students test results within seconds after completion of the test. The paper-and-pencil version is checked and tallied by hand then reported several days later to students. To measure how popular this is, item 8 reads: "The sooner I receive my test results, the better."

The paper administered test allows students to review and change answers during the test. This option is not provided in the computer administered test. Item 10 measures this discrepancy, "I would like to have gone back later in the test to possibly have changed some previous answers."

Science and Computers in General

Two items measure student attitude toward science and computers. Item 1 reads "I like science," and item 2 reads "I enjoy working on computers." These items were designed to
identify possible causes if students registered unfavorable attitudes toward the computer-administered test.

An instructor attended the administration of the computerized exam to oversee the operation of the computers and to record observational data. The effect of the instructor's presence on students' attitudes was measured by item 16, "I'm glad an instructor was present in case problems came up".

Students answered the questionnaire items by marking one of five drawn faces that best depicted how they felt about the statement or question. The first and most affirmative, or favorable, face is represented by a big smile. The third, or middle, face shows no expression. That is, no smile or frown. The fifth and most negative appearing face has a big frown indicating disapproval. The second and fourth faces are appropriate intermediate expressions in this continuum.

The questionnaire format meets the following criteria as defined by Borg and Gall (1983).

1. The questionnaire is attractive.
2. The questionnaire is easy to complete.
3. The items are numbered.
4. A brief, clear instruction is stated.
5. The terms "questionnaire" or "checklist" are not used.
6. An important item is not placed at the end of the questionnaire.
7. Items are clearly relevant.

Questionnaire data are reported by frequency of response. The
results are analyzed in conjunction with students' test scores on graphic related items, interview results, and observational data.

**Interview Design**

The purposes of the interview shown in Appendix D were:

1. To allow students to clarify or elaborate on any item they marked in the questionnaire.
2. To identify specific advantages or disadvantages students perceived and why.

The interview was designed to follow-up in greater detail any item of concern introduced in the questionnaire. It was conducted by an instructor immediately after students completed their questionnaire.

The interview consists of 19 items. The 1st and 2nd interview items key the interviewer to ask students their subject minor and previous computer experience. This information provided additional descriptions of the students in respect to this study's content.

In items 3 through 16 the interviewer refers the subjects to their completed questionnaire. While students viewed their questionnaire, the interviewer asked why they chose a particular response on each item. The students were then able to clarify the specific strengths and weaknesses they observed.

Interview items 5 and 8 present different prompts for the interviewer to ask students. In item 5, the interviewer
attempted to identify additional comments that could be displayed during the computer test's lag times. In item 8, the interviewer asked students to discriminate between immediate test result feedback and feedback provided hours or days later.

Items 17, 18, and 19 provide a second chance for the interviewer to obtain information that subjects hesitated earlier to offer.

Interview data was analyzed in conjunction with students' scores on graphic related items, questionnaire results, and observational data.

Method of Observation

An instructor observed the computerized test administration to collect observational data. Observational data is recorded at the bottom of students' interview sheets. This information was then analyzed in conjunction with students' scores on graphic related items, and questionnaire and interview results.

Preliminary Field Test: Subjects

Twelve students, graduates and undergraduates, enrolled in elementary education science methods courses 401 and 424, summer quarter, 1987, were randomly selected from an
accessible population of 51 subjects. They participated in the research project as part of their course requirement.

**Preliminary Field Test: Instruments**

In the preliminary field test, five instruments are used to collect data: the original Scientific Literacy Test developed by Daugs, the computer adapted Scientific Literacy Test, the questionnaire, interview, and observation forms developed for this study. From these instruments, only the original Scientific Literacy Test has yet to be described. Following is a description of this test.

The Scientific Literacy Test (Daug, 1986) was designed for use in an elementary education science course at Utah State University. It is modeled after the 1982 British Columbia Science Assessment (Taylor, 1982) and is used to measure three components of students' scientific literacy: content background, science process skills, and attitudes. Content area competencies are assessed in biology, chemistry, geology, and physics, as well as process skills and attitude toward science. In each component, students are required to demonstrate a minimum competency, of 80% correct response.

This science preassessment test contains 80 multiple choice items. Twenty-five of the questions utilize a diagram. The student uses a diagram to extract information necessary to
answer the question. The remaining 55 items are text questions only.

The test is printed on both sides of 16 pages. Students record their responses on a separate form. These forms are corrected by hand and scored. Results are reported using a graph depicting scores in six categories as shown in Appendix E. Categories are identified on the horizontal axis. These are: "LS" (Life Science), "ES" (Earth Science), "PC" (Physics and Chemistry), "SA" (Skill A), "SB" (Skill B), and "NS" (attitude toward science). On the vertical axis are listed the frequency of correct responses from 0 to 17. Directly above each abbreviation on the horizontal axis are two symbols placed at varying degrees. One symbol represents the maximum possible score attainable in a specific category. The other symbol, always below the first, indicates the 80% cut off for remediation. Students' scores are plotted according to the number of correct responses in each category. If the student's score falls below both of the previously described marks, then the individual is assigned remediation practice. This type of reporting allows students to see only the general result their performance. Students are not told the specific test items they missed nor are they allowed to view the test again. Thus the instructor is able to use the same test each quarter.

Measurement for test reliability was conducted with 249 students over a two-year time span using the Livingston criterion-referenced adjustment of Kuder Richardson 20. The Kuder-Richardson 20 reliability coefficient registered .84 (Daugs & Richards, 1988).
Test validity was addressed by matching test items with the standards and objectives contained in a field trial version of the Utah Core Curriculum (cited in Daugs & Richards, 1988). The British Columbia Science Assessment Report (cited in Daugs & Richards, 1988) also addresses validity considerations.

Preliminary Field Test: Procedures

Procedures for the preliminary field test used the design:

R X Q Y  Group A had six subjects.
R Y X Q  Group B had six subjects.
R = random assignment
X = computer treatment
Y = paper-and-pencil treatment
Q = questionnaire and interview

All paper-and-pencil testing was conducted during regular class hours in the science methods course classroom. All computerized testing was conducted during class time on three Apple IIe microcomputers in the same school's computer learning center. Students not participating in the study were dismissed for the duration of the preliminary field testing period.

Due to time restrictions and availability of computer terminals, students in group A were divided evenly into 2 subgroups to administer the computer-adapted test. Subgroup 1 received the computer exam on day 1 and the subgroup 2 received it on day 3. All subjects in group A were given the paper-and-
Students in group B were administered the paper-and-pencil test on day 1. Then group B was evenly divided into 2 subgroups to administer the computer test. Subgroup 1 received the computer-adapted test on day 5 and subgroup 2 received it on day 7.

Test administration was conducted by competent instructors in a professional manner. All students were told prior to taking the computerized test that it was being field tested for future use in a similar education course. Also, they were informed that an instructor would be available to assist them in operating the computer.

When students completed the test, they answered the questionnaire while sitting in front of the computer. After finishing the questionnaire, they moved to a neighboring classroom where the instructor interviewed them and answered their questions regarding this study.

**Preliminary Field Test Results: Students' Test Scores**

Students' test score results are displayed in Figures 1, 2, and 3. The 25 graphic-related test items are represented on the horizontal and vertical axes. Each figure's quadrants represent a combination of students' scores on both the paper-and-pencil and computer-administered tests. For example, students who answered the same question correctly on both test forms are...
identified in quadrant I. Numbers running diagonally indicate the frequency of a particular response made by the students. The total possible frequency on any one item is 12.

Preliminary Field Test Results: Questionnaire

The students completed all questionnaire items. The questionnaire measured student attitude toward: (a) science and computers in general, (b) specific aspects of the computer administered test, and (c) the computerized test in comparison to the original paper version of the test.

Science and Computers

Following is a summary of the questionnaire items designed to measure student attitude toward science and computers.

Item 1. Student attitude toward science is 75% favorable, 25% no preference, and 0% disapproval.

Item 2. Student attitude toward working on computers is 92% favorable, 8% no preference, and 0% disapproval.

Aspects of the Computerized Test

Following is a summary of nine items on the questionnaire that addressed student attitude toward specific aspects of the computerized test.

Item 3. Student attitude toward practice questions'
**FIGURE 1** Students' test score results on graphic related items (20, 30, 31, 33, 36, 41, 42, 43) in the preliminary field test.
FIGURE 2  Students' test score results on graphic related items (44, 45, 46, 47, 48, 49, 50, 52) in the preliminary field test.
FIGURE 3  Students' test score results on graphic related items (53, 54, 55, 59, 61, 63, 64, 65, 71) in the preliminary field test.
usefulness is 75% favorable, 25% no preference, and 0% disapproval.

**Item 4.** Student attitude toward the computer generated pictures' ease of use is 50% favorable, 50% no preference, and 0% disapproval.

**Item 5.** Student attitude toward the brief comments during lag times are 75% favorable, 25% no preference, and 0% disapproval.

**Item 9.** Student attitude toward the question not being on the same screen as the picture is 33% favorable, 25% no preference, and 42% disapproval.

**Item 11.** Student attitude toward pausing for a picture to be displayed is 50% favorable, 50% no preference, and 0% disapproval.

**Item 12.** Student attitude about waiting for new questions to be loaded is 50% favorable, 42% no preference, and 8% disapproval.

**Item 13.** Student attitude toward safeguards against entering unintentional responses is 92% favorable, 8% no preference, and 0% disapproval.

**Item 14.** Student attitude about switching the floppy disks is 67% favorable, 33% no preference, and 0% disapproval.

**Item 15.** Student attitude toward computer instruction on the text is 92% favorable, 0% no preference, and 8% disapproval.

**Student Attitude Toward Form of Test Administration**

Following is a summary of four items on the questionnaire that
addressed student attitude toward the computer-adapted test in comparison with the paper-and-pencil administered test.

**Item 6.** Students preferred the computer-administered test in 75% of the responses, 25% indicate no preference, and 0% show disapproval.

**Item 7.** Students preferred the computer-generated pictures in 83% of the responses, 17% indicate no preference, and 0% show disapproval.

**Item 8.** Students preferred quickly generated test results 83% of the time, 17% indicate no preference, and 0% show disapproval.

**Item 10.** Students wanted the choice to review previous answers 67% of the time, 8% indicate no preference, and 25% show disapproval.

Regarding the instructor's presence during the administration, results on item 16 indicates that 92% favor his presence, 8% indicate no preference, and 0% show disapproval.

Two possible limitations to the questionnaire results exist. Item 7 has a "double-barreled" (Borg & Gall, 1983, p. 421) tendency. Some students responded to the word "color" rather than "black and white." Others noted the words "computer's picture" rather than the "paper's drawing."

Also, one student stated that she responded positively to item 10 indicating that the unavailable option to return and change a previous answer was acceptable. To accurately indicate her stated preference, the subject should have marked a disapproving response on questionnaire item 10. However, no change is made.
in reporting this student's questionnaire result.

**Preliminary Field Test Results: Summary of Interview Items**

**Listing of Items**

All subjects participated in the interview. Following is a summary of each interview item.

**Item 1.** Ten of the 12 subjects were elementary education majors. One student identified early childhood and another special education. Math/Science was the most common subject minor. Other subject minors included language arts, Spanish, math, and social studies.

**Item 2.** All of the subjects had previous computer experience. This experience was most often through university course work. Five of the 12 students used a word processor on a regular basis. One student had experience in data processing.

**Item 3.** Six of the respondents said they would have done fine without use of the computer-adapted test's practice questions. Three subjects stated respectively: the practice questions provided comfort in knowing what to expect, the practice questions did not matter, and the color used in practice question 2 was unclear.

**Item 4.** Regarding the ease in using computer graphics, one-fourth of the respondents stated that the bugs (rock louse, insects, animals) are unclear (Items 43, 49, and 54). Three students said the spoon in item 61 is not clear. Three students
indicated that the heads are not clear (Item 54). Two students found item 54's instructions difficult to follow. Each of the following statements were by individual subjects: the leaves in item 45 are not clear, all the pictures are fine, I do not understand item 42, I do not like item 20's zigzaggedness, the pictures are esthetically pleasing, I prefer items 54 and 36 on the computer, and I do not like having to switch back and forth between screens.

**Item 5.** Half of the respondents stated that the brief comments presented during lag times prevent boredom. Two subjects preferred a straight forward explanatory comment. Two subjects welcomed the pause.

**Item 6.** Three subjects preferred the computer test rather than the paper exam because it is more fun. Three students also said it seems easier, that is, less hassle. Two subjects said they like the color graphics and two others like the quickly generated test results. Individual responses include: preference for the computer exam if the student can review previous questions, preference for the computer exam if lag time for loading pictures can be reduced, the computer is not as stressing, and the paper administered test is preferred because questions can be reviewed.

**Item 7.** Two students felt the color pictures are more clear than the paper exam's drawings. Two people said the computer graphics are interesting and exciting. Individual responses include: preference for the paper exam's drawing because room and aerial pictures are easier (Items 50 and 52), preference for
the computer graphics if they are better, preference for the computer graphics except items depicting bugs and "hewts" (Items 43, 49, 53, and 54), and one subject wants the graphics more like those seen on television.

**Item 8.** Four students indicated that quick notification of their test results is very important. Two subjects wanted more time before results are reported to them.

**Item 9.** Regarding the necessity to switch between graphic and text screens, 4 subjects wanted the two to be combined. Individual responses included: it is annoying, I worry about pressing the wrong key to review the picture or question, I prefer it to be separate because it gives more time to think about the question while waiting for the picture to appear, my train of thought is lost between switching screens, and problems occur on items 31 and 54.

**Item 10.** Four subjects wanted the option to go back and change previous answers. Two students did not want this option because they would have spent too much time reviewing. Individual responses are: I want to double check previous responses, the program crashed, therefore, I want to correct the lost data; I want to review just one or two previous answers; and I want to identify clues in previous questions to answer later items.

**Item 11.** Regarding the lag time for a picture to be loaded, two students welcomed the opportunity to think about the question while waiting. Two subjects did not like switching between
screens. Two subjects welcomed the opportunity to relax for a moment.

**Item 12.** One student stated that waiting for the computer to load more questions is a nice break. The other respondent suggested shortening the lag time if possible.

**Item 13.** Regarding safeguards against pressing the wrong key, 2 students wanted the option to return and change previous answers. One subject was not aware of the safeguards.

**Item 14.** One student reminded the interviewer that the program crashed while switching floppy disks. The other respondent said the procedure is simple after it is understood.

**Item 15.** Regarding any directions given during the computerized exam, three students experience difficulty with item 54. One subject did not understand item 44. Another suggested that graphics and text be combined to simplify instructions.

**Item 16.** Two students said the instructor's presence provides security and another subject said it is helpful.

**Item 17.** Three students identified the following computer strengths respectively: the computerized test is more fun and less stressful, it is not as tedious, it seems faster than the paper form.

Three subjects similarly identified a computer weakness: the graphics are not as clear on the computer as on the paper form, the computer lacks the capability to review previous answers, and the computer needs additional protections against pressing a
key accidently.

**Item 18.** Individual responses about aspects of the computer adapted test that students liked are: the test is an excellent science test, fast reporting of test results is appreciated, and this form of test administration is nice.

**Item 19.** Five students suggested improvement can be made on item 54's computer operation instructions. Additional individual recommendations include: clearer instructions on item 44, clarification of item 42, and better computer operational instructions to call up item 31's picture.

**Preliminary Field Test Results: Observations**

Observational data collected during administration of the computer-adapted test are: a syntax error in item 9, a formatting error under "PC" located in the test results, item 32's responses B and C are the same, bug's legs are difficult to identify on item 54, typing error in item 5, a test crashed when switching floppy disks, and one student says that item 45 was easier on the computer than in paper-and-pencil form.

**Assessment of Preliminary Field Test Results**

A secondary purpose of this study was to conduct a preliminary field test in order to (a) assess graphic item equivalency between computer and paper test administration, (b)
assess student attitude toward the initial product, and (c) provide insight into product improvement through interviews and observations in conjunction with other available data.

Assessment of Graphic Item Equivalency

Graphic item equivalency between the two forms of test administration is determined by assessing the data summarized in Figures 1, 2, and 3 (pages 36, 37, 38). The location and frequency of students' scores in each figure are considered. Scores located in quadrants I and III indicate probable item equivalency. Scores located in quadrants II and IV indicate a possible contaminant variable favoring one of the two forms of test administration. The frequency of a response in quadrant II or IV indicate the degree of test bias to a specific item. Most of the responses in these two sectors have a frequency of 1 or 2. This result was anticipated. According to Wise, Boettcher, Harvey, and Plake, a "...small mean discrepancy between CBT (Computer Based Testing) and PPT (Paper-and-Pencil Testing) has been fairly consistently found in previous research" (1987, p. 3). Such are the findings in this study.

Items 33 and 54, however, are easily identifiable as outliers (Borg & Gall, 1983) thereby indicating possible inequality. The possible causes for these two items' high frequency are discussed in the interview and observational analysis.

In reference to this study's question 2, the data presented in Figures 1, 2, and 3 indicate that computer graphic item
equivalency is possible to the extent necessary to encourage further development of the product. However, the decision to continue product development is also dependent upon an affirmative response to question 3: students' attitude toward the product.

