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

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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
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of

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ABSTRACT

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

by

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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,

1986b). 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 X Q Y (Group A had six subjects)

R Y X 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 IIe 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

```
10175  INPUT Q$
10180  POKE 49233,0
10185  POKE 49164,0
```

"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.
3. Science and computers in general.

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 instructors 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 (Daugs, 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-

pencil test on day 7.

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'

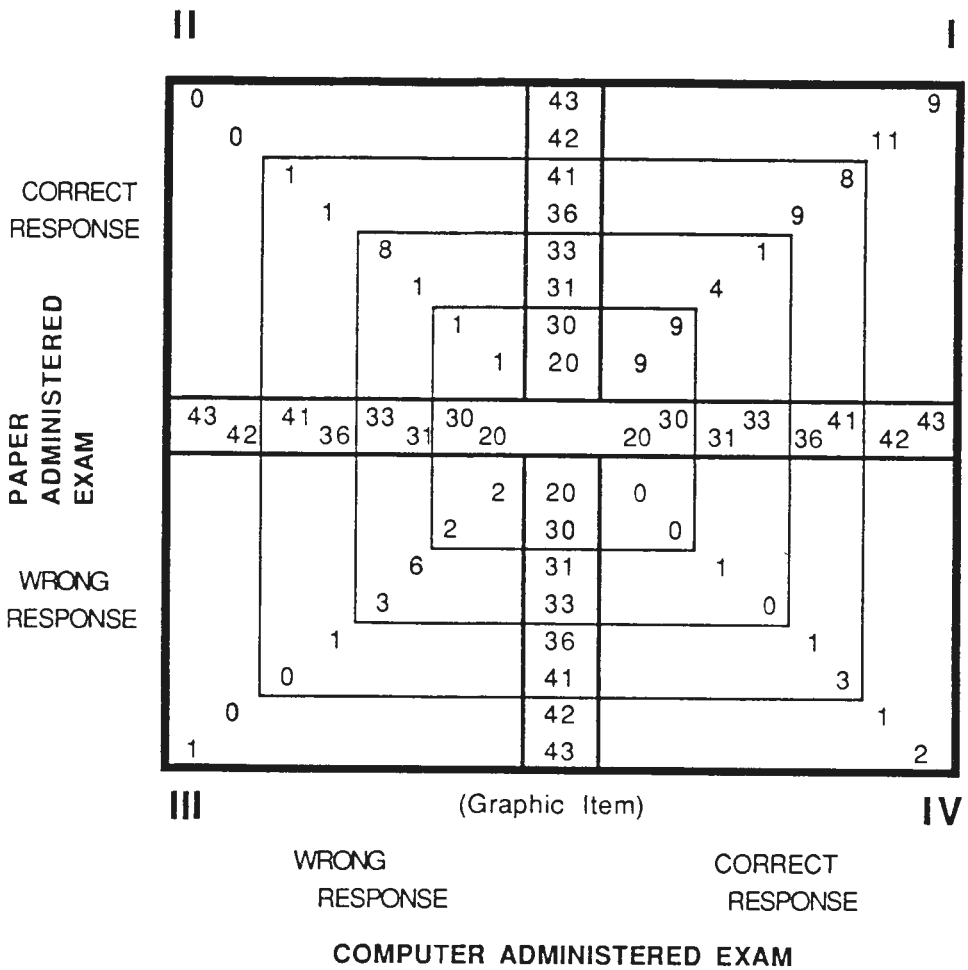


FIGURE 1 Students' test score results on graphic related items (20, 30, 31, 33, 36, 41, 42, 43) in the preliminary field test.

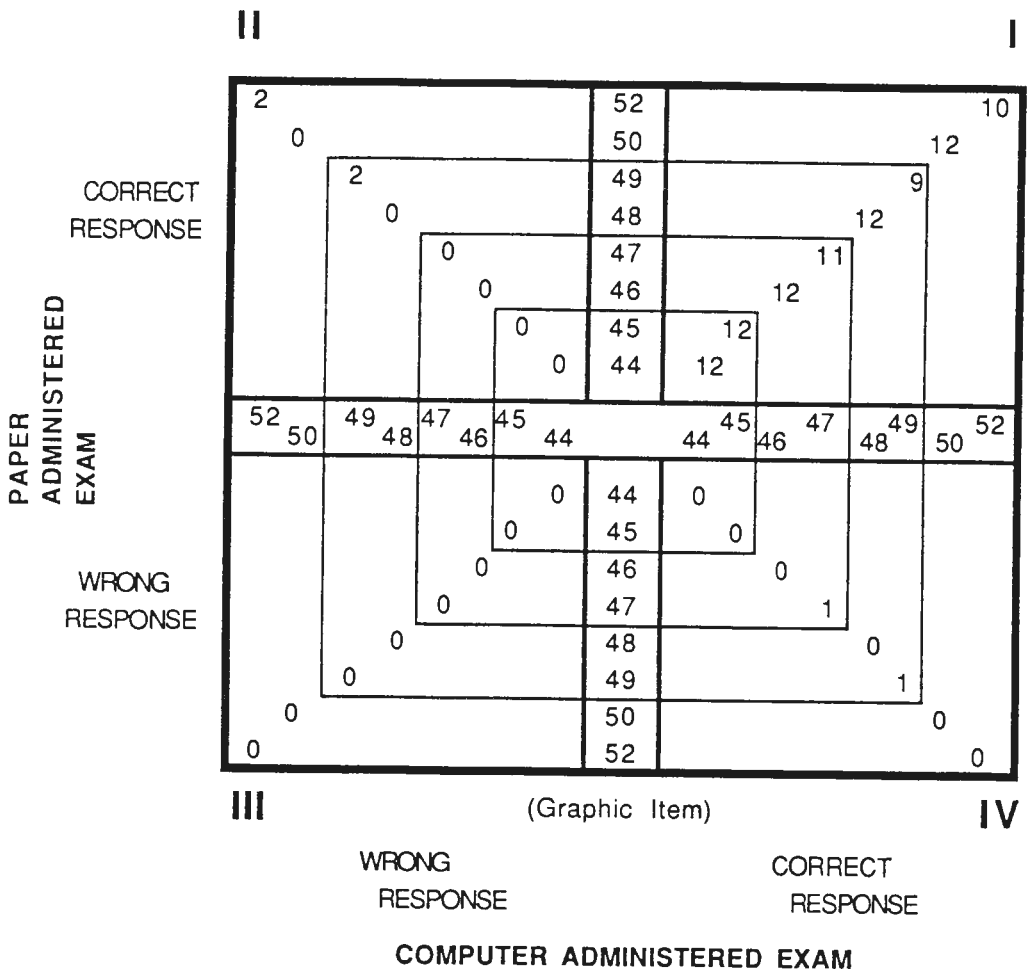


FIGURE 2 Students' test score results on graphic related items (44, 45, 46, 47, 48, 49, 50, 52) in the preliminary field test.