Assessment of Students' Attitudes

Data to assess student attitude in the preliminary field test were collected through administration of the questionnaire. The results show that students' attitudes toward computers and the preliminary product in general are favorable in 67% of the responses, 24% of the responses indicate no preference, and 9% show disapproval (Appendix F, items 2-15). (Note that favorable responses on item 10 are interpreted as disapproval toward the computer test form and are calculated as such in these percentage reports.) Specifically, 92% of the students favored the opportunity to work on computers (Appendix F, item 2). Students preferred aspects of the computer-administered test over the paper-and-pencil exam in 67% of the responses (Appendix F, items 6, 7, 8, 10). In 65% of the responses, students indicated a favorable attitude toward the unique aspects of the computer-adapted test. Because of the high percentage of students' positive responses toward the computer-adapted test (Appendix F, items 3, 4, 5, 9, 11, 12, 13, 14, 15) and its successful programming, continued development and research of the computer-adapted test is warranted.
Preliminary Product Revisions

The final purpose of the preliminary field test was to identify and revise problems found in the computer-adapted test. Following, is a discussion on each revision made.

**Revision of outliers.** Items 33 and 54 were previously identified as outliers (Figures 1, 2, and 3). A possible explanation for the variance in student performance on item 33 is difficult to identify. In interviews, subjects never mentioned item 33. Similarly, no reference was made to item 33 in the observational data. Therefore, it is reasonable to assume that the cause may be a programming error. All commands and subroutines associated with item 33 were rechecked and found to be in order. Following a discussion with colleagues, it was decided that the computer graphic depiction of the camera lens should be redrawn (Appendix A, item 33). There is no empirical evidence to support this action. However, by refining the camera lens drawing, new data can be collected to provide additional insight in determining the cause of this discrepancy.

Two possible causes for the variance in item 54 were identified in the interviews. Five of twelve subjects (Appendix G, item 4) state that the bugs are not clear (Appendix A, item 54). In order to identify the bug, a clear graphic depiction of wings and legs is necessary. The graphics were refined by lengthening and shortening the legs on bugs B, D, and E. The second possible cause of discrepancy was related to the formatting of the question (Appendix G, item 19). The question and identification
key were first shown on the screen. The students then called up the next screen to view the bugs. This procedure contrasts with all other graphic test items. The computer recorded an error when students follow the usual procedure and enter an inappropriate response for this particular item. The problem was fully resolved by combining the question and identification key with the graphics, and adding a new subroutine to handle unacceptable responses.

Revision of second practice question. In an interview, one student commented (Appendix G, item 3) that the second practice question requires a person to identify the color of an object depicted in the computer drawing. However, the object's color was not listed as one of the multiple choice options. Later it was discovered that the graphic's colors are dependent upon the color setting of the monitor. Therefore, a different question is applied to the same graphics.

Revision of graphic related test items. Among the 16 questionnaire items, the frequency of negative responses is highest on item 9 (Appendix F). Five of the twelve subjects disapproved of having the graphics and questions presented on separate screens. Revisions were made on all graphic related items not fitting the desired format so that a question's stem is also presented on the related graphic screen. However, in order to answer a graphic related question, students are still required to leave the graphics mode and enter their response when the full question appears on the screen.

After the preliminary field test, it was noted that item 41 on
the computer may cause an invalid response. The question is designed to measure students' classification skills. The figures to be classified on the paper-and-pencil test are printed in black and white. In contrast, the figures presented on the computer use several colors. This possible contaminant variable may explain item 41's higher frequency count in Figure 1 favoring the computer administered exam. Therefore, the computer graphic figures were redrawn in white on a dark screen.

In an interview, one student stated that item 45 is easier on the computer than in the paper-and-pencil form. Therefore, the computer drawn leaves were revised to appear more like those depicted in the paper version.

On interview item 4, five students state that the graphic depiction of bugs in item 43 and 49 are not clear. However, evidence reported in Figures 1 and 2 indicate that lack of clarity had no effect on the accuracy of a student's response to item 43 and possibly minimal effect on item 49. Therefore, some minor revisions were made to refine the computer drawn bugs to appear more like those printed on the paper exam.

Three subjects stated (Appendix G, item 4) that the aerial view of a person's head in computer test item 52 is difficult to identify. Therefore, the aerial view of heads was redrawn using a different combination of hair and face color to make it more easily recognized.

While reviewing the computerized test, it was noted the large square in item 59 appears more like a rectangle than a square.
Thus, the shape was redrawn to properly depict a square as referred to in the question.

Three people stated (Appendix G, item 4) that the spoon in computer test item 61 is not clear. Clarity of the spoon is not essential in order to answer the question correctly. However, the lack of precision was sufficient to have 25% of the respondents comment on it (Appendix G, item 4). The spoon was redrawn to make it more similar to the drawing in the paper-and-pencil test.

Additional minor revisions. One student (Appendix H) identified a syntax error that was corrected in test item 9.

One student identified (Appendix H) a formatting error in test results listed under "PC".

One student identified (Appendix H) response "B" and "C" in item 32 as being the same response.

One student identified (Appendix H) a typing error.

Summary of revisions. Following is a summary of the revisions previously identified.

A. Practice question 2, develop new question.
B. Item 5, correct typo error.
C. Item 9, correct syntax error.
D. Item 20, include question with picture.
E. Item 30, include question with picture.
F. Item 31, include question with picture.
G. Item 32, retype answer B and C.
H. Item 33, form camera lens to be more oval in shape.
I. Item 41, replace color figures with white figures.
J. Item 43, adjust length of bug legs.
K. Item 45, add flower characteristics similar to paper version.
L. Item 46, combine question with picture
M. Item 47, duplicate picture and included question.
N. Item 48, duplicate picture and included question.
O. Item 49, refine bugs where needed.
P. Item 52, refine "heads".
Q. Item 54, change format and include question with picture.
R. Item 59, construct a square to replace the rectangle.
S. Item 61, refine "spoon and substance."
T. Item 65, include question with picture.
U. Item 66, include question with picture.
V. Item 67, include question with picture.
W. Item 71, include question with picture.
X. Item 80, change "scientists" to singular form.
Y. Change score result format of "PC 9/11 Pass" by moving it one space left.
Z. Write subroutine to safeguard student response when switching between screens.

Aspects not revised. The following aspects of the computer-adapted test were not revised.

Results of questionnaire and interview item 10 (Appendix F and G) indicate that the majority of students wanted the option to review their responses to previous test items. Technologically
speaking, this can be done. However, the course instructor does not want this option made available (Conversation with Daugs, August, 1987). Therefore, it was not revised.

The course instructor refuted one student's response to interview item 10 that previous test items can provide clues to a later question. In addition, reviewing previous test items may complicate the test administration resulting in confusion for students. Therefore, no revision was made to accommodate the students' suggestion.

Questionnaire and interview results on item 14 indicate that most students were comfortable with removing and inserting floppy disks. They will not need to do this once the computer-adapted test is loaded on to the CORVUS System's hard disk. Until then, no attempt will be made to revise this feature.

Making improvements on the computer's lag time is not technologically possible with the available hardware. Fortunately, 50% of the students responses to questionnaire item 11 is favorable and the remaining 50% indicate no preference. Also, student comments on interview item 11 (Appendix G) are in favor of the lag time by a ratio of 2 to 1. Therefore, the inability to make this revision is not critical to the successful application and continual of development of the computer-adapted test.

Results of questionnaire and interview item 16 indicate that students prefer having an instructor present. This is viewed as being unfortunate because the test is designed to be self-administered. It is expected that the revisions made thus far will provide greater security for students take the test. Until
this variable is measured again, an instructor's presence may be necessary.

**Follow-up Field Test**

The purpose of the follow-up field test was to measure the effect on student performance caused by revisions made to the computer-adapted test. An abridged version of the Scientific Literacy Test was used to measure student performance because of time restraints and students' familiarity with the original test.

**Research Approach**

The remaining 34 students enrolled in the science method courses were administered an abridged version of the Scientific Literacy Test five weeks following completion of the preliminary field test. The field test design was as follows:

- R X Y (Group A = 17 subjects)
- R Y X (Group B = 17 Subjects)
- R = Random assignment
- X = Computer test administration
- Y = paper-and-pencil test administration

The testing procedure controlled for order effect (Borg & Gall, 1983) by first administering the paper version of the test to
Group A and the computerized version to Group B. After completing the first (either x or y) test, each group was administered the version of the test that they had not taken. This counterbalance design eliminated the possible confounding of order effects with treatment effects.

Description of Subjects

The follow-up field test subjects included the remaining 34 students in the accessible population of the preliminary field test. They participated as part of the science course requirement.

Description of Instruments

An abridged version of the Scientific Literacy Test (Appendix I) was developed for administration in the follow-up field-test. This was because subjects in the follow-up field-test were selected from the same population used in the preliminary field-test; and the class schedule permitted only two hours to administer the computerized test using three computer terminals. Usually it takes one hour to complete the original exam. Only 10 minutes is needed to complete the abridged test.

Another reason was that the 34 subjects selected to participate in the follow-up field-test had completed the original
Scientific Literacy Test in paper form five weeks earlier. Therefore, administering the same lengthy test again could have resulted in students' lack of effort and concern toward it.

Following is a list of items from the original test reassigned to a new position in the abridged exam.

<table>
<thead>
<tr>
<th>Abridged Exam Item</th>
<th>Original Test Item</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>59</td>
</tr>
<tr>
<td>2</td>
<td>78</td>
</tr>
<tr>
<td>3</td>
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<tr>
<td>9</td>
<td>54</td>
</tr>
<tr>
<td>10</td>
<td>61</td>
</tr>
</tbody>
</table>

Items 9, 26, and 78 were included in the abridged exam in order to create a treatment similarly applied in the preliminary field test; and because the items are short in length.

Items 33 and 54 were included in the abridged test because they were identified as outliers in the preliminary field test results (Figures 1 and 2). The remaining graphic items were revised to a greater extent than any other graphic items. Therefore, they are included to collect new data following the preliminary revisions.
All other components of the abridged exam are identical to the recently revised computer-adapted Scientific Literacy Test.

Test Administration Procedures

The main field test was conducted in the same classroom settings as the preliminary field test. Six subjects reported to an assistant instructor every 20 minutes over a two-hour time span. The assistant instructor directed them to their randomly preassigned location: the computer room (Group A) or the classroom (Group B). When the subjects completed their first version of the exam, they were assigned the other location to finish the other version of the abridged test. The students were excused after they completed both forms of the exam.

An instructor was present in both test administrations. Students were told to follow the directions provided at the beginning of both test forms. Any concerns were to be addressed to the instructor. Students interested in their test scores or further explanation of the research were provided information after all testing had been completed.

Follow-up Field Test Results

Test administration Groups A and B each had one attrition. Thus, sixteen subjects in both groups completed the exams. Test
order for group A was first computer then paper-and pencil. Group B's test order was paper-and-pencil then computer. Students' test results are represented in Figures 4, 5, 6, and 7.

Follow-up Field Test: Analysis

Items 33 (item 4 in the abridged test) and 54 (item 9 on the abridged test) were again identified as outliers. The possible cause for the variance is easily identified.

In the paper-and-pencil test's item 33 (item 4 in the abridged test), the camera lens labeled "B" is identified as "C" in the computer test's drawing. Likewise, figure "C" on the paper version is labeled "B" on the computer. This provides an explanation for the location of item 33 in Figures 1, 4, 5, 6, and 7.

Comparing the paper drawing of item 54 (item 9 in the abridged test) with the computer drawing, the bug labeled "F" had noticeably shorter hind legs in the computer graphics depiction. When revising the preliminary item, text was accidently written over the top of the bug's hind legs. This action was sufficient to cause students to mistakenly identify bug "F". This also provides an explanation for item 54's position in Figures 4, 5, 6, and 7.

The remaining abridged test items again show a "... small mean discrepancy ..." (Wise et al., 1987, p 3) between the two modes of test administration for graphic and non-graphic test items (Refer
Paper Test Results
(Number of Correct Responses)

Legend
Abridged Test (AT) Item 1 = Scientific Literacy Test (SLT) Item 59
AT Item 2 = SLT Item 78
AT Item 3 = SLT Item 41
AT Item 4 = SLT Item 33
AT Item 5 = SLT Item 26
AT Item 6 = SLT Item 52
AT Item 7 = SLT Item 45
AT Item 8 = SLT Item 9
AT Item 9 = SLT Item 54
AT Item 10 = SLT Item 61

Figure 4 Follow-up field test results showing group A's computer-administered test scores compared with group A's paper-and-pencil administered test scores.
Paper Test Results
(Number of Correct Responses)

Legend
Abridged Test (AT) Item 1 = Scientific Literacy Test (SLT) Item 59
AT Item 2 = SLT Item 78
AT Item 3 = SLT Item 41
AT Item 4 = SLT Item 33
AT Item 5 = SLT Item 26
AT Item 6 = SLT Item 52
AT Item 7 = SLT Item 45
AT Item 8 = SLT Item 9
AT Item 9 = SLT Item 54
AT Item 10 = SLT Item 61

Figure 5 Follow-up field test results showing group B's computer-administered test scores compared with group B's paper-and-pencil administered test scores.
Figure 6  Follow-up field test results comparing group A's computer-administered test scores with group B's computer-administered test scores.
Paper Administered Test Results

Legend
Abridged Test (AT) Item 1 = Scientific Literacy Test (SLT) Item 59
AT Item 2 = SLT Item 78
AT Item 3 = SLT Item 41
AT Item 4 = SLT Item 33
AT Item 5 = SLT Item 26
AT Item 6 = SLT Item 52
AT Item 7 = SLT Item 45
AT Item 8 = SLT Item 9
AT Item 9 = SLT Item 54
AT Item 10 = SLT Item 61

Figure 7 Follow-up field test results comparing group A's paper-and-pencil administered test scores with group B's paper-and-pencil administered test scores.
to Figures 4, 5, 6, and 7). The remaining items, therefore, were viewed as reasonably equivalent.
CHAPTER IV
DISCUSSION

Purposes of the Study

The primary purpose of this study was to develop a procedure which would make it possible to present complex graphics within the framework of the computerized Scientific Literacy Test.

The three secondary purposes of this study were:

1. To design a questionnaire that measures student attitude toward (a) science and computers in general, (b) specific aspects of the computer-administered test, and (c) the computerized test in comparison with the paper version of the test.

2. To conduct a preliminary field test in order to (a) assess graphic test-item equivalency between computer and paper test administration, (b) assess student attitude toward the product, and (c) provide information for product improvement.

3. To conduct a follow-up field test to assess specific-item equivalency following any revisions stemming from the preliminary field-test results.

Methods and Procedures

The methods used in this study follow the initial portions of
the research and development cycle described by Borg and Gall (1983).

The sequence of major activities were as follow:

A. Develop a computer program capable of presenting the Scientific Literacy Test’s complex drawings.
B. Adapt the Scientific Literacy Test for use on the Apple IIe computer.
C. Identify and prepare an accessible population for administering the exam.
D. Prepare questionnaire and interview formats.
E. Conduct the preliminary field test.
F. Analyze student performance, questionnaire and interview responses, and observations.
G. Revise product based upon preliminary field test results.
H. Conduct a follow-up field test to measure the effect of preliminary field test revisions.
I. Analyze and report results from follow-up field test.

Limitations

The following four limitations were recognized after completing all field testing.

1. Students’ questionnaire responses are categorized as favorable, no preference, and disapproving. The various facial
expressions used in the response format (Appendix C) may suggest such descriptions, but at no time were subjects informed of this. There is no data to indicate that subjects interpreted the facial expressions one way or the other. However, in future research that uses a similar rating scale, a description of facial expressions should be provided.

2. Questionnaire items 1, 5, 7, 10, 13, 15, and 16 (Appendix C) may be better suited using an agree - disagree type of response format. One student (Appendix F, item 10) responded to the questionnaire item in such a manner. Future researchers applying similar questionnaire items should use a response format that best accommodates a question's stem.

3. An unusually high frequency of favorable responses are recorded on questionnaires. This result is unexpected considering the many weaknesses of the product that students identified during interviews. Perhaps the Hawthorne Effect played a role in these future teachers' charitable evaluations. Teachers have responded similarly in previous research (Borg & Gall, 1983).

4. The counterbalance design used in administering the test eliminated the confounding of order effects with treatment effects. If students' order of test administration were recorded, additional information could have been available in assessing the preliminary product.
Conclusions

An analysis of the data reported in this study supports the following conclusions regarding the development of this computer adapted form of the Scientific Literacy Test:

1. Presenting complex graphics within the framework of administering the computer-adapted Scientific Literacy Test provides evidence that the required programming procedure can be developed.

2. The data presented in Figures 1 - 7 provides evidence that application of the programming procedure could result in reasonable graphic test item equivalency between the two forms of test administration.

3. Questionnaire results indicate favorable student attitude toward use of the computer-adapted Scientific Literacy Test.

4. The three previously cited conclusions support the continued development and research of the computer-adapted Scientific Literacy Test.

Significance of the Conclusions

A specific and a general significance was drawn from the conclusions.

The specific significance is that program subgoals 2.1, 2.2, and 2.3 (Daugs, 1986) can be achieved. That is, student level of
scientific literacy can be assessed through application of a computer-adapted form of the Scientific Literacy Test.

The general significance relates to the development and application of complex graphics on Apple II computers. Dazzle Draw provides the means for designing graphics that is unsurpassed by all other software programs available for the Apple II computer. Educational application of Dazzle Draw prior to this study was limited to a single graphic display. Now, any number of Dazzle Draw graphics can be displayed in an interactive computer program.

**Recommendations**

The conclusions of this study led to the recommendation that further development and research of the preliminary form of the computer-adapted Scientific Literacy Test should be conducted. In doing so, the following questions need to be addressed.

1. What effect do the latest revisions have on item equivalency. This particularly applies to test items 33 and 54.
2. To what extent do the two forms of test administration have concurrent validity? An experimental research design should be used to measure this.
3. What effect do the revisions have on student attitude toward the product?
4. Are there new or additional aspects of the product that
can be improved.

5. What type and to what extent do human factors affect student performance on a computer-administered test?

Any future research conducted on this study’s product should wait until the computer-adapted form of the Scientific Literacy Test is loaded onto a hard disk system. This was the original intent for the finalized product.
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Field, C. E. (1985, June). Dazzle draw. inCider, 3, 87. (From Microcomputer Index, 1985, 6(3-4) Abstract No. IC06-012)


Appendix A. The Scientific Literacy Test
PART A - LIFE SCIENCE

(1) For quick energy before a race, it would be best for a runner to have

A. a hard-boiled egg
B. a hot dog
C. a cup of coffee
D. a candy bar

(2) Fertilization takes place when a sperm

A. reaches a certain age
B. enters an egg
C. becomes an egg
D. becomes an embryo

(3) Why can large bodies of water clean themselves from the pollution of organic matter such as body wastes and dead organisms?

A. Fish eat the organic matter
B. Algae decompose the organic matter
C. The organic matter settles to the bottom and is not changed
D. Bacteria decompose the organic matter

(4) Which of the following statements is true about seeds?

A. All plants produce seeds
B. All seeds are good to eat
C. All fruits contain a large number of seeds
D. Every seed contains a young plant, stored food and a seed coat
(5) Which of the following substances is added to drinking water to help prevent tooth decay?
   A. Fluoride ...........................................
   B. Chlorine ...........................................
   C. Calcium ...........................................
   D. Iodide ............................................

(6) Which ONE of the following is prepared from the seeds of plants?
   A. Tea ..............................................
   B. Flour ............................................
   C. Salt ..............................................
   D. Sugar ............................................

(7) What is the second stage in the life cycle of a housefly?
   A. Adult ............................................ 
   B. Egg .............................................
   C. Larva ...........................................
   D. Pupa ............................................

(8) Which ONE of the following features is NOT an adaptation to life in water?
   A. Streamlined shape ................................
   B. Fins ............................................
   C. Webbed Feet ....................................
   D. Lungs ...........................................

(9) Which gas produced during photosynthesis is useful to animals?
   A. Carbon dioxide .................................
   B. Oxygen ........................................
   C. Carbon monoxide ................................
   D. Nitrogen .......................................
(10) Which of the following is often considered to be the simplest biological unit of structure?

A. The organism .......................................... .
B. The tissue .............................................. .
C. The organ .............................................. .
D. The cell ................................................. .

(11) What is the chief reason glass and plastic wastes are particularly troublesome?

A. They form ugly litter................................. .
B. They are easily changed into poisonous substances .......
C. They float on top of bodies of water ...................
D. They resist being changed by natural processes ......

(12) To which body system do the lungs belong?

A. Sensory ..................................................... .
B. Respiratory ............................................. .
C. Circulatory ............................................. .
D. Digestive ................................................ .

(13) Today, almost no one gets polio because

A. bad water, which used to cause polio, has been cleaned up ......................... .
B. doctors have found new drugs which cure polio when it happens ................. .
C. people eat better food and get more exercise, so they are healthier ............
D. people are given a vaccine which keeps them from getting polio ............... .
(14) Which ONE of the following is a characteristic of ALL birds but of no other animal? Birds
   A. tend to migrate.................................
   B. lay eggs.....................................
   C. fly...........................................
   D. have a body covered by feathers.............

(15) The organisms in a food chain responsible for converting light energy to a usable form are called
   A. decomposers...................................
   B. herbivores...................................
   C. producers...................................
   D. consumers...................................

LIFE SCIENCE: Score ___ out of 15
(16) How is dew formed?

A. Water vapor condenses on cold grass or other cold surfaces.
B. It is left on the grass by rain.
C. It forms in the air and falls on the grass.
D. It forms from melted frost.

(17) Which ONE of the following is a fossil fuel?

A. Wood
B. Paper
C. Natural gas
D. Limestone

(18) Which ONE of these is true about the planet Venus?

A. It is about the same size as the earth and is like it in most other ways.
B. Scientists know more about the surface of Venus than they do about Mars.
C. It is about the same size as the earth but has a very different atmosphere.
D. Venus has many satellites.

(19) What does the statement that the relative humidity is 50% mean?

A. The atmosphere would be saturated with water if the air temperature were 50°C.
B. The atmosphere contains half as much water as it could contain at its present temperature.
C. The atmosphere contains 50 g of water per cubic metre.
D. The chance of rain is 50%.
(20) Examine the following diagram.

What effect can the crop duster, cattle, salt stored in piles outdoors, and farmer spreading fertilizer ALL have?

A. Improve the soil
B. Kill insects that attack crops
C. Make plants bigger and faster
D. Make the stream water impure

(21) The moon is the brightest object in the night sky because it

A. is fluorescent
B. produces its own light
C. reflects light from the sun
D. reflects light from nearby stars

(22) Crude oil comes from

A. mines like coal
B. a factory
C. the juices of plants
D. wells in the earth
(23) Which ONE of the following is true?

A. Some planets revolve around the sun in one direction or another. 
B. Only the earth revolves around the sun. 
C. Planets do not revolve around the sun. 
D. All planets revolve around the sun in the same direction.

(24) Which statement best describes how the earth's surface changes over billions of years?

A. A flat surface is gradually pushed up into steeper and steeper mountains until the world is covered with mountains. 
B. Very steep mountains gradually wear down until most of the world is worn down to sea level. 
C. Very steep mountains and flat plains stay side by side for billions of years with little change. 
D. Very steep mountains gradually wear down into flat surfaces that may be again pushed up into mountains, and so on over and over again.

(25) For which of the following are earth satellites NOT used?

A. To reflect radio and T.V. signals back to earth. 
B. To help predict weather. 
C. To capture solar energy to provide power for cities. 
D. To help make maps by photographing the earth.

(26) Which ONE of the following is presently helping to shape the surface of the moon?

A. Glaciers 
B. Plants 
C. Meteorites 
D. Streams
(27) The water that flows into the ocean as rivers
A. all comes from town and city sewage disposal plants
B. all comes from lakes at the heads of the rivers
C. reaches the river by many paths through the air, over the land surface, or underground
D. was lifted from underground caverns to the surface of the earth by gravity

(28) Which term BEST describes an object such as Saturn's moon Titan or Earth's moon?
A. A planet
B. A star
C. An asteroid
D. A satellite

(29) Which of the following helps to account for the fact that a compass can be used to find north on Earth?
A. Earth reflects the Sun's light
B. Earth has only one moon
C. Earth's temperature is not constant
D. Earth has a magnetic field

EARTH/SPACE: Score ____ out of 14
(30) Below are five diagrams of electric circuits.

A. A 
B. B 
C. C 
D. E 

Which diagram shows two cells in series?

A. A 
B. B 
C. C 
D. E 

(31) In which circuit will the light bulb(s) not work?

A. A 
B. B 
C. C 
D. D 

(32) When a light beam hits a mirror surface at a certain angle

A. it bounces away at the same angle.................
B. it always bounces back along the same line........
C. it bounces away at a greater angle.................
D. it bounces away at a smaller angle.................
(33) Which diagram below BEST shows what happens when light hits a camera lens?

A.  
B.  
C.  
D.  

(34) Most of the chemical energy of the gasoline burned in a car is not used to move the car. Into what is it changed?

A. Heat  
B. Electricity  
C. Light  
D. Magnetism  

(35) Sugar is added to water at a temperature of 85°C until no more will dissolve. The sugar and water solution is allowed to cool. Which of the following is most likely to occur next?

A. More sugar will dissolve in the water when the water reaches room temperature.  
B. The sugar will slowly rise to the surface of the liquid in the container.  
C. Crystals of sugar will begin to appear around the sides of the container.  
D. The solution will gradually become cloudy as the sugar reacts with the water.
(36) Two identical spring balances are arranged as shown below. Which spring balance will show the greater reading?

A. #1

B. #2

C. Both will show the same

D. One cannot predict which balance will show the greater reading.

(37) When a guitar string is tightened the string makes a higher pitched sound because the tighter string vibrates

A. slower

B. faster

C. closer

D. further

(38) It is possible to pass white light through a piece of glass called a prism and produce a spectrum (a short piece of a rainbow). What does the prism do to the light?

A. It subtracts colors from the light passing through

B. It adds colors to the light passing through

C. It breaks it up into the colors from which it is made

D. It absorbs the light from the source
(39) Which of the following would be the most important factor in improving the SPEED of a pair of roller skates?

A. Making the wheels rounder ........................................
B. Reducing friction by ball bearings ......................
C. Designing better-fitting boots .................................
D. Putting big treads on the wheels .............................

(40) When a light beam passes through air and then into water in an aquarium, it bends. What is this bending called?

A. Spectrum ............................................................
B. Refraction ..........................................................
C. Reflection ..........................................................
D. Diffusion ...........................................................
(41) All of these are Bobbos.

None of these is a Bobbo.

Which ONE of these is a Bobbo?

A. .........................................................
B. .........................................................
C. .........................................................
D. .........................................................
Here is a chart of shapes. Which shape is missing from Space 1?

A Rock Louse has a body which is oval in shape. Each antenna is about one half the length of its body. It has seven pairs of legs.

Which ONE of the following is a Rock Louse?
The following is an identification key for eight students in a class. Use this key, step by step, to find the name of the blue-eyed blond girl.

<table>
<thead>
<tr>
<th>Step 1.</th>
<th>Sex-boy</th>
<th>Go to Step 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sex-girl</td>
<td>Go to Step 5</td>
</tr>
</tbody>
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<tr>
<th>Step 2.</th>
<th>Eyes Blue</th>
<th>Go to Step 3</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Eyes Brown</td>
<td>Go to Step 4</td>
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<tr>
<th>Step 3.</th>
<th>Hair Blond</th>
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<tr>
<td></td>
<td>Hair Dark</td>
<td>Lynn</td>
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</table>

<table>
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<th>Step 4.</th>
<th>Hair Blond</th>
<th>Nicky</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hair Dark</td>
<td>Bobby</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 5.</th>
<th>Eyes Blue</th>
<th>Go to Step 6</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eyes Brown</td>
<td>Go to Step 7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 6.</th>
<th>Hair Blond</th>
<th>Pat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hair Dark</td>
<td>Beverly</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Step 7.</th>
<th>Hair Blond</th>
<th>Terry</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hair Dark</td>
<td>Lee</td>
</tr>
</tbody>
</table>

What is the name of the blue-eyed, blond girl?

A. Pat .......................................................... 
B. Lee ........................................................... 
C. Leslie ........................................................ 
D. Terry ..........................................................
(45) All of these are lilies.

(46) None of these is a lily.

Which ONE of these is a lily?

A. ...................................................

B. ...................................................

C. ...................................................

D. ...................................................
Here is a graph which shows how fast green plants make simple sugar when the brightness of the light is changed.

For which part of the graph is it true that making the light brighter hardly changes the rate of making simple sugar?

A. Between O and U
B. Between V and Y
C. Between W and X
D. Between U and W

According to the graph, plants make the most simple sugar when the light is

A. very dim
B. very bright
C. not too bright and not too dim
D. strong at any time of day

At which brightness are the plants making the greatest amount of simple sugar?

A. O
B. W
C. V
D. Z
149) All of these are insects.

None of these is an insect.

Which ONE of these is an insect?

A. ............................................
B. ............................................
C. ............................................
D. ............................................
(50) A girl enters a room. There is a bed along the wall to her LEFT, a window in the wall in FRONT of her and a table along the wall to her RIGHT. Which of the rooms below did she enter?

A. \begin{array}{c}
\text{Bed} \\
\text{Door} \\
\text{Window} \\
\text{Table}
\end{array}

B. \begin{array}{c}
\text{Table} \\
\text{Door} \\
\text{Bed} \\
\text{Window}
\end{array}

C. \begin{array}{c}
\text{Table} \\
\text{Door} \\
\text{Bed} \\
\text{Window}
\end{array}

D. \begin{array}{c}
\text{Bed} \\
\text{Door} \\
\text{Window} \\
\text{Table}
\end{array}

(51) All of these are Ungulates.

Deer
Buffalo
Goat
Cow

None of these is an Ungulate.

Raccoon
Wolf
Tiger
Rat

Which ONE of the following is an Ungulate?

A. Dog 
B. Bear 
C. Sheep 
D. Beaver
In the diagrams below you are looking down on a scene from an airplane. Jim says, "The car which is in front of me is behind John and the tree on my left is on his right".

According to Jim's description, which is the correct diagram?

A.  
B.  
C.  
D.  
(53) All of these are Hewts.

None of these is a Hewt.

Which ONE of these is a Hewt.

A. .................................................................
B. .................................................................
C. .................................................................
D. .................................................................
Here are six unknown animals. Look at them carefully.

Use the identification key below to find out the name of CREATURE F.

<table>
<thead>
<tr>
<th>Step 1. wings</th>
<th>Go to Step 2</th>
<th>Go to Step 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>no wings</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| Step 2. wings stick out to the side | Go to Step 3 | Go to Step 4 |
| wings do not stick out to the side |              |              |

| Step 3. hind legs as long as body | Crayefly | Thread-waisted Wasp |
| hind legs shorter than body      |          |                   |

| Step 4. wings cover all of abdomen (rear end) | Leaf Bug | Housefly |
| wings do not cover all of abdomen       |          |         |

| Step 5. six legs | Bristletail |
| eight legs       | Spider      |

Creature F is a

A. Thread-waisted Wasp ............................................................
B. Crayefly .................................................................
C. Leaf Bug .................................................................
D. Bristletail ..............................................................
In the diagram below, you are looking down on a scene from an airplane.

Jim says, "The railway is behind me and on John's right".

Where is the tree?

A. Behind John ...........................................
B. Behind Jim ...........................................
C. In front of John .......................................
D. On Jim's right .......................................
Sarah wanted to find out if temperature has an effect on the growth of bread mold. She grew the mold in nine containers, each with the same amount and type of nutrients.

Three containers were kept at 0°C.
Three containers were kept at room temperature (about 21°C).
Three containers were kept at 90°C.

The containers were examined at the end of four days.

What is the factor which Sarah will look for?
A. Changes in the amount of nutrients in each container
B. The amount of growth of the bread mold
C. Numbers of containers at each temperature
D. Differences in the temperature of the containers

What did Sarah make different between her containers?
A. The number of containers at each temperature
B. The amount of nutrients in each container
C. The growth of the bread mold in the containers
D. The temperature of the containers

Which is the MOST important reason Sarah used three containers at each temperature?
A. She put different kinds of nutrient in each container
B. She knew that averages are the best data in growth experiments
C. She was afraid some containers might break
D. She had no good reason for doing this
A student wished to find out how many ants there were in one square metre of his lawn. He divided one square metre up into 100 equal patches and counted the ants in five of the patches. He obtained the numbers of 3, 4, 4, 7 and 7.

What is the BEST estimate for the total number of ants on one square metre?

A. 400 .....................................................
B. 500 .....................................................
C. 700 .....................................................
D. None of the above .................................

Which of the following problems would be easiest to answer from a SINGLE experiment?

A. Do light and salt in the water affect the growth of plants?..............................
B. What factors affect the growth of plants......................
C. Do light and no water affect the sprouting of plant seedlings?..............................
D. Does light affect the growth of bean seedlings?..............
(61) Look at this picture.

What observation can you make from it?
A. A person is holding powder from the box in the spoon.
B. A person is stirring baking soda into water.
C. A person is taking something from the measuring cup on the table.
D. A person is holding a spoon with something in the spoon.

(62) Molly suspected that 'vegetables contain water'. In order to test this idea she decided to test five different vegetables: lettuce, carrots, fresh peas, spinach and potatoes. She put a piece of each into one of five test tubes and heated them. She saw drops of liquid collect on the wall of each test tube. She tested the drops and found they were water. Molly's teacher suggested that this experiment needed a control. What control should Molly have used?
A. Heat a test tube with water in it
B. Heat a test tube with meat in it
C. Heat an empty test tube
D. Heat a test tube with cereal in it
(63) The treeline is the highest altitude at which trees can grow. The following table relates treeline to distance from the equator.

<table>
<thead>
<tr>
<th>Distance from Equator</th>
<th>Treeline</th>
</tr>
</thead>
<tbody>
<tr>
<td>1000 km</td>
<td>4000 m</td>
</tr>
<tr>
<td>2500 km</td>
<td>3500 m</td>
</tr>
<tr>
<td>5000 km</td>
<td>3000 m</td>
</tr>
<tr>
<td>6500 km</td>
<td>1500 m</td>
</tr>
</tbody>
</table>

According to the table above, the farther you are from the equator

A. the higher the treeline...                   
B. the lower the treeline...                  
C. the taller the trees...                    
D. the smaller the trees...                   