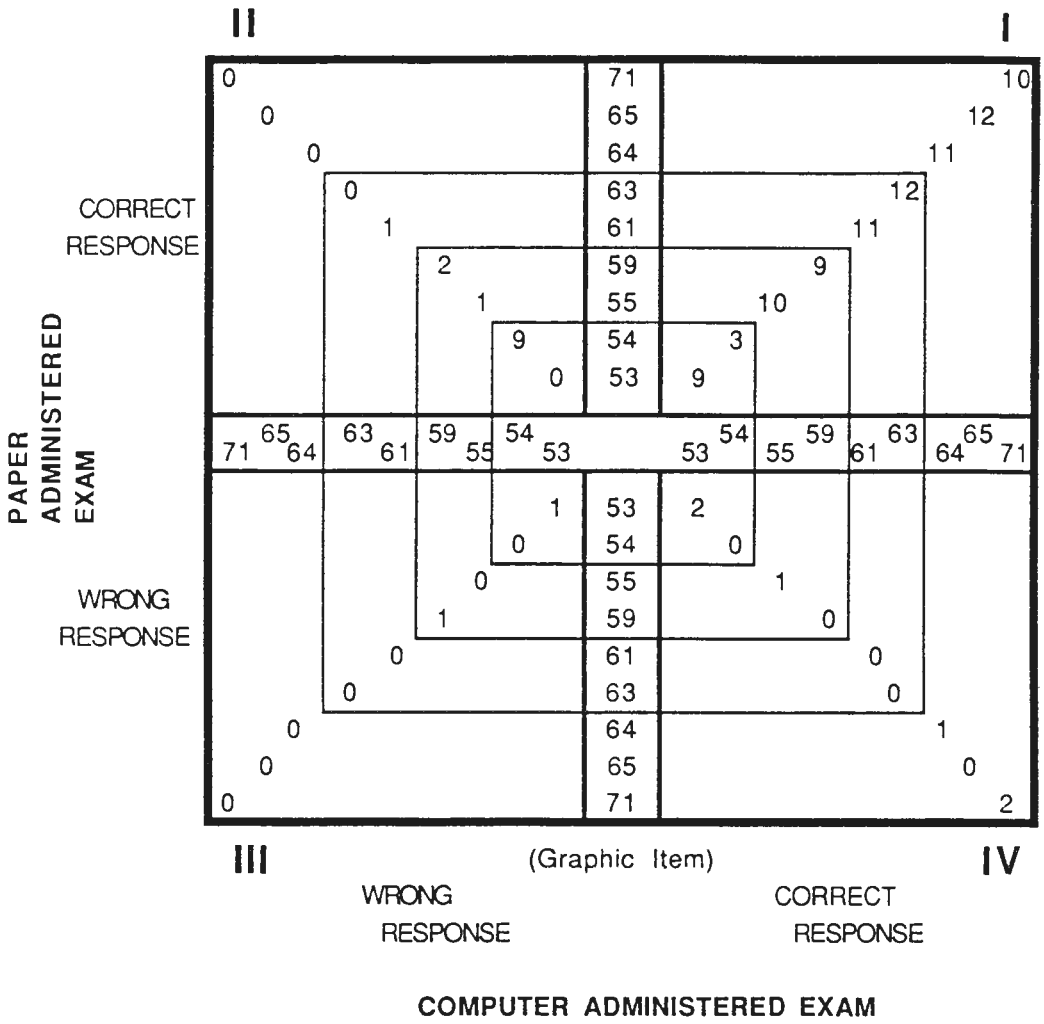


FIGURE 3 Students' test score results on graphic related items (53, 54, 55, 59, 61, 63, 64, 65, 71) in the preliminary field test.

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 admininstered 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.

Abridged Exam Item	Original Test Item
1	59
2	78
3	41
4	33
5	26
6	52
7	45
8	9
9	54
10	61

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.