(64) Four students did four different experiments and graphed their results as shown below.

Each planned to take a measurement every day for five days. However, on the third day the school was closed. Which graph would give the poorest estimate for the third day?

A. ....................................................
B. ....................................................
C. ....................................................
D. ....................................................
The graph below shows some results from an experiment testing heartbeats that result from different kinds of activity.

In this experiment, what is the factor which the experimenter wishes to observe?

A. Which type of activity produces 120 heartbeats per minute
B. The type of activity
C. If walking is good for a person
D. The number of heartbeats per minute

What factor was changed in order to get the data?

A. The number of heartbeats per minute
B. The type of activity
C. The speed at which people walk
D. How fast people swim

What hypothesis was the experimenter likely testing?

A. Type of activity affects heartbeat rate
B. The faster a person moves from place to place, the faster his heart beats
C. Activity improves a person's health
D. If you change the heartbeat rate you make people change their activity
Sue wanted to find out what might affect the length of bean seedlings. She placed a bean wrapped in moist tissue paper in each of ten identical test tubes. She put five test tubes in a rack in a sunny window. She put five test tubes in a rack in a dark refrigerator. She measured the length of bean seedlings in each group after one week.

Which of the following factors did Sue test for their effect on the length of the bean seedlings?

A. Moisture and length of test tube
B. Light and temperature
C. Light and amount of time
D. Temperature and moisture

What is the MOST important reason Sue used five test tubes at each temperature?

A. She wished to test five different conditions
B. Averages provide better data in growth experiments
C. She was afraid she might break some test tubes
D. She had no good reason for doing this

Sue found that the seedlings grew better in the rack on the sunny window. Why might Michael criticize her experiment?

A. There is no reason to criticize her experiment
B. She should have put different amounts of water in the test tubes
C. She cannot tell if the better growth is a result of temperature or of light or of both
D. She did not need to use so many test tubes
(71) Each dot in the graph below shows the measurements made by a scientist while he watched a beetle's movements for ten minutes.

The graph shows that

A. the beetle was looking for food.
B. the beetle changes direction every half minute.
C. the beetle was trying to climb the wall.
D. the beetle's movements were not steady.

(72) When we say that a scientist has formed a HYPOTHESIS about an experiment we mean that he has

A. designed equipment needed for the experiment.
B. indicated which measurements will be made and how they should be carried out.
C. described how the experiment might turn out by stating how one factor might affect another.
D. observed all the things that happened during the experiment.

EXPERIMENTATION: Score ___ out of 17
PART C - NATURE OF SCIENCE

(73) When acting like a scientist, it would NOT be right to
A. do someone else's experiment again
B. let your feelings affect the results
C. announce results different from those in your textbook
D. take a great many measurements

(74) Which of the following is a THEORY rather than an OBSERVATION?
A. The centre of the earth is liquid
B. The average temperature of the South Pole is lower than the average temperature at the Tropic of Capricorn
C. A ship can start from a point, sail around the earth, and return to the same point
D. The temperature at the bottom of a very deep well is higher than the temperature at the surface

(75) You were doing an investigation into the boiling temperature of corn syrup and found that it boiled at 130°C. You read in your science text, however, that corn syrup boils at 125°C. When you report your results to the class in front of your teacher you should
A. assume your thermometer was wrong and report 125°C as your finding
B. report your 130°C results regardless of what people might think
C. report only the 125°C since that is what it should be
D. report that you made an error and will redo the investigation

(76) Three of the following are statements of fact. Which statement is a HYPOTHESIS?
A. The rings of Saturn were formed from a moon that exploded
B. The boiling point of water is 100°C
C. Hydrogen was first prepared by Cavendish in 1766
D. A litre of water has a mass of 1 kilogram
(77) Scientists of today can work on more complex problems than the scientists of the past because they

A. are more intelligent than earlier scientists
B. work much harder than earlier scientists
C. have more imagination than earlier scientists
D. build on the work of earlier scientists

(78) In summer, John noticed that the air in his tires became hotter when his car was driven over a long distance.

The statement above is an example of

A. a theory
B. a principle
C. an observation
D. a law

(79) Most things fall if they are not held up (law of gravity) but helium-filled balloons rise. Scientists seek to explain this by

A. rejecting the law of gravity because it does not seem to work for helium balloons
B. forgetting it because the world is unexplainable anyway
C. assuming that helium balloons are an exception to the law of gravity
D. looking for a second factor besides gravity acting on helium balloons

(80) When we say that a scientist forms a HYPOTHESIS about an experiment we mean that the scientist

A. describes how the experiment was carried out
B. suggests how to make exact measurements
C. gives directions for doing the experiments properly
D. makes a careful guess about what will happen
Appendix B. The Computer Adapted Scientific Literach Test
PRINT "Before proceeding, check to see that the 'CAPS LOCK' key is pressed down."
PRINT "In order for the computer to record your answers, this key must be in the locked position during the exam."
PRINT "Press RETURN to go on. >"; QS
PRINT "Introduction to Science Diagnostic Exam, Elementary Education, Utah State University."
PRINT "All 80 questions are multiple choice."
PRINT "To answer a question, simply 1. type the letter (A,B,C,D) that matches the correct answer. 2. then press RETURN."
PRINT "There are two kinds of questions. About 1/3 of the questions use a picture while the remainder do not."
PRINT "Press RETURN JUST ONCE and you will see what I mean."
INPUT QS
PRINT "This is the first of 2 PRACTICE questions."
PRINT "How would you describe today's weather?"
PRINT "A. HOT AND SUNNY.  B. WARM AND COMFORTABLE.  C. COOL AND THREATENING.  D. NON-EXISTENT OF THE ABOVE."
PRINT "(If you want to change your answer BEFORE you press RETURN, you can NOT go back and change your answer.)"
PRINT "Press RETURN (ONLY ONCE) to go on."
180 PRINT 0$;"BLOAD PRACTICE1.AS2300"
183 CALL 768
185 POKE 49153,0
187 POKE 49239,0
188 POKE 49237,0
189 POKE 49232,0
190 POKE 49235,0
198 GOSUB 10151
199 HOME
200 PRINT "PRACTICE question #2"
205 PRINT
210 PRINT "REFERRING TO THE PREVIOUS PICTURE, THE AIRPLANE IS FLYING IN THE DIRECTION..."
215 PRINT
225 PRINT
230 PRINT "(TYPE THE LETTER 'P' AND 'RETURN' TO SEE THE PICTURE AGAIN.)"
235 PRINT
240 INPUT ">";GS
245 IF GS = "P" THEN PRINT "ONE MOMENT WHILE I GET THE PICTURE.": GOTO 180
246 GOTO 10010
247 GOTO 245
250 HOME
260 PRINT "Both PRACTICE questions have been completed. If you have any concerns regarding the previous information, feel free to ask the instructor for clarification."
265 PRINT
270 PRINT "You may now select to do one of the following:"
271 PRINT
272 PRINT "A. Begin the exam.  B. Review the PRACTICE questions again."
275 PRINT
280 INPUT ">";GS
285 IF GS = "B" THEN GOTO 28
290 HOME
300 PRINT "GOOD LUCK!"
305 PRINT CHR$(4);"CHAIN PARTI"
9999 END
10000 IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 125
10005 INPUT "OOPS! A TYPING ERROR HAS TAKEN PLACE. YOUR ONLY CHOICES ARE A,B,C,D. (Also, check to see that the 'CAPS LOCK' key is pressed down.) TRY AGAIN.>";GS: GOTO 10000
10010 IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 250
10015 INPUT "OOPS! A TYPING ERROR. SELECT A,B,C,D, OR (P FOR PICTURE). THEN PRESS RETURN. (Is the 'CAPS LOCK' key down?) TRY AGAIN.>";GS: GOTO 245
10150 REM BRING UP DIAGRAM
10151 POKE 49153,0
10155 POKE 49239,0
10160 POKE 49237,0
10165 POKE 49232,0
10175 INPUT GS
10180 POKE 49233,0
10185 POKE 49154,0
10195 RETURN
PART A - LIFE SCIENCE

FOR QUICK ENERGY BEFORE A RACE, IT WOULD BE BEST FOR A RUNNER TO HAVE...

A. A HARD-BOILED EGG.
B. A HOT DOG.
C. A CUP OF COFFEE.
D. A CANDY BAR.

FERTILIZATION TAKES PLACE WHEN A SPERM... A. REACHES A CERTAIN AGE.
B. ENTERS AN EGG.
C. BECOMES AN EGG.
D. BECOMES AN EMBRYO.

WHICH CAN LARGE BODIES OF WATER CLEAN THEMSELVES FROM THE POLLUTION OF ORGANIC MATTER SUCH AS BODY WASTES AND DEAD ORGANISMS?

A. FISH EAT THE ORGANIC MATTER.
B. ALGAE DECOMPOSE THE ORGANIC MATTER.
C. THE ORGANIC MATTER SETTLES TO THE BOTTOM AND IS NOT CHANGED.
D. BACTERIA DECOMPOSE THE ORGANIC MATTER.

WHICH OF THE FOLLOWING STATEMENTS IS TRUE ABOUT SEEDS?

A. ALL PLANTS PRODUCE SEEDS.
B. ALL SEEDS ARE GOOD TO EAT.
C. ALL FRUITS CONTAIN A LARGE NUMBER OF SEEDS.
D. EVERY SEED CONTAINS A YOUNG PLANT, STORED FOOD, AN ENDOCOAT.

WHICH OF THE FOLLOWING SUBSTANCES IS ADDED TO DRINKING WATER TO HELP PREVENT TOOTH DECAY?

A. FLUORIDE.
B. CHLORINE.
C. CALCIUM.
D. IODINE.
625 PRINT
630 INPUT ">";GS
633 GOSUB 10000
640 PRINT " WHICH ONE OF THE FOLLOWING IS PREPARED FROM THE SEEDS OF PLANTS?"
645 PRINT
650 PRINT "A. TEA. " A. TEA.
655 PRINT "B. SALT. " B. SALT.
660 PRINT "C. FLOUR. " C. FLOUR.
665 PRINT "D. SUGAR. " D. SUGAR.
670 PRINT
675 PRINT " WHAT IS THE SECOND STAGE IN THE LIFE CYCLE OF A HOUSEFLY?"
680 PRINT
685 PRINT "A. ADULT. " A. ADULT.
690 PRINT "B. LARVA. " B. LARVA.
695 PRINT "C. PUPA. " C. PUPA.
700 PRINT "D. EGG. " D. EGG.
705 PRINT
710 PRINT "WHAT IS THE FIRST STAGE IN THE LIFE CYCLE OF A HOUSEFLY?"
715 PRINT
720 PRINT "A. EGG. " A. EGG.
725 PRINT "B. LARVA. " B. LARVA.
730 PRINT "C. PUPA. " C. PUPA.
735 PRINT "D. ADULT. " D. ADULT.
740 PRINT
745 PRINT "WHAT IS THE FIRST STAGE IN THE LIFE CYCLE OF A HOUSEFLY?"
750 PRINT
755 PRINT "A. EGG. " A. EGG.
760 PRINT "B. LARVA. " B. LARVA.
765 PRINT "C. PUPA. " C. PUPA.
770 PRINT "D. ADULT. " D. ADULT.
775 PRINT
780 PRINT "WHAT IS THE LIFE CYCLE OF A HOUSEFLY?"
785 PRINT
790 PRINT "A. EGG. " A. EGG.
795 PRINT "B. LARVA. " B. LARVA.
800 PRINT "C. PUPA. " C. PUPA.
805 PRINT "D. ADULT. " D. ADULT.
810 PRINT
815 PRINT "WHAT IS THE LIFE CYCLE OF A HOUSEFLY?"
820 PRINT
825 PRINT "A. EGG. " A. EGG.
830 PRINT "B. LARVA. " B. LARVA.
835 PRINT "C. PUPA. " C. PUPA.
840 PRINT "D. ADULT. " D. ADULT.
845 PRINT
850 PRINT "WHAT IS THE LIFE CYCLE OF A HOUSEFLY?"
855 PRINT
860 PRINT "A. EGG. " A. EGG.
865 PRINT "B. LARVA. " B. LARVA.
870 PRINT "C. PUPA. " C. PUPA.
875 PRINT "D. ADULT. " D. ADULT.
880 PRINT
885 PRINT "WHAT IS THE LIFE CYCLE OF A HOUSEFLY?"
890 PRINT
895 PRINT "A. EGG. " A. EGG.
900 PRINT "B. LARVA. " B. LARVA.
905 PRINT "C. PUPA. " C. PUPA.
910 PRINT "D. ADULT. " D. ADULT.
915 PRINT
920 PRINT "WHAT IS THE LIFE CYCLE OF A HOUSEFLY?"
925 PRINT
930 INPUT ">";GS
933 GOSUB 10000
940 PRINT " WHICH ONE OF THE FOLLOWING FEATURES IS NOT AN ADAPTATION TO LIFE IN THE WATER?"
945 PRINT
950 PRINT "A. STREAMLINED SHAPE. " A. STREAMLINED SHAPE.
955 PRINT "B. FINS. " B. FINS.
960 PRINT "C. WEBBED FEET. " C. WEBBED FEET.
965 PRINT "D. LUNGS. " D. LUNGS.
970 PRINT
975 PRINT "WHICH GAS PRODUCED DURING PHOTOSYNTHESIS IS USEFUL TO ANIMALS?"
980 PRINT
985 PRINT "A. CARBON DIOXIDE. " A. CARBON DIOXIDE.
990 PRINT "B. OXYGEN. " B. OXYGEN.
995 PRINT "C. CARBON MONOXIDE. " C. CARBON MONOXIDE.
1000 PRINT "D. NITROUS OXIDE. " D. NITROUS OXIDE.
1005 PRINT
1010 PRINT " WHICH GAS PRODUCED DURING PHOTOSYNTHESIS IS USEFUL TO ANIMALS?"
1015 PRINT
1020 PRINT "A. CARBON DIOXIDE. " A. CARBON DIOXIDE.
1025 PRINT "B. OXYGEN. " B. OXYGEN.
1030 PRINT "C. CARBON MONOXIDE. " C. CARBON MONOXIDE.
1035 PRINT "D. NITROUS OXIDE. " D. NITROUS OXIDE.
1040 PRINT
1045 PRINT " WHICH GAS PRODUCED DURING PHOTOSYNTHESIS IS USEFUL TO ANIMALS?"
1050 PRINT
1055 PRINT "A. CARBON DIOXIDE. " A. CARBON DIOXIDE.
1060 PRINT "B. OXYGEN. " B. OXYGEN.
1065 PRINT "C. CARBON MONOXIDE. " C. CARBON MONOXIDE.
1070 PRINT "D. NITROUS OXIDE. " D. NITROUS OXIDE.
1075 PRINT
1080 PRINT " WHICH GAS PRODUCED DURING PHOTOSYNTHESIS IS USEFUL TO ANIMALS?"
1085 PRINT
1090 PRINT "A. CARBON DIOXIDE. " A. CARBON DIOXIDE.
1095 PRINT "B. OXYGEN. " B. OXYGEN.
1100 PRINT "C. CARBON MONOXIDE. " C. CARBON MONOXIDE.
1105 PRINT
1110 PRINT " WHICH GAS PRODUCED DURING PHOTOSYNTHESIS IS USEFUL TO ANIMALS?"
1115 PRINT
1120 PRINT "A. CARBON DIOXIDE. " A. CARBON DIOXIDE.
1125 PRINT "B. OXYGEN. " B. OXYGEN.
1130 PRINT "C. CARBON MONOXIDE. " C. CARBON MONOXIDE.
1135 PRINT "D. NITROUS OXIDE. " D. NITROUS OXIDE.
1140 PRINT
1145 PRINT " WHICH GAS PRODUCED DURING PHOTOSYNTHESIS IS USEFUL TO ANIMALS?"
1150 PRINT
1155 PRINT "A. CARBON DIOXIDE. " A. CARBON DIOXIDE.
1160 PRINT "B. OXYGEN. " B. OXYGEN.
1165 PRINT "C. CARBON MONOXIDE. " C. CARBON MONOXIDE.
1170 PRINT "D. NITROUS OXIDE. " D. NITROUS OXIDE.
1175 PRINT
1180 PRINT " WHICH GAS PRODUCED DURING PHOTOSYNTHESIS IS USEFUL TO ANIMALS?"
1185 PRINT
1190 PRINT "A. CARBON DIOXIDE. " A. CARBON DIOXIDE.
1195 PRINT "B. OXYGEN. " B. OXYGEN.
1200 PRINT "C. CARBON MONOXIDE. " C. CARBON MONOXIDE.
1205 PRINT "D. NITROUS OXIDE. " D. NITROUS OXIDE.
1210 PRINT
1215 PRINT " WHICH GAS PRODUCED DURING PHOTOSYNTHESIS IS USEFUL TO ANIMALS?"
1220 PRINT
1225 PRINT "A. CARBON DIOXIDE. " A. CARBON DIOXIDE.
1230 PRINT "B. OXYGEN. " B. OXYGEN.
1235 PRINT "C. CARBON MONOXIDE. " C. CARBON MONOXIDE.
1240 PRINT "D. NITROUS OXIDE. " D. NITROUS OXIDE.
1245 PRINT
1250 PRINT " WHICH GAS PRODUCED DURING PHOTOSYNTHESIS IS USEFUL TO ANIMALS?"
1255 PRINT
1260 PRINT "A. CARBON DIOXIDE. " A. CARBON DIOXIDE.
1265 PRINT "B. OXYGEN. " B. OXYGEN.
1270 PRINT "C. CARBON MONOXIDE. " C. CARBON MONOXIDE.
1275 PRINT "D. NITROUS OXIDE. " D. NITROUS OXIDE.
1280 PRINT
1285 PRINT " WHICH GAS PRODUCED DURING PHOTOSYNTHESIS IS USEFUL TO ANIMALS?"
1290 PRINT
1295 PRINT "A. CARBON DIOXIDE. " A. CARBON DIOXIDE.
1300 PRINT "B. OXYGEN. " B. OXYGEN.
1305 PRINT "C. CARBON MONOXIDE. " C. CARBON MONOXIDE.
1310 PRINT "D. NITROUS OXIDE. " D. NITROUS OXIDE.
A. They form ugly litter.
B. They are easily changed into poisonous substances.
C. They float on top of bodies of water.
D. They resist being changed by natural processes.