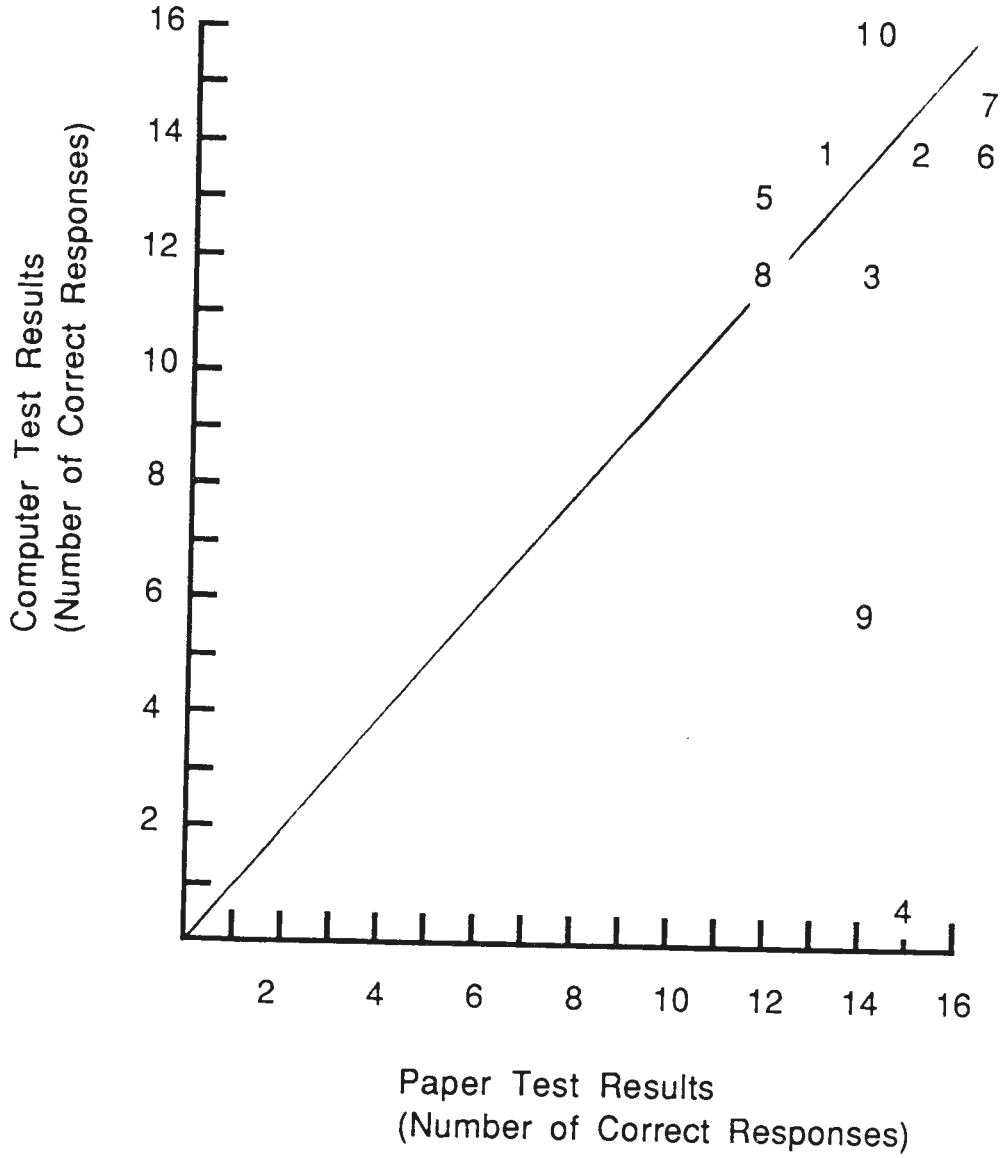
Students' test results are represented in Figures 4, 5, 6, and 7.

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

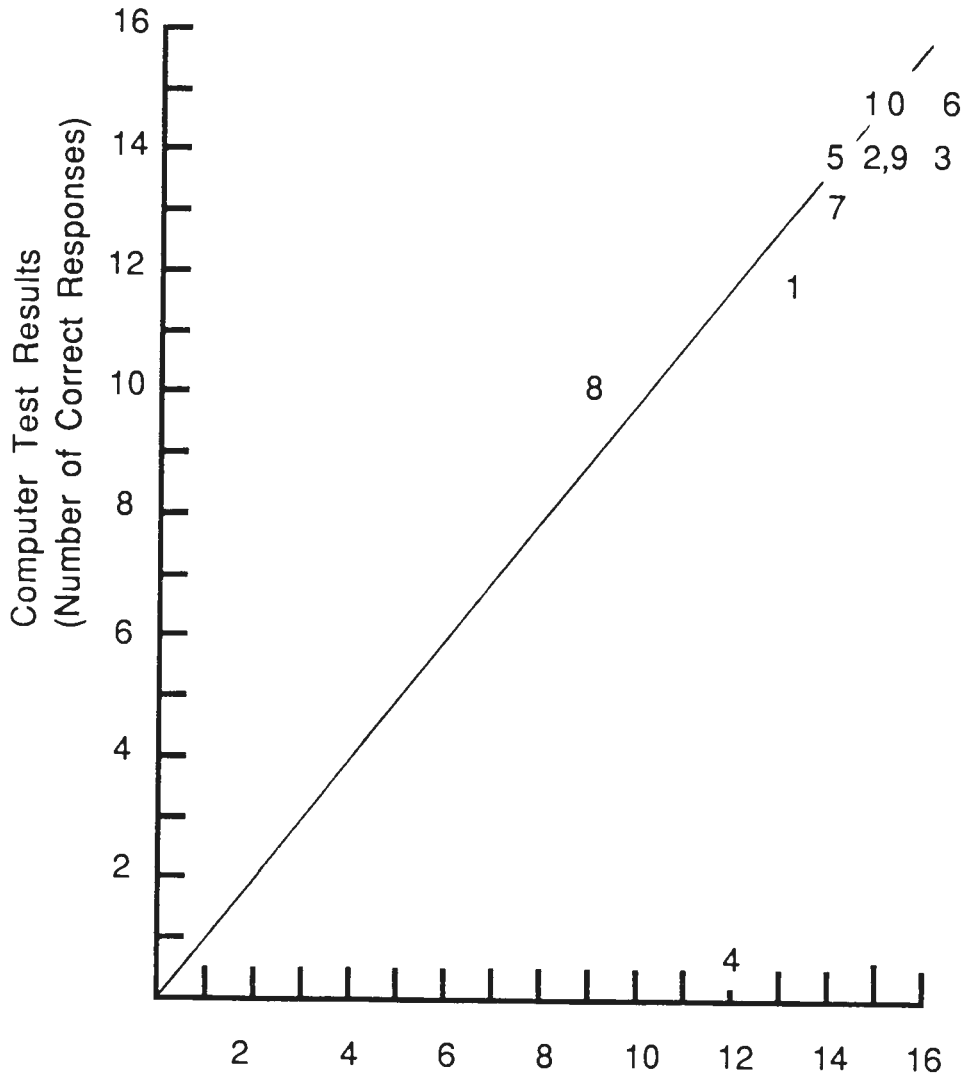


Legend

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.

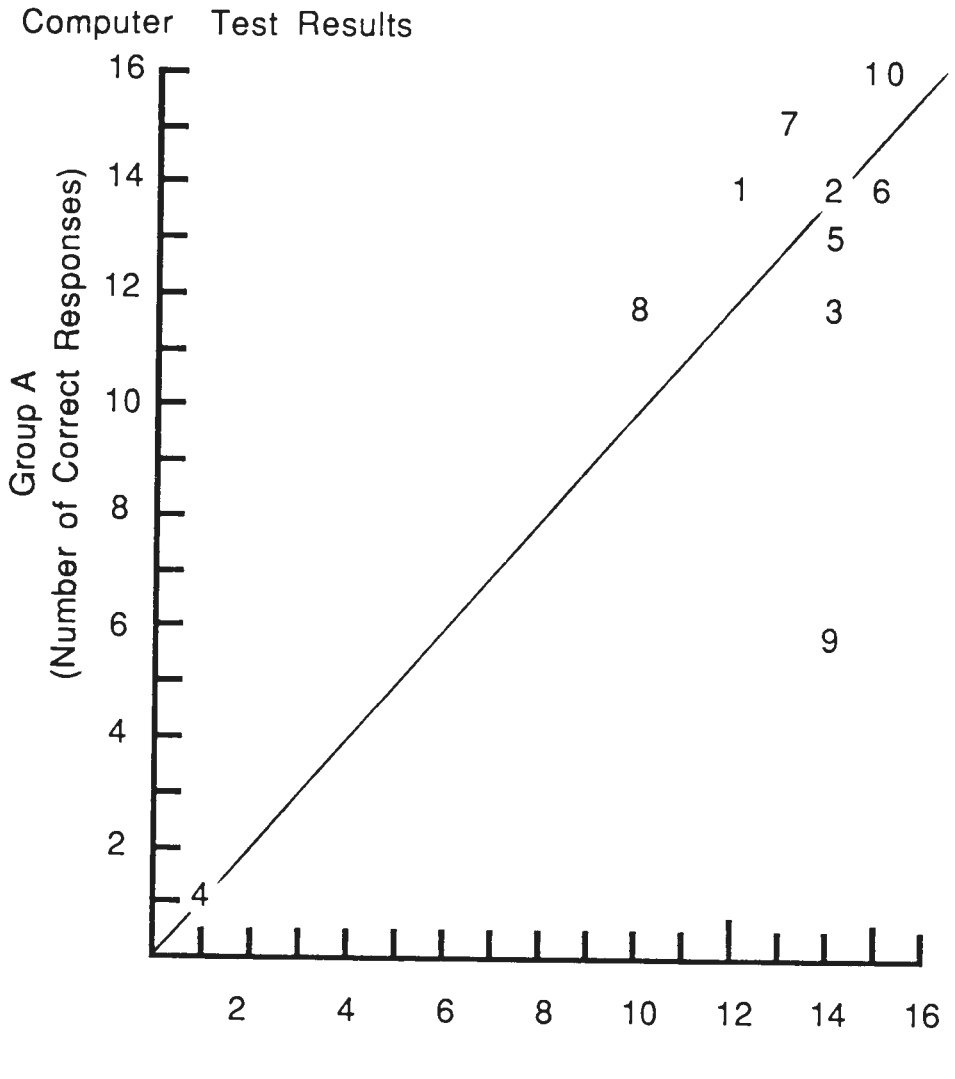


Legend

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.

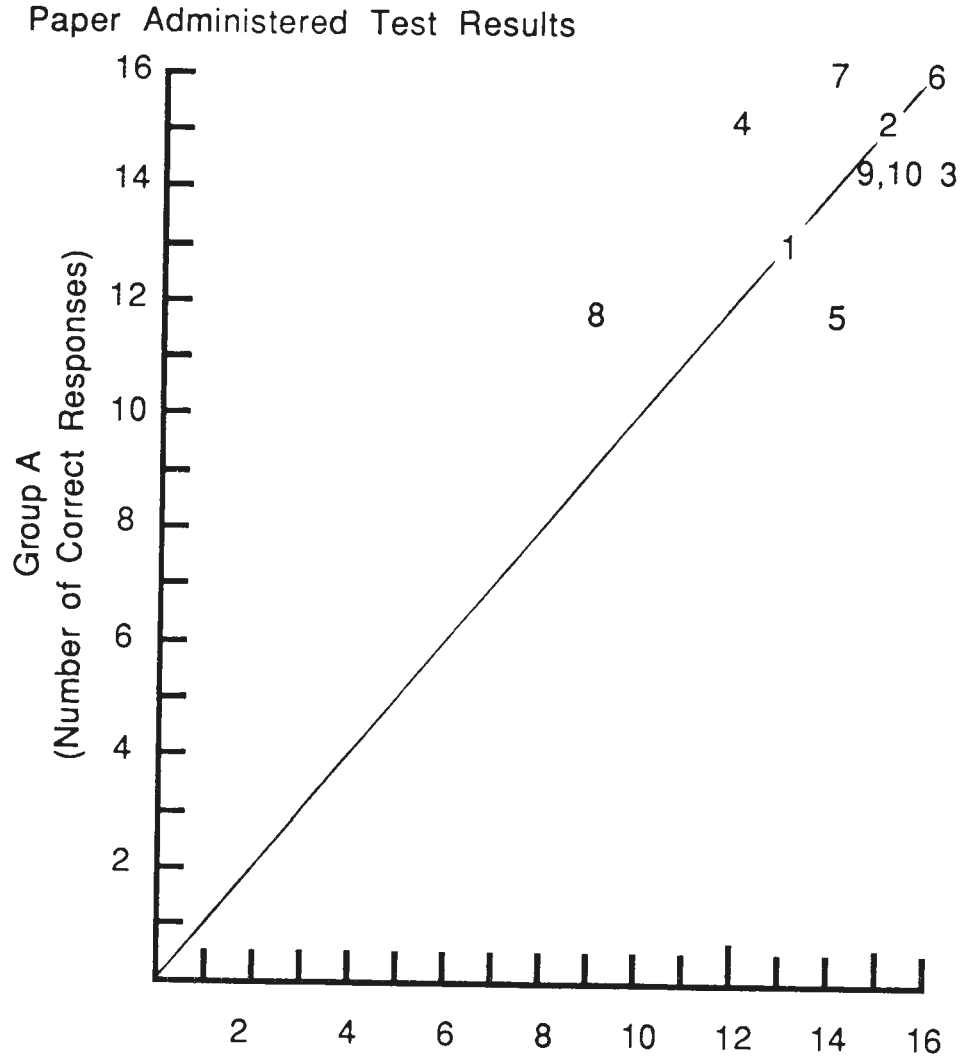


Legend

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 6 Follow-up field test results comparing group A's computer-administered test scores with group B's computer-administered test scores.