Print "A. They form ugly litter."
Input ">"; GS
Gosub 10000
Home
Print "B. They are easily changed into poisonous substances."
Print "C. They float on top of bodies of water."
Print "D. They resist being changed by natural processes."

Print "To which body system do the lungs belong?"
Print "A. Sensory."
Print "C. Circulatory."
Print "B. Respiratory."
Print "D. Digestive."

Print "Today, almost no one gets polio because"
Print "A. bad water, which used to cause polio, has been cleaned up."
Print "B. doctors have found new drugs which cure polio when it happens."
Print "C. people eat better food and get more exercise, so they are healthier."
Print "D. people are given a vaccine which keeps them from getting polio."

Print "Which one of the following is a characteristic of all birds but of no other animal? Birds"
Print "A. tend to migrate."
Print "B. lay eggs."
Print "C. fly."
Print "D. have a body covered by feathers."

Print "The organisms in a food chain responsible for converting light energy to a usable form are called"
Print "A. decomposers."
Print "B. herbivores."
Print "C. producers."
Print "D. consumers."

Print "The next 14 questions focus on earth/science content."
One moment please."
10000 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10002 IF GS = "A" OR GS = "B" OR GS = "C" OR GS = "D" THEN GOTO 10035
10020 INPUT "OOPS! MISTYPED RESPONSE. YOUR ONLY CHOICES ARE A, B, C, D. TRY AGAIN. >"; GS: GOTO 10002
10025 HOME
10035 LET RS(N) = GS
10038 LET N = N + 1
10040 RETURN
10150 REM BRING UP DIAGRAM
10151 POKE 49153,0
10155 POKE 49239,0
10160 POKE 49237,0
10165 POKE 49232,0
10170 POKE 49235,0
10175 INPUT "TYPE RETURN TO READ THE QUESTION."; GS
10180 POKE 49164,0
10185 POKE 49164,0
10195 RETURN

10 DS = CHR$(4)
12 PRINT CHR$(4); "LOAD DHURES.MOVER"
99 HOME
1600 PRINT "PART B - EARTH/SPACE"
1601 PRINT "#16"
1605 PRINT
1610 PRINT "HOW IS DEW FORMED?"
1615 PRINT
1620 PRINT "A. WATER VAPOR CONDENSES ON SURFACE COLD SURFACES. B. IT IS LEFT ON THE GRASS BY RAIN. C. IT FORMS IN THE AIR AND FALLS ON THE GRASS. D. IT FORMS FROM MELTED FROST."
1623 PRINT
1625 PRINT
1630 INPUT "?"; GS
1633 GOSUB 10000
1700 PRINT "#17"
1705 PRINT
1710 PRINT "WHICH ONE OF THE FOLLOWING IS A FOSSIL FUEL?"
1715 PRINT
1720 PRINT "A. WOOD. B. PAPER. C. NATURAL GAS. D. L""I
1725 PRINT
1730 INPUT "?"; GS
1733 GOSUB 10000
1735 HOME
1800 PRINT "#18"
1805 PRINT
1810 PRINT "WHICH ONE OF THESE IS TRUE ABOUT THE PLANET VENUS?"
1815 PRINT
1820 PRINT "A. IT IS ABOUT THE SAME SIZE AS THE EARTH AND IS LIKE IT IN MOST OTHER WAYS. B. SCIENTISTS KNOW MORE ABOUT THE SURFACE OF VENUS THAN THEY DO ABOUT MARS. C. IT IS ABOUT THE SAME SIZE AS THE EARTH. D. VENUS HAS MANY SATELLITES."
1825 PRINT
1830 INPUT "?"; GS
1833 GOSUB 10000
1835 HOME
1900 PRINT "#19"
1905 PRINT
1910 PRINT "WHAT DOES THE STATEMENT THAT THE RELATIVE HUMIDITY IS 50% MEAN?"
1915 PRINT "A. THE ATMOSPHERE WOULD BE SATURATED WITH WATER IF THE AIR TEMPERATURE WERE 50 DEGREES CELSIUS."
1920 PRINT "B. THE ATMOSPHERE CONTAINS HALF AS MUCH WATER AS IT COULD CONTAIN AT ITS PRESENT TEMPERATURE."
1921 PRINT "C. THE ATMOSPHERE CONTAINS 50 G OF WATER PER CUBIC METRE."
1922 PRINT "D. THE CHANCE OF RAIN IS 50%.
1923 PRINT "THE ATMOSPHERE CONSISTS OF MORE WATER THAN IT COULD CONTAIN AT ITS PRESENT TEMPERATURE.
1924 PRINT "THE ATMOSPHERE CONTAINS 50 G OF WATER PER CUBIC METRE.
1925 PRINT "THE CHANCE OF RAIN IS 50%.
1926 PRINT "THE NEXT QUESTION HAS TWO PARTS - 1ST, A PICTURE; 2ND, THE QUESTION.
1927 PRINT "WHAT EFFECT CAN THE CROP DUSTER, CATTLE SALT STORED IN PILES OUTDOORS, AND THE FARMER SPREADING FERTILIZER ALL HAVE?"
1928 PRINT "A. IMPROVE THE SOIL. B. KILL INSECTS AT ATTACK CROPS. C. MAKE PLANTS GROW BIGGER AND FASTER. D. MAKE THE STREAM WATER IMPURE."
1929 PRINT "TIIE MOON IS THE BRIGHTEST OBJECT IN THE NIGHT SKY BECAUSE IT..."
1930 PRINT "A. IS FLUORESCENT. B. PRODUCES ITS OWN LIGHT. C. REFLECTS LIGHT FROM THE SUN. D. REFLECTS LIGHT FROM NEARBY STARS."
1931 PRINT "CRUDE OIL COMES FROM..."
1932 PRINT "A. MINES LIKE COAL. B. A FACTORY. C. THE JUICES OF PLANTS. D. WILDS IN THE EARTH."
PRINT "A. SOME PLANETS REVOLVE AROUND THE SUN IN ONE DIRECTION OR ANOTHER. B. ONLY THE EARTH REVOLVES AROUND THE SUN. C. PLANETS DO NOT REVOLVE AROUND THE SUN."

PRINT "D. ALL PLANETS REVOLVE AROUND THE SUN IN THE SAME DIRECTION."

INPUT "">";GS
GOSUB 10000
HOME
PRINT " WHICH STATEMENT BEST DESCRIBES HOW THE EARTH'S SURFACE CHANGES OVER BILLIONS OF YEARS?"

PRINT "A. A FLAT SURFACE IS GRADUALLY PUSHED UP INTO STEEP MOUNTAINS UNTIL THE WORLD IS COVERED WITH MOUNTAINS."

PRINT "B. VERY STEEP MOUNTAINS GRADUALLY WEAR DOWN UNTIL MOST OF THE WORLD IS WORN DOWN TO SEA LEVEL."

PRINT "C. VERY STEEP MOUNTAINS AND FLAT PLAINS STAY SIDE BY SIDE FOR BILLIONS OF YEARS WITH LITTLE CHANGE."

PRINT "D. VERY STEEP MOUNTAINS GRADUALLY WEAR DOWN IN TO FLAT SURFACES THAT MAY BE AGAIN PULLED UP INTO MOUNTAINS, AND SO ON OVER AND OVER AGAIN."

INPUT "">";GS
GOSUB 10000
PRINT " FOR WHICH OF THE FOLLOWING ARE EARTH SATELLITES NOT USED?"

PRINT "A. TO REFLECT RADIO AND T.V. SIGNALS BACK TO EARTH."

PRINT "B. TO HELP PREDICT WEATHER."

PRINT "C. TO CAPTURE SOLAR ENERGY TO PROVIDE POWER FOR CITIES."

PRINT "D. TO HELP MAKE MAPS BY PHOTOGRAPHING THE EARTH."

INPUT "">";GS
GOSUB 10000
HOME
PRINT " WHICH ONE OF THE FOLLOWING IS PRESENTLY HELPING TO SHAPE THE SURFACE OF THE MOON?"

PRINT "A. GLACIERS."

PRINT "B. PLANTS."

PRINT "C. METEORITES."

PRINT "D. STREAMS."

INPUT "">";GS
GOSUB 10000
HOME
PRINT "I HAVE TO LOAD UP SOME MORE QUESTIONS"

PRINT "JUST A SECOND."

PRINT CHR$(4);"CHAIN PART3"

REM TAKE RESPONSE AND CHECK FOR MISMATCH
IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 10035

INPUT "OOPS! MISTYPED RESPONSE. YOUR ONLY CHOICES ARE A, B, C, D. TRY AGAIN?">";GS: GOTO 10002

IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 10035
10015 INPUT "OOPS! MISTYPED RESPONSE. P FOR PICTURE). THEN PRESS RETURN.
   TRY AGAIN."); GS: RETURN
10035 LET RS(M) = GS
10038 LET N = N + 1
10040 RETURN
10150 REM BRING UP DIAGRAM
10151 POKE 49153,0
10155 POKE 49239,0
10160 POKE 49237,0
10165 POKE 49232,0
10175 INPUT QS
10180 POKE 49233,0
10185 POKE 49164,0
10189 HOME
10193 RETURN

10 D3 = CHRS (4)
12 PRINT CHRS (4); "LOAD DIGRAPH.MOVER"
99 HOME
2700 PRINT "       " #27
2705 PRINT
2710 PRINT "THE WATER THAT FLOWS INTO THE OCEAN AS RIVERS"
2715 PRINT
2720 PRINT " A. ALL COMES FROM TOWN AND CITY SEWAGE DISPOSA
   L PLANTS. B. ALL COMES FROM LAKES AT THE HEADS OF
   THE RIVERS."
2723 PRINT " C. REACHES THE RIVER BY MANY PATHS THROUGH THE AIR,
   OVER THE LAND SURFACE, OR UNDERGROUND. D. WA
   S LIFTED FROM UNDERGROUND CAVERNS TO THE SURFACE OF THE
   EARTH BY GRAVITY."
2725 PRINT
2730 INPUT ">"; GS
2733 GOSUB 10000
2735 HOME
2800 PRINT 
   "       " #28
2805 PRINT
2810 PRINT "WHICH TERM BEST DESCRIBES AN OBJECT SUCH AS SATURN'S MOON TIT
   AN OR EARTH'S MOON?"
2815 PRINT
2820 PRINT " A. A PLANET. B. A STAR. C. AN ASTEROID. D. A
   SATELLITE."
2825 PRINT
2830 INPUT ">"; GS
2833 GOSUB 10000
2900 PRINT 
   "       " #29
2905 PRINT
2910 PRINT "WHICH OF THE FOLLOWING HELPS ACCOUNT FOR THE FACT THAT A COMP
   ASS CAN BE USED TO FIND NORTH ON EARTH?"
2915 PRINT
2920 PRINT " A. EARTH REFLECTS THE SUN'S LIGHT. B. EARTH HAS ONLY
   ONE MOON. C. EARTH'S TEMPERATURE IS NOT CO
   NSTANT. D. EARTH HAS A MAGNETIC FIELD."
2925 PRINT
2930 INPUT ">"; GS
2933 GOSUB 10000
2935 HOME
3000 PRINT
3005 PRINT " PART C - PHYSICS/CHEMISTRY"
JOTO PRINT "THE FIRST QUESTION IN THIS SECTION AGAIN HAS A PICTURE AND A QUESTION."
3013 PRINT
3015 PRINT "THE MOMENT."
3020 PRINT CHR$(4);"LOAD NUMBER20,AS2300"
3025 CALL 768
3030 GOSUB 10151
3035 HOME
3040 PRINT "130"
3045 PRINT
3050 PRINT "FROM THE PREVIOUS PICTURE, WHICH DIAGRAMSHOwed TWO CELLS IN SERIES?"
3055 PRINT
3065 PRINT "A. A  
3070 PRINT "A. B  
3075 PRINT "A. C  
3080 PRINT "B. B  
3085 PRINT "B. D  
3090 PRINT "B. E"
3095 PRINT "(TYPE THE LETTER 'P' AND RETURN TO SEE THE PICTURE AGAIN.)"
3098 GOSUB 10010
3099 PRINT "31 USES THE SAME PICTURE."
3100 PRINT DS;"LOAD NUMBER31,AS2300"
3105 CALL 768
3106 GOSUB 10151
3110 PRINT "32"
3115 PRINT "IN WHICH CURCUIT WILL THE LIGHT BULB(S) NOT WORK?"
3120 PRINT "A. A  
3125 PRINT "A. C  
3130 PRINT "B. B  
3135 PRINT "B. C  
3140 PRINT "C. D  
3145 PRINT "C. E"
3150 PRINT "(TYPE THE LETTER 'P' AND RETURN TO SEE THE PICTURE AGAIN.)"
3155 PRINT "33 USES THE SAME PICTURE."
3160 INPUT ">";GS
3165 IF GS = "P" THEN PRINT "I'LL GET IT FOR YOU."; GOSUB 3020
3170 GOSUB 10010
3175 IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 3095
3180 GOTO 3085
3185 PRINT "33 USES THE SAME PICTURE."
3190 PRINT DS;"LOAD NUMBER33,AS2300"
3195 CALL 768
3200 PRINT "33 USES THE SAME PICTURE."
3205 PRINT "34 USES THE SAME PICTURE."
3210 PRINT "WHEN A LIGHT BEAM HITS A MIRROR SURFACE AT A CERTAIN ANGLE"  
3215 PRINT "A. IT BOUNCES AWAY AT THE SAME ANGLE.  B. IT ALWAYS BOUNCES BACK ALONG THE SAME ANGLE."
3220 PRINT "C. IT BOUNCES AWAY AT A GREATER ANGLE.  D. IT BOUNCES AWAY AT A SMALLER ANGLE."
3225 PRINT "GISE WHAT, ANOTHER PICTURE. ANOTHER MOMENT."
3230 PRINT DS;"LOAD NUMBER33,AS2300"
CALL 749
3320 GOSUB 10151
3330 PRINT "WHICH DIAGRAM BEST SHOWS WHAT HAPPENS WHEN LIGHT HITS A CAMERA LENS?"
3340 PRINT "A. A   B. B   C. C   D. D"
3350 PRINT "(TYPE THE LETTER 'P' AND RETURN TO SEE THE PICTURE AGAIN.)"
3360 INPUT ">";GS
3370 IF GS = "P" THEN PRINT "COMPUTERS ARE SLOW AREN'T THEY."; GOTO 3310
3380 IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 3395
3390 GOSUB 10010
3400 PRINT "WHEN LIGHT HITS A CAR IS NOT USED TO MOVE THE CAR. INTO WHAT IS IT CHANGED?"
3410 PRINT "A. HEAT.   B. ELECTRICITY.   C. LIGHT.   D. MAGNETISM."
3420 PRINT "(P FOR PICTURE) THEN PRESS RETURN."
3430 INPUT ">";GS
3440 IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 3395
3450 PRINT CHRS (4);"CHAIN PART 4"
9999 END
10000 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10002 IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 10035
10005 INPUT "OOPS! MISTYPED RESPONSE. YOUR ONLY CHOICES A,B,C,D OR (P FOR PICTURE) THEN PRESS RETURN.
10010 IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 10035
10015 INPUT "OOPS! MISTYPED RESPONSE. SELECT A,B,C,D OR (P FOR PICTURE) THEN PRESS RETURN.
10020 LET KS(N) = GS
10025 LET N = N + 1
10030 RETURN
10035 REM BRING UP DIAGRAM
10040 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10045 LET N = N + 1
10050 RETURN
10055 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10060 LET N = N + 1
10065 RETURN
10070 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10080 LET N = N + 1
10085 RETURN
10090 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10095 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10100 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10105 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10110 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10115 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10120 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10125 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10130 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10135 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10140 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10145 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10150 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10155 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10160 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10165 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10170 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10175 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10180 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10185 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10190 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10195 REM TAKE RESPONSE AND CHECK FOR MISMATCH
PRINT "SUGAR IS ADDED TO WATER AT A TEMPERATURE OF 85 DEGREES CELSIUS UNTIL NO MORE WILL DISSOLVE. THE SUGAR AND WATER SOLUTION IS ALLOWED TO COOL."