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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APPENDICES

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 in NOT an adaptation to life in 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 useable form are called

A. decomposers.....____
B. herbivores.....____
C. producers.....____
D. consumers.....____

LIFE SCIENCE: Score ____ out of 15

PART B - EARTH/SPACE

(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 .....___

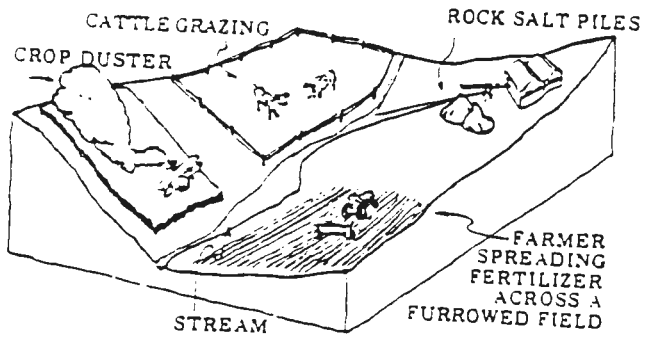
(18) Which ONE of these is true about the planet Venus?

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.....___

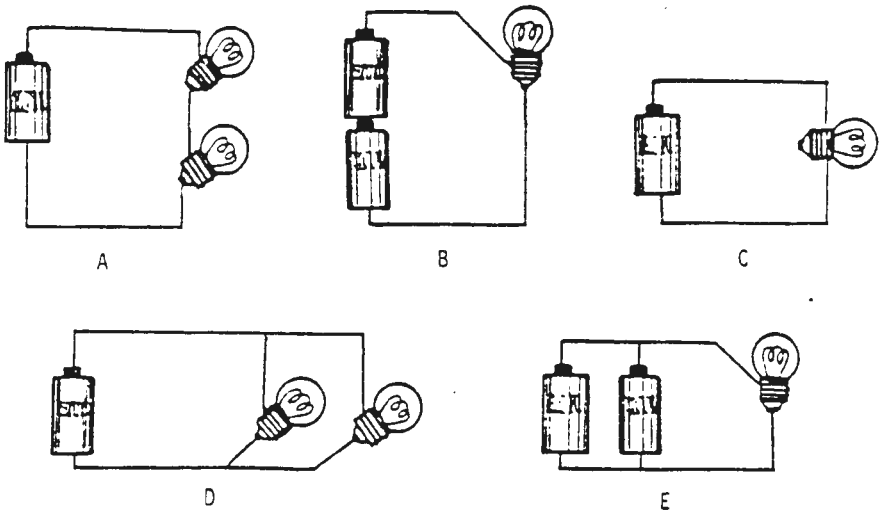
C. Earth's temperature is not constant.....___

D. Earth has a magnetic field.....___

EARTH/SPACE: Score _____ out of 14

PART C - PHYSICS/CHEMISTRY

(30) Below are five diagrams of electric circuits.



Which diagram shows two cells in series?

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

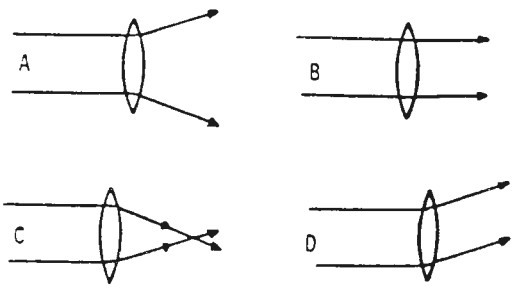
(31) In which circuit will the light bulb(s) not work?

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. .....____

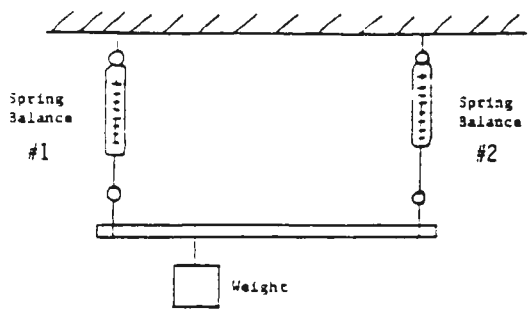
(34) Most of the chemical energy of the gasoline burned in a car is not used to move the car. Into what is it changed?

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 .....____

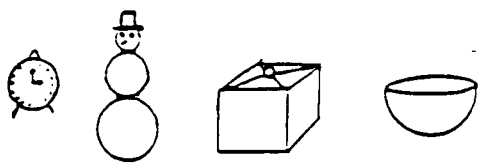
PHYSICS/CHEMISTRY: Score ____ out of 11

TEST TOTAL _____ OUT OF 40

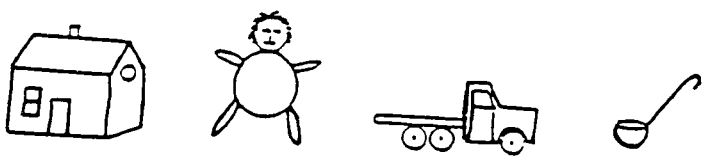
PART A - CLASSIFICATION and COMMUNICATION

(41) All of these are Bobbos.

None of these is a Bobbo.



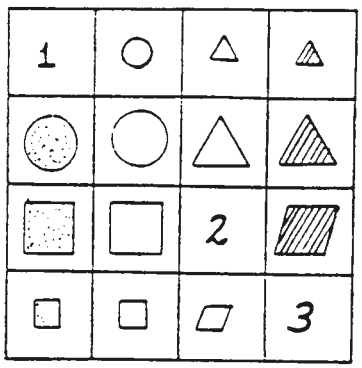
Which ONE of these is a Bobbo?



A B C D

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

(42) Here is a chart of shapes.



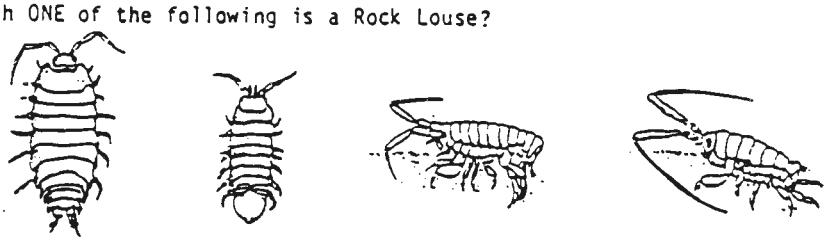
A B C D

Which shape is missing from Space 1?

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

(43) 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?



A B C D

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

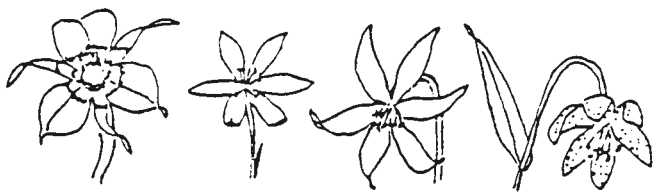
(44) The following is an identification key for eight students in a class. Use this key, step by step, to find the name of the blue-eyed blond girl.

Step 1.	Sex-boy Sex-girl	Go to Step 2 Go to Step 5
Step 2.	Eyes Blue Eyes Brown	Go to Step 3 Go to Step 4
Step 3.	Hair Blond Hair Dark	Leslie Lynn
Step 4.	Hair Blond Hair Dark	Nicky Bobby
Step 5.	Eyes Blue Eyes Brown	Go to Step 6 Go to Step 7
Step 6.	Hair Blond Hair Dark	Pat Beverly
Step 7.	Hair Blond Hair Dark	Terry Lee

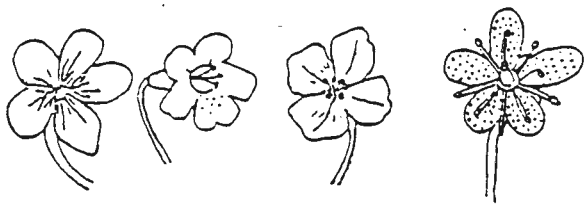
What is the name of the blue-eyed, blond girl?

A. Pat .....____
B. Lee .....____
C. Leslie .....____
D. Terry .....____

(45) All of these are lilies.



None of these is a lily.



Which ONE of these is a lily?

A B C D

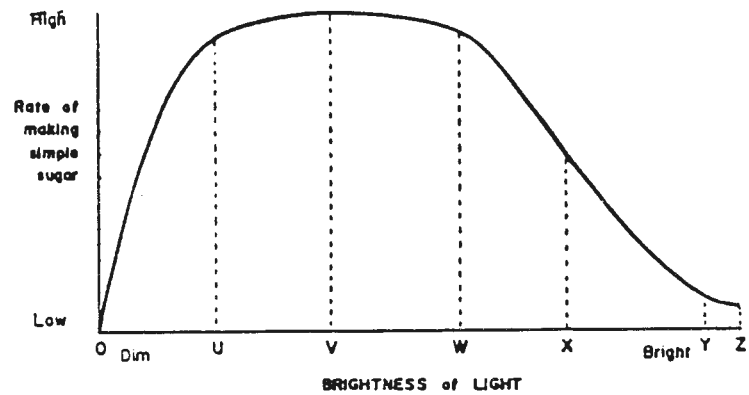
A. .....___

B. .....___

C. .....___

D. .....___

(46) 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 .....____

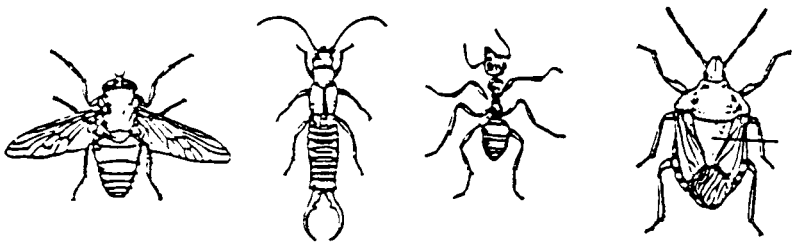
(47) According to the graph, plants make the most simple sugar when the light is

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

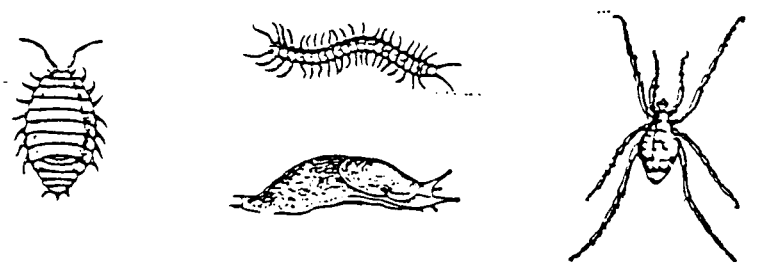
(48) At which brightness are the plants making the greatest amount of simple sugar?

A. O .....____
B. W .....____
C. V .....____
D. Z .....____

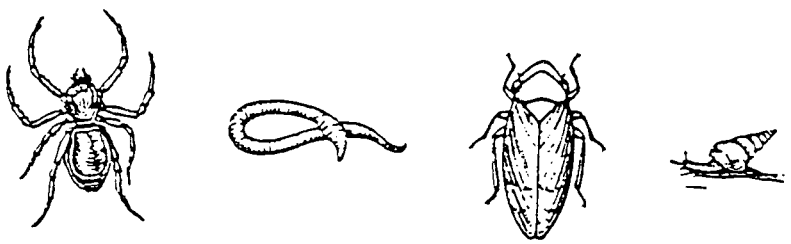
(49) All of these are insects.



None of these is an insect.



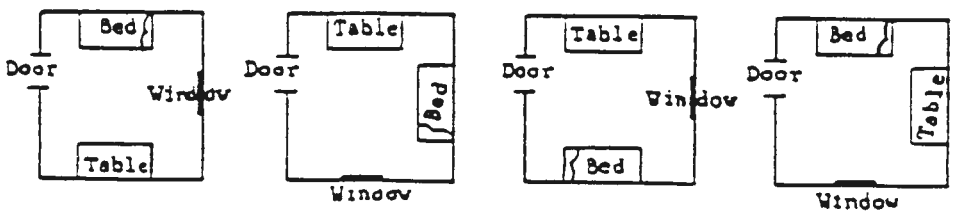
Which ONE of these is an insect?



A B C D

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 B C D

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

(51) All of these are Ungulates.