PRINT "WHICH OF THE FOLLOWING IS MOST LIKELY TO OCCUR NEXT?"

PRINT A. MORE SUGAR WILL DISSOLVE IN THE WATER WHEN THE WATER REACHES ROOM TEMPERATURE.

PRINT B. THE SUGAR WILL SLOWLY RISE TO THE SURFACE OF THE LIQUID IN THE CONTAINER.

PRINT C. CRYSTALS OF SUGAR WILL BEGIN TO APPEAR AROUND THE SIDES OF THE CONTAINER.

PRINT D. THE SOLUTION WILL GRADUALLY BECOME CLOUDY AS THE SUGAR REACTS WITH THE WATER.

PRINT "BE SURE NOT TO PRESS ANY KEYS UNTIL THE PICTURE IS ON THE SCREEN."

PRINT DS; "LOAD NUMBER36,452000"

CALL 768
GOSUB 10151
PRINT "B"
GOTO 136
PRINT "USING THE PICTURE YOU JUST SAW, WHICH SPRING BALANCE WILL SHOW THE GREATER READING?"

PRINT A. #1.
PRINT B. #2.
PRINT C. BOTH WILL SHOW THE SAME.
PRINT D. ON E CAN'T PREDICT WHICH WILL SHOW THE GREATER READING."

PRINT "WHEN A GUITAR STRING IS TIGHTENED THE STRING MAKES A HIGH PITCHED SOUND BECAUSE THE TIGHTER STRING VIBRATES...."

PRINT A. SLOWED.
PRINT B. FASTER.
PRINT C. CLOSER.
PRINT D. FAR AWAY.

PRINT "IT IS POSSIBLE TO PASS WHITE LIGHT THROUGH A PIECE OF GLASS CALLED A PRISM AND PRODUCE A SPECTRUM (A SHORT PIECE OF A RAINBOW). WHAT DOES THE PRISM DO TO THE LIGHT?"

PRINT A. IT SUBTRACTS COLORS FROM THE LIGHT PASSING THROUGH.
PRINT B. IT ADDS COLORS TO THE LIGHT PASSING THROUGH.
PRINT C. IT BREAKS IT UP INTO THE COLORS FROM WHICH IT IS MADE.
PRINT D. IT ABSORBS THE LIGHT FROM THE SOURCE."
WHICH OF THE FOLLOWING WOULD BE THE MOST IMPORTANT FACTOR IN IMPROVING THE SPEED OF A PAIR OF ROLLER SKATES?

A. MAKING THE WHEELS ROUNDER.
B. REDUCING FRICTION BY BALL BEARINGS.
C. DESIGNING BETTER-FITTING BOOTS.
D. PUTTING BIG TREADS ON THE WHEELS.

WHEN A LIGHT BEAM PASSES THROUGH AIR AND THEN INTO WATER IN A N AQUARIUM, IT BENDS. WHAT IS THIS BENDING CALLED?

A. SPECTRUM.
B. REFRACTION.
C. REFLECTION.
D. DISSOLUTION.

STOP HERE! REMOVE THE 1ST DISK AND INSERT THE 2ND DISK. THEN PREPARE THE FLOPPY DISK.
PRINT DS; "LOAD NUMBER41,AS2000"
CALL 768
GOSUB 10151
HOME
PRINT "ONLY ONE OF THE CHOICES WAS A BOBBO, WHICH ONE WAS IT?"
PRINT "A. A B. B C. C D. D"
PRINT "WHICH ONE WAS IT?"
PRINT "A. A B. B C. C D. D"
PRINT "THE LETTER 'P' AND RETURN TO SEE THE PICTURE AGAIN.")" INPUT ">";CS
IF CS = "P" THEN PRINT "I'LL GO FIND SOME BOBBOS AGAIN."; GOTO 4110
GOSUB 10010
IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 4295
GOTO 4185
HOME
PRINT "PATIENCE IS A VIRTUE."
PRINT DS; "LOAD NUMBER42,AS2000"
CALL 768
GOSUB 10151
PRINT ""#42"
PRINT "HAVING VIEWED THE PREVIOUS CHART, WHICH SHAPE IS MISSING FROM SPACE 1?"
PRINT "A. A B. B C. C D. D"
PRINT "THE LETTER 'P' AND RETURN AGAIN.")" INPUT ">";GS
IF GS = "P" THEN PRINT "ONE CHART COMING UP."; GOTO 4210
GOSUB 10010
IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 4295
GOTO 4285
HOME
PRINT "SETTING UP NEXT PICTURE."
PRINT DS; "LOAD NUMBER43,AS2000"
CALL 768
GOSUB 10151
PRINT "IN THE PREVIOUS DIAGRAM, WHICH ONE REPRESENTED A ROCK LQUSE?"
PRINT "A. A B. B C. C D. D"
PRINT "THE LETTER 'P' AND RETURN TO SEE THE BUGS AGAIN.")" INPUT ">";GS
PRINT ""#43"
4385 IF GS = "P" THEN PRINT " IN SEARCH OF A ROCK LOUSE."
4390 GOSUB 10010
4391 IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 4395
4393 GOTO 4385
4395 HOME
4397 PRINT " PULLING TOGETHER MORE QUESTIONS."
4398 PRINT CHR$(4); "CHAIN PARTS"
9999 END
10000 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10002 IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 10035
10005 INPUT "OOPS! MISTYPED RESPONSE. YOUR CHOICES ARE ON
10006 L Y A,B,C,D.
10007 TRY AGAIN. >";GS: GOTO 10002
10010 IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 10035
10014 PRINT
10015 INPUT "OOPS! MISTYPED RESPONSE. SELECT A,B,C,D, OR
10016 (P FOR PICTURE). THEN PRESS RETURN.
10017 TRY AGAIN. >";GS: RETURN
10035 LET RS(N) = GS
10038 LET N = N + 1
10040 RETURN
10150 REM BRING UP DIAGRAM
10151 POKE 49153,0
10153 POKE 49239,0
10160 POKE 49237,0
10165 POKE 49233,0
10175 INPUT QS
10180 POKE 49233,0
10185 POKE 49164,0
10189 HOME
10195 RETURN

10 DS = CHR$(4)
12 PRINT CHR$(4); "BLOOD DHIERES.MOVER"
99 HOME
4400 PRINT " #44"
4410 PRINT "THE FOLLOWING IS AN IDENTIFICATION KEY FOR EIGHT STUDENTS IN
1 N A CLASS. USE THIS KEY, STEP BY STEP, TO FIND THE NAME OF THE BLUE-
2 EYED BLONDE GIRL."
4414 PRINT
4415 PRINT "STEP 1. SEX-BOY GO TO STEP 2 SEX-GIRL
4416 GO TO STEP 5
4417 PRINT "STEP 3. HAIR BLOND LESLIE HAIR DARK
LYNN
4418 PRINT "STEP 4. HAIR BLOND NICKY
HAIR DARK BOBBY"
4419 PRINT "STEP 5. EYES BLUE GO TO STEP 6 EYES BROWN
GO TO STEP 7
4420 PRINT "STEP 6. HAIR BLOND PAT
HAIR DARK BEVERLY"
4421 PRINT "STEP 7. HAIR BLOND TERRY
HAIR DARK
LEE WHAT IS THE NAME OF THE BLUE-EYED, BLONDE GIRL?
A. PAT
C. LESLIE
B. LEE
D. TERRY"
4430 INPUT " >";GS
4433 GOSUB 10000
4435 HOME
4490 PRINT " THESE PICTURES ARE 'SLOWWW' GOOD."
4510 PRINT DS; "BLOOD NUMBER43,A$2000"
4515 CALL 768
4520 GOSUB 10151
4550 PRINT " #45"
PRINT
PRINT "ONLY ONE OF THE PREVIOUS CHOICES WAS A LILY. WHICH ONE WAS THE LILY?"
PRINT
PRINT "A. A C. C
B. B D. D"
PRINT
PRINT "(TYPE THE LETTER 'P' AND RETURN TO SEE THE LILIES AGAIN.)"
PRINT >";GS
IF GS = "P" THEN PRINT "16 LILIES ON THE WAY.": GOTO 4510
GOSUB 10010
IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 4595
GOTO 4588
HOME
PRINT "ORGANIZING A PICTURE." PRINT DS;"BLOAD NUMBER46,AS2000"
CALL 768
GOSUB 10151
PRINT "146"
PRINT
PRINT "FOR WHICH PART OF THE GRAPH IS IT TRUE THAT MAKING THE LIGHT BRIGHTER HARDLY CHANGES THE RATE OF MAKING SIMPLE SUGAR?"
PRINT
PRINT
PRINT "(TYPE THE LETTER 'P' AND RETURN TO SEE THE DIAGRAM AGAIN.)"
PRINT >";GS
IF GS = "P" THEN PRINT "SO YOU WANT TO SEE THE GRAPH AGAIN? O.K."": GOTO 4610
GOSUB 10010
IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 4695
GOTO 4688
HOME
PRINT "147"
PRINT
PRINT "YOU MAY REFER BACK TO THE PREVIOUS GRAPHTO AID YOU IN ANSWERING THIS QUESTION."
PRINT
PRINT "ACCORDING TO THE GRAPH, PLANTS MAKE THE MOST SIMPLE SUGAR WHEN THE LIGHT IS 15"
PRINT
PRINT "A. VERY DIM. B. VERY BRIGHT. C. NOT TOO BRIGHT AND NOT TOO DIM. D. STONG AT ANY TIME OF DAY."
PRINT
PRINT "(TYPE THE LETTER 'P' TO REVIEW THE PICTURE OF THE GRAPH.)"
PRINT >";GS
IF GS = "P" THEN PRINT "RECALLING THE GRAPH."": GOTO 4740
GOSUB 10010
IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 4795
PRINT DS;"BLOAD NUMBER46,AS2000"
CALL 768
GOSUB 10151
GOTO 4700
HOME
PRINT "AGAIN, YOU WILL NEED TO REVIEW THE GRAPH IN ORDER TO ANSWER THIS QUESTION."
PRINT "AT WHICH BRIGHTNESS ARE THE PLANTS MAKING THE GREATEST AMOUNT OF SIMPLE SUGAR?"
PRINT A. O
PRINT C. V
PRINT B. W
PRINT D. Z

PRINT "(TYPE THE LETTER 'P' AND RETURN TO REVIEW THE GRAPH.)"
INPUT ">"; CS
IF CS = "P" THEN PRINT "LOCATING GRAPH."; GOTO 4860
GOSUB 10010
IF (CS = "A") OR (CS = "B") OR (CS = "C") OR (CS = "D") THEN GOTO 4889
GOTO 4836
4860 PRINT DS; "LOAD NUMBER45,A$2000"
4865 CALL 768
4870 GOSUB 10151
4875 GOTO 4800
4880 HOME
4890 PRINT "DON'T LET THIS NEXT PICTURE BUG YOU."
4910 PRINT DS; "LOAD NUMBER49,A$2000"
4915 CALL 768
4920 GOSUB 10151
4950 PRINT #49"
4955 PRINT
4960 PRINT "FROM THE PREVIOUS DISPLAY, WHICH ONE WASTHE INSECT?"
4965 PRINT A. A
PRINT C. C
PRINT B. B
PRINT D. D

PRINT "(TYPE THE LETTER 'P' AND RETURN TO SEE THE PICTURE AGAIN.)"
INPUT ">"; CS
IF CS = "P" THEN PRINT "COLLECTING THE INSECTS."; GOTO 4910
GOSUB 10010
IF (CS = "A") OR (CS = "B") OR (CS = "C") OR (CS = "D") THEN GOTO 4960
4985 GOSUB 10010
4986 IF (CS = "A") OR (CS = "B") OR (CS = "C") OR (CS = "D") THEN GOTO 4990
4988 GOTO 4980
4990 HOME
4995 PRINT "THIS NEXT DIAGRAM IS ROOMY."
5010 PRINT DS; "LOAD NUMBER50,A$2000"
5015 CALL 768
5020 GOSUB 10151
5050 PRINT ">#50"
5055 PRINT
5060 PRINT "WHICH OF THE ROOMS DID SHE ENTER?"
5065 PRINT A. A
PRINT C. C
PRINT B. B
PRINT D. D

PRINT "(TYPE THE LETTER 'P' AND RETURN TO SEE THE ROOMS AGAIN.)"
INPUT ">"; CS
IF CS = "P" THEN PRINT "REVISITING THE ROOMS."; GOTO 5010
GOSUB 10010
5092 IF (CS = "A") OR (CS = "B") OR (CS = "C") OR (CS = "D") THEN GOTO 5095
5094 GOTO 5085
STOP HERE! REMOVE THIS DISK AND INSERT THE 3RD ONE.
THEN PRESS RETURN.
PRINT "CHAIN PART6"

INPUT QS
END
REM TAKE RESPONSE AND CHECK FOR MISMATCH
IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 10035

INPUT "OOPS! MISTYPED RESPONSE.
YOUR ONLY CHOICES ARE A, B, C, D.
TRY AGAIN.";GS: GOTO 10002
IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 10035

INPUT "OOPS! MISTYPED RESPONSE.
SELECT A, B, C, D, OR (P FOR PICTURE). THEN PRESS RETURN.

TRY AGAIN.";GS: RETURN
LET BS(N) = GS
LET N = N + 1
RETURN
REM BRING UP DIAGRAM
POKE 49153,0
POKE 49239,0
POKE 49237,0
POKE 49232,0
INPUT QS
POKE 49164,0
HOME
RETURN

10 QS = CHRS (4)
12 PRINT CHRS (4); "BLOAD DUHRES.MOVER"
99 HOME
5100 PRINT "#51"
5105 PRINT
5110 PRINT "ALL OF THESE IS AN UNGULATE.
BUFFALO"
5112 PRINT "DEER"
5113 PRINT "GOAT"
5115 PRINT "COW"
5120 PRINT "RACCOON"
5125 PRINT "RAT"
5130 INPUT "Which one of the following is an UNGULATE?"
5135 GOSUB 10000
5140 HOME
5150 PRINT "ONE MOMENT."
5160 PRINT QS; "BLOAD NUMBERS2.A52000" .
5170 CALL 768
5215 GOSUB 10151
5220 GOSUB 10151
5250 PRINT 
5255 PRINT
5260 PRINT "According to Jim's description, which is the correct diagram?"
5265 PRINT
5270 PRINT A. A C. C
B. B D. D
PRINT "ONLY ONE OF THE CHOICES REPRESENTED A HEWT. WHICH ONE WAS A HEWT." 
PRINT "A. A  B. B  C. C  D. D"
PRINT "CREATURE F IS A ...
PRINT "CREATURE F IS A THREAD-WAISTED WASP."
PRINT "CREATURE F IS A THREAD-WAISTED WASP."
PRINT "A. THREAD-WAISTED WASP."
PRINT "B. CRANEFLY."
PRINT "C. LEAF BUG."
PRINT "D. BRISTLETAIL." 
PRINT "IDLE TAIL."
PRINT "HUNTING FOR HEWTS."
PRINT "IDENTIFYING SIX UNKNOWN ANIMALS."
PRINT "ORGANIZING MORE QUESTIONS."
PRINT "TAKING RESPONSE AND CHECK FOR MISSMATCH" 
INPUT "OOPS! MISTYPED RESPONSE. TRY AGAIN. >";GS: GOTO 10002
10010 IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 10035
10015 INPUT "OOPS! MISTyped RESPONSE. SELECT A,B,C,D, OR (P FOR PICTURE). THEN PRESS RETURN. TRY AGAIN.";GS: GOTO 10000
10020 HOME
10025 LET RS(N) = GS
10030 LET N = N + 1
10035 RETURN
10100 REM BRING UP DIAGRAM
10040 POKE 49153,0
10150 POKE 49154,0
10160 POKE 49237,0
10165 POKE 49232,0
10170 POKE 49233,0
10180 POKE 49164,0
10185 HOME
10190 RETURN
10200 DIM = CHR$(4)
10210 PRINT CHRS$(4);"BLOOD DIRES.MOVER"
10215 HOME
5510 PRINT DS;"BLOOD NUMBER55,A$2000"
5515 CALL 768
5520 GOSUB 10151
5530 PRINT "55"
5535 PRINT
5540 PRINT "JIM SAID, 'THE RAILWAY IS BEHIND ME AND ON JOHN'S RIGHT'. USE THE PREVIOUS PICTURE TO ANSWER WHERE WAS THE TREE?"
5545 PRINT
5550 PRINT "A. BEHIND JOHN. B. BEHIND JIM. C. IN FRONT OF JOHN. D. ON JIM'S RIGHT."
5555 PRINT
5560 PRINT " (TYPE THE LETTER 'P' AND RETURN TO VIEW THE Scene AGAIN.)"
5565 PRINT
5570 IF GS = "P" THEN PRINT "LOCATING PICTURE."; GOTO 5510
5575 PRINT
5580 INPUT">";GS
5585 IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 5550
5590 GOTO 5583
5595 HOME
5600 LET SMALLC = 56
5602 PRINT "USE THE FOLLOWING INFORMATION TO ANSWER QUESTIONS 56, 57, AN D 58."
5604 GOTO 5606
5605 HOME
5606 PRINT
5607 PRINT "SARAH WANTED TO FIND OUT IF TEMPERATURE HAS AN EFFECT ON THE GROWTH OF BREAD MOLD. SHE GREW THE MOLD IN NINE CONTAINERS, EACH WITH THE SAME AMOUNT AND TYPE OF NUTRIENTS."
5608 PRINT
5609 PRINT "THREE CONTAINERS WERE KEPT AT 0 DEGREES CELS"
5610 PRINT
5611 PRINT "THREE CONTAINERS WERE KEPT AT ROOM TEMPERATURE (ABOUT 21 DEGREES C.)."
5612 PRINT "THREE CONTAINERS WERE KEPT AT 90 DEGREES CELSIUS."
5613 PRINT
5614 PRINT "THE CONTAINERS WERE EXAMINED AT THE END OF FOUR DAYS."
PRINT "HAVING JUST READ THE INFORMATION, WHAT IS THE FACTOR WHICH SARAH WILL LOOK FOR?"