Deer
Buffalo
Goat
Cow

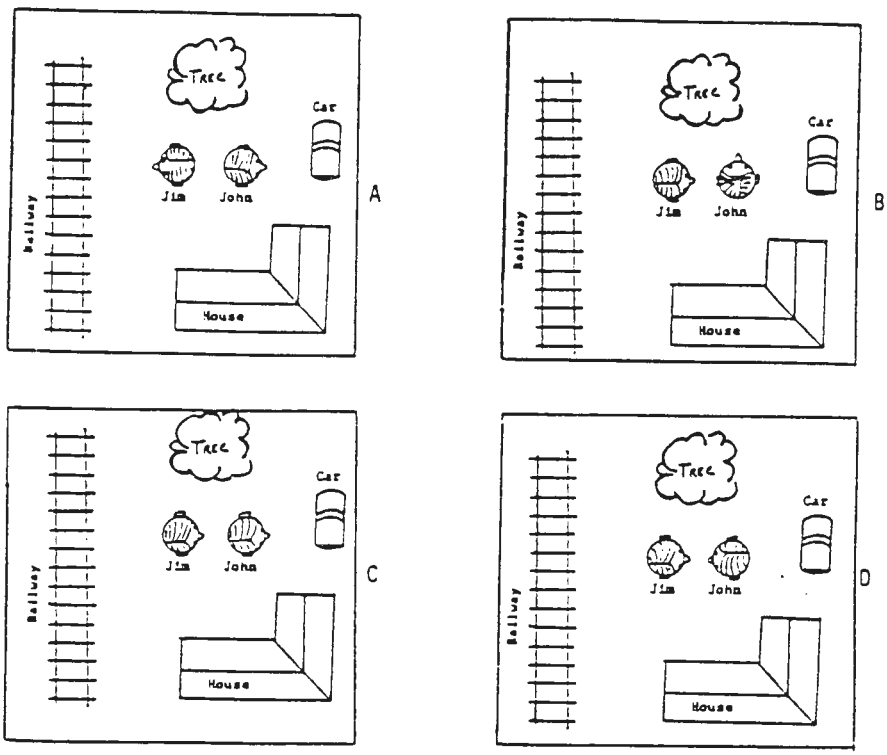
None of these is an Ungulate.

Raccoon
Wolf
Tiger
Rat

Which ONE of the following is an Ungulate?

A. Dog .....____
B. Bear .....____
C. Sheep .....____
D. Beaver .....____

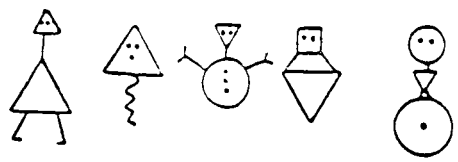
(52) In the diagrams below you are looking down on a scene from an airplane. Jim says, "The car which is in front of me is behind John and the tree on my left is on his right".



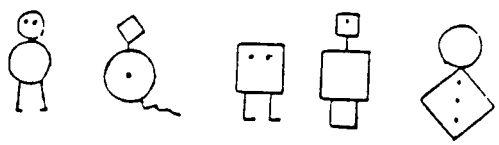
According to Jim's description, which is the correct diagram?

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

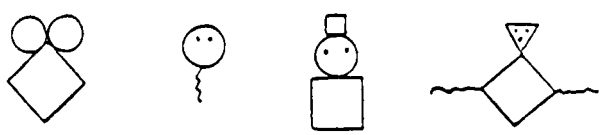
(53) All of these are Hewts.



None of these is a Hewt.



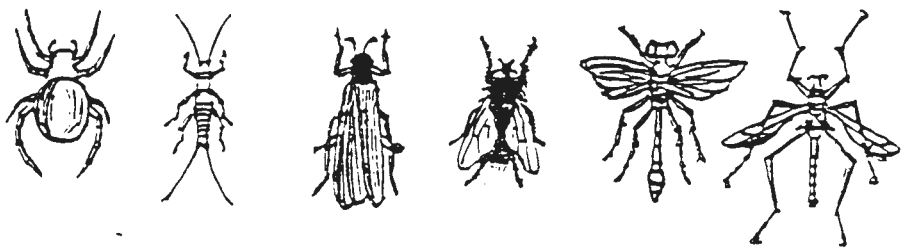
Which ONE of these is a Hewt.



A B C D

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

(54) Here are six unknown animals. Look at them carefully.



A B C D E F

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

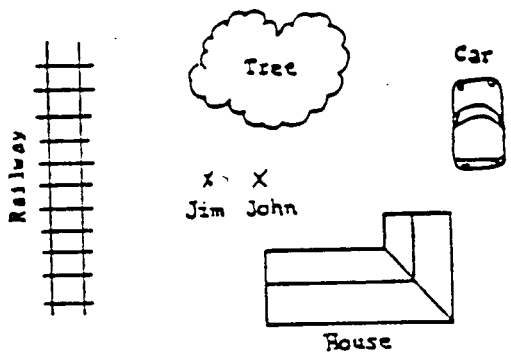
Step 1. wings no wings	Go to Step 2 Go to Step 5
Step 2. wings stick out to the side wings do not stick out to the side	Go to Step 3 Go to Step 4
Step 3. hind legs as long as body hind legs shorter than body	Cranefly Thread-waisted Wasp
Step 4. wings cover all of abdomen (rear end) wings do not cover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

Creature F is a

A. Thread-waisted Wasp .....___
B. Cranefly .....___
C. Leaf Bug .....___
D. Bristletail .....___

-11-

(55) 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 .....____

CLASSIFICATION & COMMUNICATION: Score

____ out of 15

PART B - EXPERIMENTATION

(56) 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 $0^{o}C$.
Three containers were kept at room temperature (about $21^{o}C$).
Three containers were kept at $90^{o}C$.

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.....____

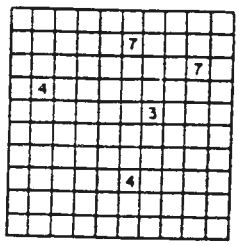
(57) What did Sarah make different between her containers?

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.....____

(58) 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.....____

(59) 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 .....____

(60) 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 .....___

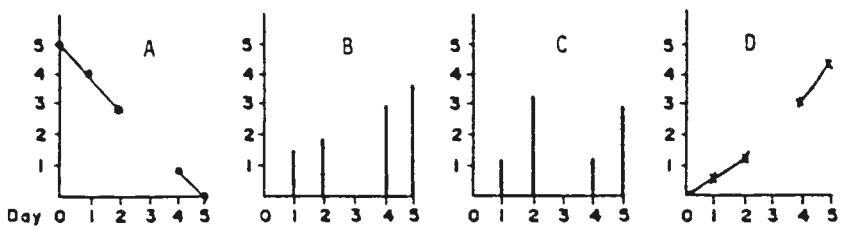
(63) The treeline is the highest altitude at which trees can grow. The following table relates treeline to distance from the equator.