PRINT "A. CHANGES IN THE AMOUNT OF NUTRIENTS IN EACH CONTAINER.
B. THE AMOUNT OF GROWTH OF THE BREAD MOLD IN THE CONTAINERS.
C. NUMBERS OF CONTAINERS AT EACH TEMPERATURE.
D. DIFFERENCES IN THE TEMPERATURE OF THE CONTAINERS."

PRINT "(TYPE THE LETTER 'P' AND RETURN AGAIN TO SEE THE INFORMATION AGAIN.)"

INPUT ">";G$

IF G$ = "P" THEN GOTO 5700
GOSUB 10010
IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN GOTO 5700
GOTO 5685
HOM$ E
PRINT "WHAT DID SARAH MAKE DIFFERENT BETWEEN HER CONTAINERS?"
PRINT "A. THE NUMBER OF CONTAINERS AT EACH TEMPERATURE.
B. THE AMOUNT OF NUTRIENTS IN EACH CONTAINER.
C. THE GROWTH OF THE BREAD MOLD IN THE CONTAINERS.
D. THE TEMPERATURE OF THE CONTAINERS."

PRINT "(TYPE THE LETTER 'P' AND RETURN AGAIN TO REVIEW THE INFORMATION.)"

INPUT ">";G$

IF G$ = "P" THEN GOTO 5745
GOSUB 10010
IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN GOTO 5745
GOTO 5734
HOM$ E
PRINT "WHICH IS THE MOST IMPORTANT REASON SARAH USED THREE CONTAINERS AT EACH TEMPERATURE?"

PRINT "A. SHE PUT DIFFERENT KINDS OF NUTRIENT IN EACH CONTAINER.
B. SHE KNEW THAT AVERAGES ARE THE BEST DATA IN GROWTH EXPERIMENTS"
PRINT "C. SHE Was AFRAID SOME CONTAINERS MIGHT BREAK THIS.
D. SHE HAD NO GOOD REASON FOR DOING THIS."

PRINT "(TYPE THE LETTER 'P' AND RETURN AGAIN TO CHECK THE INFORMATION.)"
IF GS = 'P' THEN GOTO 5310
GOSUB 10210
IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 5850
GOTO 5340
HOME
PRINT "ONE MOMENT."
PRINT DS; "LOAD NUMBERS A, B, C, D"
CALL 768
GOSUB 10151
PRINT 
PRINT "FORM THE PRIOR DIAGRAM, WHAT IS THE BESTESTIMATE FOR THE TOTAL NUMBER OF ANTS ON ONE SQUARE METRE?"
PRINT "A. 400"
PRINT "B. 500"
PRINT "C. 720"
PRINT "D. NO"
PRINT "NE OF THE ABOVE."
PRINT "(TYPE THE LETTER 'P' AND RETURN TO SEE THE DIAGRAM AGAIN.)"
INPUT ">"; GS
IF GS = "P" THEN PRINT "RETRIEVING SQUARE METRE OF ANTS."
GOTO 5910
GOSUB 10010
IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 5995
HOME
PRINT "WHICH OF THE FOLLOWING PROBLEMS WOULD BE EASIEST TO ANSWER FROM A SINGLE EXPERIMENT?"
PRINT "A. DO LIGHT AND SALT IN THE WATER AFFECT THE GROWTH OF PLANTS?"
PRINT "B. WHICH FACTORS AFFECT THE GROWTH OF PLANTS?"
PRINT "C. DO LIGHT AND NO WATER AFFECT THE SPROUTING OF PLANT SEEDLINGS?"
PRINT "D. DOES LIGHT AFFECT THE GROWTH OF BEAN SEEDLINGS?"
INPUT ">"; GS
GOSUB 10000
HOME
PRINT "STOP HERE! INSERT D ISK #4.
THEN PRESS RETURN."
INPUT ZS
PRINT CHRS (4); "CHAIN PART 8"
END
REM TAKE RESPONSE AND CHECK FOR MISMATCH
IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 10035
INPUT "OOPS! MISTYPED RESPONSE. YOUR ONLY CHOICES ARE A, B, C, D. TRY AGAIN. >"; GS: GOTO 10002
10010 IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 10035
10015 INPUT "OOPS! MISTYPED RESPONSE. SELECT A, B, C, D, OR (P FOR PICTURE). THEN PRESS RETURN.
TRY AGAIN. >"; GS: RETURN
10035 LET RS(N) = GS
10038 LET N = N + 1
10040 RETURN
10150 REM BRING UP DIAGRAM
10151 POKE 49133, 0
10155 POKE 49219, 0
10160 POKE 49237, 0
10165 POKE 49232, 0
10 INPUT QS
10180 POKE 49233,0
10185 POKE 49164,0
10190 HOME
10195 RETURN

10 D$ = CHR$(4)
12 PRINT CHR$(4);"LOAD DIRES.MOVE"
99 HOME
6010 PRINT D$;"LOAD NUMBER1,A$2000"
6015 CALL 768
6020 GOSUB 10151
6050 PRINT 
6055 PRINT "USING THE PREVIOUS PICTURE, WHAT OBSERVATION DID YOU MAKE?"
6060 PRINT
6070 PRINT " A. A PERSON IS HOLDING POWDER FORM THE BOX IN THE SPOON.  
B. A PERSON IS STIRRING BAKING SODA INTO WATER." 
6073 PRINT " C. A PERSON IS TAKING SOMETHING FROM THE MEASURING CUP ON THE TABLE.  D. A PERSON IS HOLDING A SPOON WITH SOMETHING IN THE SPOON."
6075 PRINT
6078 PRINT " (TYPE THE LETTER 'P' AND RETURN TO SEE THE PICTURE AGAIN.)"
6080 INPUT ">";GS
6083 IF GS="P" THEN PRINT ": I'M HURRING - SORT OF.: GOTO 6010
6087 GOSUB 10010
6088 IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 6095
6090 GOTO 6083
6095 HOME
6200 PRINT 
6205 PRINT
6210 PRINT " MOLLY SUSPECTED THAT VEGETABLES CONTAIN WATER. IN ORDER TO TEST THIS IDEA SHE DECIDED TO TEST FIVE DIFFERENT VEGETABLES: LETTUCE, CARROTS, FRESH PEAS, SPINACH, AND POTATOES."
6213 PRINT " SHE PUT A PIECE OF EACH INTO ONE OF FIVE TEST TUBES AND HEATED THEM. SHE TESTED THE DROPS AND FOUND THEY WERE WATER. MOLLY'S TEACHER SUGGESTED THAT THIS EXPERIMENT NEEDED A CONTROL."
6214 PRINT
6215 PRINT
6216 PRINT " WHAT CONTROL SHOULD MOLLY HAVE USED?"
6218 PRINT
6220 PRINT " A. HEAT A TEST TUBE WITH WATER IN IT.  B. HEAT A TEST TUBE WITH MEAT IN IT."
6222 PRINT " C. HEAT AN EMPTY TEST TUBE.  D. HEAT A TEST TUBE WITH CEREAL IN IT."
6230 INPUT ">";GS
6233 GOSUB 10000
6235 HOME
6300 PRINT 
6305 PRINT
6307 PRINT " THE TREELINE IS THE HIGHEST ALTITUDE AT WHICH TREES CAN GROW. THE FOLLOWING TABLE RELATES TREELINE TO DISTANCE FROM THE EQUATOR."
6309 PRINT
6310 PRINT " DISTANCE FROM EQUATOR"
6313 PRINT " TREELINE"
6315 PRINT 1000 KM 4000 M 2500 KM
ACCORDING TO THE TABLE ABOVE, THE HIGHER THE TREELINE, THE MORE THE TREES.

PRINT " EACH PLANNED TO TAKE A MEASUREMENT EVERY DAY FOR FIVE DAYS. HOWEVER, ON THE THIRD DAY THE SCHOOL WAS CLOSED."

PRINT " WHICH GRAPH GAVE THE POOREST ESTIMATE FOR THE THIRD DAY?"

PRINT " A. A  B. B  C. C  D. D"

PRINT " (TYPE THE LETTER 'P' AND RETURN TO REVIEW THE PICTURE AGAIN.)"

INPUT " >" ; GS

IF GS = " P" THEN PRINT " FOUR GRAPHS ON THE WAY.": GOTO 640

IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 6495

GOTO 6485

HOME

PRINT " ANOTHER GRAPH QUESTION."

GOSUB 10151

PRINT " IN THE EXPERIMENT, WHAT WAS THE FACTOR WHICH THE EXPERIMENTER WISHED TO OBSERVE?"

PRINT " A. WHICH TYPE OF ACTIVITY PRODUCES 120 HEARTBEATS PER MINUTE.  B. THE TYPE OF ACTIVITY."

PRINT " C. IF WALKING IS GOOD FOR A PERSON.  D. THE NUMBER OF HEARTBEATS PER MINUTE."

PRINT " (TYPE THE LETTER 'P' AND RETURN TO SEE THE PICTURE AGAIN.)"

INPUT " >" ; GS

IF GS = " P" THEN PRINT " BRINGING BACK HEARTBEAT EXPERIMENT." : GOTO 6510

GOSUB 10100

IF (GS = "A") OR (GS = "B") OR (GS = "C") OR (GS = "D") THEN GOTO 6594

GOTO 6585

HOME

PRINT " THE SAME GRAPH BUT, A DIFFERENT QUESTION."

GOSUB 10151
WHAT FACTOR WAS CHANGED IN ORDER TO GET THE DATA?

A. THE NUMBER OF HEARTBEATS PER MINUTE.
B. THE TYPE OF ACTIVITY.
C. THE SPEED AT WHICH PEOPLE WALK.
D. HOW FAST PEOPLE SWIM.

TYPE THE LETTER 'P' AND RETURN TO SEE THE PICTURE.

ANOTHER QUESTION USING THE SAME GRAPH.

WHAT HYPOTHESIS WAS THE EXPERIMENTER LIKELY TESTING?

A. TYPE OF ACTIVITY AFFECTS HEARTBEAT RATE.
B. THE FASTER A PERSON MOVES FROM PLACE TO PLACE, THE FASTER HIS HEART BEATS.
C. ACTIVITY IMPROVES A PERSON'S HEALTH.
D. IF YOU CHANGE THE HEARTBEAT RATE, PEOPLE CHANGE THEIR ACTIVITY.

DID YOU KNOW THAT YOU TYPED '...'? YOUR CHOICES ARE A, B, C, D, OR 'P' FOR PICTURE. THEN PRESS RETURN.

PULLING TOGETHER MORE QUESTIONS.

CHAIN PART9

END
Sue wanted to find out what might affect the length of bean seedlings.

She placed a bean wrapped in moist tissue paper in each of ten identical test tubes. She put five test tubes in a rack in a sunny window.

She put five test tubes in a rack in a dark refrigerator.

She measured the length of bean seedlings in each group after one week.

Which of the following factors did Sue test for their effect on the length of the bean seedlings?

A. moisture and length of test tube.  
B. light and temperature.  
C. light and amount of time.  
D. temperature and moisture.

The most important reason Sue used five test tubes at each temperature was:

A. she wished to test five different conditions.  
B. averages provide better data in growth experiments.  
C. she was afraid she might break some test tubes.  
D. she had no good reason for doing this.

One week after the experiment, Sue found that the seedlings grew better in the rack on the sunny window. Why might Michael criticize her experiment?

A. there is no reason to criticize her experiment.  
B. she should have put different amounts of water in the test tubes.  
C. she cannot tell if the better growth is a result of temperature or of light or of both.
D. She did not need to use so many test tubes.

Input "";G$,
Gosub 10000
Home

Print "One moment."
Print D$; "BLOAD NUMBER1.A$2000"
Call 768
Gosub 10151
Print "#71"
Print
Print "The previous graph showed that"
Print
Print "A. The beetle was looking for food.  B. The beetle changes direction every half minute."
Print "C. The beetle was trying to climb the wall.  D. The beetle's movements were not steady."
Print
Print "(Type the letter 'P' and return to see the previous graph again.)"
Input "";G$,
If G$ = "P" Then Print "Recalling beetle graph."; Goto 7110
Gosub 10010
If (G$ = "A") Or (G$ = "B") Or (G$ = "C") Or (G$ = "D") Then Goto 7195
Goto 7185
Home
Print
Print "When a scientist has formed a hypothesis about an experiment we mean that he has"
Print
Print "A. Designed equipment needed for the experiment." Print "B. Indicated which measurements will be made and how they should be carried out."
Print "C. Described how the experiment might turn out by stating how one factor might affect another."
Print "D. Observed all the things that happened during the experiment!"
Print
Input "";G$,
Gosub 10000
Home
Print
Print "Which of the following is a theory rather than an observation?"
Print "A. The center of the earth is liquid."
Print
When acting like a scientist, it would not be right to
A. Do someone else's experiment again.
B. Let your feelings affect the results.
C. Announce results different from those in your textbook.
D. Take a great many measurements."
SOUTH POLE IS LOWER THAN THE AVERAGE TEMPERATURE AT THE TROPIC OF CAPRICORN.

A SHIP CAN START FROM A POINT, SAIL AROUND THE EARTH, AND RETURN TO THE SAME POINT.

THE TEMPERATURE AT THE BOTTOM OF A VERY DEEP WELL IS HIGHER THAN THE TEMPERATURE AT THE SURFACE.

A SHIP CAN START FROM A POINT, SAIL AROUND THE EARTH, AND RETURN TO THE SAME POINT.

THE TEMPERATURE AT THE BOTTOM OF A VERY DEEP WELL IS HIGHER THAN THE TEMPERATURE AT THE SURFACE.

ORGANIZING QUESTIONS.

A SHIP CAN START FROM A POINT, SAIL AROUND THE EARTH, AND RETURN TO THE SAME POINT.

THE TEMPERATURE AT THE BOTTOM OF A VERY DEEP WELL IS HIGHER THAN THE TEMPERATURE AT THE SURFACE.

A SHIP CAN START FROM A POINT, SAIL AROUND THE EARTH, AND RETURN TO THE SAME POINT.

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A SHIP CAN START FROM A POINT, SAIL AROUND THE EARTH, AND RETURN TO THE SAME POINT.

THE TEMPERATURE AT THE BOTTOM OF A VERY DEEP WELL IS HIGHER THAN THE TEMPERATURE AT THE SURFACE.
THREE OF THE FOLLOWING ARE STATEMENTS OF FACT. WHICH STATEMENT IS A HYPOTHESIS?

A. THE RINGS OF SATURN WERE FORMED AT EXPLODED.
B. THE BOILING POINT OF WATER IS 100 DEGREES C.
C. HYDROGEN WAS FIRST PREPARED BY CAVENDISH IN 1766.
D. A LITRE OF WATER HAS A MASS OF 1 KILOGRAM.

SCIENTISTS OF TODAY CAN WORK ON MORE COMPLEX PROBLEMS THAN THE SCIENTISTS OF THE PAST BECAUSE THEY
A. ARE MORE INTELLIGENT THAN EARLIER SCIENTISTS.
B. WORK MUCH HARDER THAN EARLIER SCIENTISTS.
C. HAVE MORE IMAGINATION THAN EARLIER SCIENTISTS.
D. BUILD ON THE WORK OF EARLIER SCIENTISTS.

IN SUMMER, JOHN NOTICED THAT THE AIR IN HIS TIRES BECAME HOTTER WHEN HIS CAR WAS DRIVEN OVER A LONG DISTANCE.

THE STATEMENT ABOVE IS AN EXAMPLE OF
A. A THEORY.
B. A PRINCIPLE.
C. AN OBSERVATION.
D. A LAW.

MOST THINGS FALL IF THEY ARE NOT HELD UP (LAW OF GRAVITY) BUT HELIUM-FILLED BALLOONS RISE.

SCIENTISTS SEEK TO EXPLAIN THIS BY
A. REJECTING THE LAW OF GRAVITY.
B. FORGETTING IT BECAUSE THE WORLD IS UNEXPLAINABLE ANYWAY.
C. ASSUMING THAT HELIUM BALLOONS ARE AN EXCEPTION TO THE LAW OF GRAVITY.
D. LOOKING FOR A SECOND FORCE ACTING ON HELIUM BALLOONS.

WHEN WE SAY THAT A SCIENTIST FORMS A HYPOTHESIS ABOUT AN EXPERIMENT, WE MEAN THAT THE SCIENTIST...
8015 PRINT  A. DESCRIBES HOW THE EXPERIMENT WAS CARRIED OUT.
8020 PRINT  B. SUGGESTS HOW TO MAKE EXACT.
8023 PRINT  C. GIVES DIRECTIONS FOR DOING THE EXPERIMENTS PRL
8025 PRINT  D. MAKES A CAREFUL GUESS ABOUT WHAT WE
8030 PRINT  LL HAPPEN.
8035 PRINT  E. GIVES DIRECTIONS FOR DOING THE EXPERIMENTS PRL
8040 PRINT  "PLEASE TYPE YOUR LAST NAME:"; LASTNS
8045 PRINT  "NOW YOUR FIRST NAME:";FRMS
8050 PRINT  "WHAT IS TODAY'S DATE?";DAYS
8055 PRINT  "CALCULATING RESULTS.";
8060 PRINT  "PLEASE INFORM THE INSTRUCTOR THAT YOU ARE DONE.
THANK YOU."
8070 PRINT  CHR$(4);"CHAIN OWARIMASHIO"
9999 END
10000 REM TAKE RESPONSE AND CHECK FOR MISMATCH
10005 INPUT "OPPS! MISTYPED RESPONSE, YOUR ONLY CHOICES ARE A,B,C,D.
TRY AGAIN. >";GS: GOTO 10022
10035 LET RS(N) = GS
10038 LET N = N + 1
10040 RETURN
10150 REM BRING UP DIAGRAM
10151 POKE 49153,0
10155 POKE 49239,0
10160 POKE 49231,0
10165 POKE 49232,0
10175 INPUT QS
10180 POKE 49233,0
10185 POKE 49164,0
10190 HOME
10195 RETURN

90 DIM AZ(79)
110 FOR N = 0 TO 79
120 READ AS(N)
130 NEXT N
195 HOME
200 PRINT LASTNS;"";FRMS
205 PRINT DAYS
210 PRINT
9000 REM SCORING PROCESS
9002 LET MISS = 0
9003 LET D = 0
9004 LET LS = 0
9010 LET ES = 0
9015 LET PC = 0
9020 LET GA = 0
9025 LET SB = 0
9030 LET VS = D
9035 LET ZZ = 0
9040 LET C = 0
9045 FOR M = 0 TO 79
9050 IF AS(M) = BS(M) THEN GOTO 9060
9055 GOTO 9140
9060 LET S = M + 1
9065 GOTO 9075
9070 IF N > 79 THEN NEXT N
9072 GOTO 9300
9075 IF S = 15 THEN LS = LS + 1
9080 IF S > 15 AND S < 30 THEN ES = ES + 1
9085 IF S > 29 AND S < 41 THEN PC = PC + 1
9090 IF S > 40 AND S < 56 THEN SA = SA + 1
9095 IF S > 55 AND S < 71 THEN SB = SB + 1
9100 IF S > 72 THEN GOTO 9070
9105 IF S = 80 THEN ZZ = ZZ + 1
9110 GOTO 9070
9115 LET WZ(J) = MISS
9120 LET D = D + 1
9125 GOTO 9070
9130 IF LS > 12 THEN PRINT "LS ";LS;/15 PASS"
9135 IF LS < 12 AND LS > 9 THEN PRINT "LS ";LS;/15 REMEDIATION"
9140 IF LS < 9 THEN PRINT "LS ";LS;/15 REMEDIATION"
9145 IF ES > 11 THEN PRINT "ES ";ES;/14 PASS"
9150 IF ES < 11 AND ES > 9 THEN PRINT "ES ";ES;/14 REMEDIATION"
9155 IF ES < 9 THEN PRINT "ES ";ES;/14 REMEDIATION"
9160 IF PC > 10 THEN PRINT "PC ";PC;/11 PASS"
9165 IF PC < 9 THEN PRINT "PC ";PC;/11 REMEDIATION"
9170 IF SA > 12 THEN PRINT "SA ";SA;/15 PASS"
9175 IF SA < 12 THEN PRINT "SA ";SA;/15 REMEDIATION"
9180 IF SA < 10 THEN PRINT "SA ";SA;/15 REMEDIATION"
9185 IF SB > 14 THEN PRINT "SB ";SB;/17 PASS"
9190 IF SB < 14 AND SB > 9 THEN PRINT "SB ";SB;/17 REMEDIATION"
9195 IF SB < 9 THEN PRINT "SB ";SB;/17 REMEDIATION"
9200 IF NS > 6 THEN PRINT "NS ";NS;/8 PASS"
9205 IF NS < 6 THEN PRINT "NS ";NS;/8 REMEDIATION"
9210 PRINT "SPECIFIC PROBLEMS MISSED."
9215 PRINT "WZ(H)"; "WZ(I)"; "WZ(J)"; "WZ(K)"; "WZ(L)");
9220 PRINT "WZ(M)");
9225 LET H = H + 6
9230 LET I = I + 6
9235 LET J = J + 6
9240 LET K = K + 6
9245 LET L = L + 6
9250 LET M = M + 6
9255 NEXT X
9260 END
Appendix C. The Questionnaire
1. I like science.
2. I enjoy working on computers.
3. The two practice questions helped me understand how to respond to the test questions.
4. The pictures were easy to use.
5. I liked the various brief comments made while the computer organized pictures or more questions.
6. I would prefer to take this test on a computer rather than in paper and pencil form.
7. I liked the computer's color picture over a paper's black and white drawing.
8. The sooner I receive my test results, the better.
9. Sometimes, the picture was so large that the question could not be written along side it. How did you feel about removing the picture in order to read the question?
10. I would like to have gone back later in the test to possibly have changed some previous answers.
11. How did you feel about pausing for the picture to be displayed on the screen?
12. How did you feel about waiting for the computer to load more questions?
13. I felt comfortable knowing that if I pressed the wrong key, I could go back and change it.
14. How did you feel about removing and inserting the four floppy disks?
15. Any directions given were easy to follow.
16. I'm glad an instructor was present in case problems came up.
Appendix D. The Interview Guide
1. Identify Subject minor.

2. Identify previous experience.

3. Why?

4. Why?

5. Additional suggestions.

6. ?

7. ?

8. Compared to 2 hours-
   1 week-

9. Why?

10. Why?

11. Why?

12. Why?

13. Why?

14. Why?

15. ?

16. ?

17. Strengths?
   Weaknesses?

18. Particular like? Dislike?

19. How could the test be improved?

Observations -
Appendix E. The Graph used to Report Student Test Results
SCIENTIFIC LITERACY PROFILE

NAME ________
Appendix F. The Questionnaire Results
1. I like science.
2. I enjoy working on computers.
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4. The pictures were easy to use.
5. I liked the various brief comments made while the computer organized pictures or more questions.
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9. Sometimes, the picture was so large that the question could not be written along side it. How did you feel about removing the picture in order to read the question?
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12. How did you feel about waiting for the computer to load more questions?
13 I felt comfortable knowing that if I pressed the wrong key, I could go back and change it.

14 How did you feel about removing and inserting the four floppy disks?

15 Any directions given, were easy to follow.

16 I'm glad an instructor was present in case problems came up.
Appendix G. The Interview Results
1. What is your subject minor? If not an elementary education major, then what is your major field of study?
   A1. Early childhood, Language Arts
   A2. Language Arts
   A3. Math/Science
   A4. Math/Science
   A5. Language Arts
   A6. Language Arts
   B1. Spanish
   B2. Math
   B3. Graduate - Special Education
   B4. Social studies
   B5. Math/Science

2. What previous courses and experience have you had working with computers?
   A1. courses 101, 150, and 522; also stated that computers "scare me"
   A2. course 101, and word processing experience
   A3. courses that taught Fortran, Pascal, Basic, and word processing experience
   A4. course 150
   A5. courses 101, and 522
   A6. courses 150, and 522
B1. Courses 150, 140, and use word processor for all assignments.
B2. Course 150.
B3. At work use word processor and has had experience in data processing.
B4. Courses 140, 522, and use the computer regularly.
B5. Course 101 and use computer to prepare school assignments.
B6. Courses 522 and Pascal.

3. The two practice questions helped me understand how to respond to the test questions.
   Three subjects said that is was not necessary. (They would have done fine without the practice questions' explanations.)
   One student said that it made him or her comfortable knowing what to expect.
   One student said it did not matter.

4. The pictures were easy to use.
   Three subjects felt that item 61 was not clear (specifically the spoon).
   Five subjects said that the bugs were not clear (Items 43, 49, and 54).
   One student felt that #45 was not clear. (leaves)
   Three subjects believed #52 was not clear. (heads)
   One student felt that all pictures were A.O.K.
   Two subjects said that the instructions on #54 were not clear.
One student did not understand #42. (misread instructions.)
One student did not like #20's "zigzaggedness".
One student said the pictures were esthetically pleasing.
One student preferred #54 and #36 on the computer.
One student said that practice question #2's color was unclear.
One student did not like switching back and forth.

5. I liked the various brief comments made while the computer organized pictures or more questions.
   Two subjects would prefer a straight forward explanatory comment.
   Four subjects commented that it prevented boredom.
   Two subjects welcomed the pause.

6. I would prefer to take this test on a computer rather than in paper-and-pencil form.
   One student said yes, but he or she would like to have reviewed previous questions.
   One student said yes, if he or she did not have to wait for pictures and questions to be loaded.
   One student said yes because he or she felt more interaction with a computer.
   Two subjects said yes because they liked the colored graphics.
   Two subjects said yes due to the quickly generated test results.
One student said no, because he or she wanted more than one chance to answer the question.

Three subjects said yes, because computers are fun.
Three subjects said yes, because it seemed easier, less hassle.
One student said yes, because it was not as stressing.

7. I liked the computer's color picture over a paper's black and white drawing.
   Two subjects said color makes the pictures more clear.
   Two subjects said the pictures were exciting and interesting.
   One student said no because, the room and aerial pictures were easier on paper.
   One student said yes, if better graphics were available.
   One student said yes, except for test items depicting insects and "Hewts".
   One student wished it were like a T.V.

8. The sooner I receive my test results, the better.
   Two subjects prefer a little time before seeing their test results.
   Four subjects said this aspect is very important to them.

9. Sometimes, the picture was so large that the question could not be written along side it. How did you feel about removing the picture in order to read the question?
   One student said it was annoying.
Four subjects would prefer the picture and question to be together.

One student worried about pressing the wrong key in order to review the picture and question.

One student would prefer the two to be separate, because it gave him or her time to think about the question while waiting for the picture.

One student had particular problems with two such cases (Items 31 and 54).

One student loses their train of thought between switching screens.

10. I would like to have gone back later in the test to possibly have changed some previous answers.

One student's program crashed while inserting the second disk. Thus this individual wanted to return and correct the mistake.

Four subjects said yes.

One student would like to have doubled checked previous responses.

Two subjects said certainly not, because the temptation to stay all day worrying and checking response would be present.

One student wanted to recheck just one or two answers.

One student said yes because later questions have clues to previous questions.

One student said he or she responded favorably to the statement meaning that the test was fine as it was and not that
she would have wanted to go back and change previous answers.

11. How did you feel about pausing for the picture to be displayed on the screen?
   Two subjects did not like going back and forth between screens.
   Two subjects welcomed the opportunity to think about the question while the next screen was loading.
   Two subjects thought it was nice to relax for a moment.

12. How did you feel about waiting for the computer to load more questions?
   One student said improve it if you can.
   One student said it was a nice break.

13. I felt comfortable knowing that if I pressed the wrong key, I could go back and change it.
   Two subjects would prefer going back after completing the test to change previous answers.
   One student did not know how to do the correcting procedure.

14. How did you feel about removing and inserting the four floppy disks?
   One student's program crashed because it was done incorrectly.
   One student said that it was okay after the procedure was
understood.

15. Any directions given were easy to follow.
   One student would prefer that the graphics and text be combined.
   Three subjects said that the questions were easily understood but item 54's directions were difficult to follow.
   One student did not understand what they were to do on item 44.

16. I'm glad an instructor was present in case problems came up.
   Two subjects said the instructor provided additional security.
   One student said it was helpful.

17. Computer test strengths:
   One student said the computer test is more fun and less stressful.
   One student stated this new approach was not tedious.
   One student mentioned this test seemed faster than the paper version.

   Computer test weaknesses:
   One student said graphics were not as clear as paper and pencil.
   One student wanted the opportunity to go back and change answers.
   One student wanted additional protection against pushing an incorrect key accidentally.
18. Particular like:
   One student mentioned that this was an excellent science test.
   One student preferred not having the question and picture together.
   One student appreciated fast test results.
   One student thought this form of test administration was a nice change.

   Dislike:
   One student had trouble identifying heads (Item 52).

19. How could the test be improved.
   One student wanted instructions to be more clear on item 44.
   One student did not understand what item 42 was asking.
   Five subjects identified computer operation instructions to call up the picture on item 54.
   One student identified computer operation problems to call up the picture on item 31.
Appendix H. The Observation Results
One student identified a syntax error on item 9.

One student identified a formatting error in test results listed under "PC".

One student identified response "B" and "C" in item 32 as being the same response.

One student identified a typing error on item 5.

One student stated that the bug's legs in item 54 were difficult to identify.

One student crashed the program when changing floppy disks in the disk drive. This resulted in the computer registering the first 30 items as incorrect responses.

One student commented that item 45 was easier on the computer than in paper-and-pencil form.
Appendix I. The Abridged Version of the Scientific Literacy Test
A student wished to find out how many ants there were in one square metre of his lawn. He divided one square metre up into 100 equal patches and counted the ants in five of the patches. He obtained the numbers of 3, 4, 4, 7 and 7.

What is the BEST estimate for the total number of ants on one square metre?

A. 400 ..............................................
B. 500 ..............................................
C. 700 ..............................................
D. None of the above ............................

In summer, John noticed that the air in his tires became hotter when his car was driven over a long distance.

The statement above is an example of

A. a theory...........................................
B. a principle......................................
C. an observation.................................
D. a law............................................
(#3) All of these are Bobbos.

\[ \begin{array}{cccc}
\text{○} & \text{○} & \text{△} & \text{□}
\end{array} \]

None of these is a Bobbo.

\[ \begin{array}{cccc}
\text{△} & \text{△} & \text{□} & \text{●}
\end{array} \]

Which ONE of these is a Bobbo?

\[ \begin{array}{cccc}
\text{A} & \text{B} & \text{C} & \text{D}
\end{array} \]

A. ................................................
B. ................................................
C. ................................................
D. ................................................
Which diagram below BEST shows what happens when light hits a camera lens?

A. .................................................................
B. .................................................................
C. .................................................................
D. .................................................................

Which ONE of the following is presently helping to shape the surface of the moon?

A. Glaciers ..............................................................
B. Plants ..............................................................
C. Meteorites ..........................................................
D. Streams ...........................................................
In the diagrams below you are looking down on a scene from an airplane. Jim says, "The car which is in front of me is behind John and the tree on my left is on his right".

According to Jim's description, which is the correct diagram?

A. ...........................................
B. ...........................................
C. ...........................................
D. ...........................................
(7) All of these are lilies.

None of these is a lily.

Which ONE of these is a lily?

A. ..................................................  
B. ..................................................  
C. ..................................................  
D. ..................................................  

(#8) Which gas produced during photosynthesis is useful to animals?

A. Carbon dioxide  ....................................  
B. Oxygen ................................................  
C. Carbon monoxide ....................................  
D. Nitrogen ..............................................  
Here are six unknown animals. Look at them carefully.

Use the identification key below to find out the name of CREATURE F.

<table>
<thead>
<tr>
<th>Step 1. wings</th>
<th>Go to Step 2</th>
<th>Go to Step 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>no wings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>wings stick out to the side</td>
<td>Go to Step 3</td>
<td>Go to Step 4</td>
</tr>
<tr>
<td>wings do not stick out to the side</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Step 2. hind legs as long as body</td>
<td></td>
<td>Cranefly</td>
</tr>
<tr>
<td>hind legs shorter than body</td>
<td>Thread-waisted Wasp</td>
<td></td>
</tr>
<tr>
<td>Step 3. wings cover all of abdomen (rear end)</td>
<td></td>
<td>Leaf Bug</td>
</tr>
<tr>
<td>wings do not cover all of abdomen</td>
<td></td>
<td>Housefly</td>
</tr>
<tr>
<td>Step 4.</td>
<td></td>
<td>Bristletail</td>
</tr>
<tr>
<td>six legs</td>
<td></td>
<td>Spider</td>
</tr>
<tr>
<td>eight legs</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Creature F is a

A. Thread-waisted Wasp .................................................
B. Cranefly ..............................................................
C. Leaf Bug ..............................................................
D. Bristletail ............................................................
Look at this picture.

What observation can you make from it?

A. A person is holding powder from the box in the spoon.

B. A person is stirring baking soda into water.

C. A person is taking something from the measuring cup on the table.

D. A person is holding a spoon with something in the spoon.