Distance from Equator	Treeline
1000 km	4000 m
2500 km	3500 m
5000 km	3000 m
6500 km	1500 m

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.....____

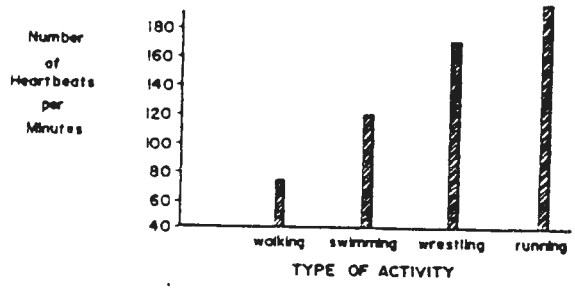
(64) Four students did four different experiments and graphed their results as shown below.



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. .....____

(65) 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 .....____

(66) 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 .....____

(67) 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.....____

(68) 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 .....____

(69) 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.....____

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

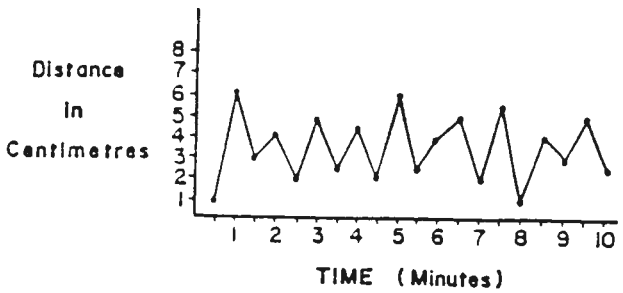
A. There is no reason to criticize her experiment.....____

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

```
3 D$ =  CHR$ (4)
5  PRINT  CHR$ (4);"BLOAD DHIRES.MOVER"
8  HOME
10  PRINT "Before proceeding, check to see that the'CAPS LOCK' key is pre
     ssed down."
11  PRINT "                                                  In order for the
     computer to recordyour answers, this key must be in the   locked pos
     ition during the exam."
14  PRINT
15  INPUT "       Press RETURN to go on. >";Q$
28  HOME
30  PRINT "Introduction to Science Diagnostic Exam,Elementary Education,
                        Utah State University."
35  PRINT
40  PRINT "All 80 questions are multiple choice."
43  PRINT
45  PRINT "To answer a question, simply              1. type the letter (
     A,B,C,D) that          matches the correct answer.          2. then
     press RETURN."
50  PRINT
55  PRINT "    There are two kinds of questions.   About 1/3 of the quest
     ions use a picturewhile the remainder do not?"
60  PRINT
65  PRINT "      Press RETURN JUST ONCE and you                 will see w
     hat I mean."
70  INPUT Q$
75  HOME
80  PRINT "     This is the first of 2                    PRACTICE questi
     ons. "
85  PRINT
86  PRINT
90  PRINT "HOW WOULD YOU DESCRIBE TODAY'S WEATHER?"
95  PRINT
100  PRINT "   A. HOT AND SUNNY.                          B. WARM AND COMFOR
     TABLE.              C. COOL AND THREATENING.                  D. NON
     E OF THE ABOVE."
105  PRINT
106  PRINT
110  PRINT "(If you want to change your answer,      press the Left Arrow
      key BEFORE you     press RETURN.  After typing RETURN, youcan NOT g
     o back and change your answer.)"
115  PRINT
120  INPUT ">";G$
123  GOTO 10000
125  HOME
130  PRINT "         You're doing great!"
135  PRINT
140  PRINT "This next example begins with a picture.The screen is not big
      enough to put the picture and the entire question up at   the same
     time."
145  PRINT
150  PRINT "   Therefore, follow the directions and you will be able to s
     witch from the     picture to the question and back as     often as
     you like before finalizing     your answer."
155  PRINT
160  PRINT "  Press RETURN (ONLY ONCE) to go on."
165  INPUT Q$
170  HOME
175  PRINT "      IT TAKES A FEW SECONDS TO                  ORGANIZE THE P
     ICTURE. "
178  POKE 49153,0
179  POKE 49239,0
```

```
180  PRINT D$;"BLOAD PRACTICE2,A$2000"
183  CALL 768
185  POKE 49153,0
187  POKE 49239,0
188  POKE 49237,0
189  POKE 49232,0
190  POKE 49235,0
198  GOSUB 10151
199  HOME
200  PRINT "       PRACTICE question #2"
205  PRINT
210  PRINT "REFERRING TO THE PREVIOUS PICTURE, THE  AIRPLANE IS FLYING IN
      THE DIRECTION..."
215  PRINT
220  PRINT "   A. TOWARD THE CATTLE.                          B. TOWARD THE FARM
     ER.                    C. OPPOSITE OF THE CATTLE.                  D. OPP
     OSITE OF THE FARMER."
225  PRINT
230  PRINT "     (TYPE THE LETTER 'P' AND 'RETURN'            TO SEE THE P
     ICTURE AGAIN.)"
235  PRINT
240  INPUT ">";G$
245  IF G$ = "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 ha
     ve any concerns    regarding the previous information, feelfree to a
     sk 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 PRAC
     TICE questions            again."
275  PRINT
280  INPUT ">";Q$
285  IF Q$ = "B" THEN : GOTO 28
290  HOME
300  PRINT "                  GOOD LUCK!"
305  PRINT  CHR$ (4);"CHAIN PART1"
9999  END
10000  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     125
10005  INPUT "OOPS!  A TYPING ERROR HAS TAKEN PLACE.  YOUR ONLY CHOICES A
     RE A,B,C,D.          (Also, check to see that the 'CAPS LOCK'key is
     pressed down.)                                TRY AGAIN.>";G$: GOTO 100
     00
10010  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "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.>";G$: GOTO
     245
10150  REM  BRING UP DIAGRAM
10151  POKE 49153,0
10155  POKE 49239,0
10160  POKE 49237,0
10165  POKE 49232,0
10175  INPUT Q$
10180  POKE 49233,0
10185  POKE 49164,0
10195  RETURN
```

```
10 DS =  CHR$ (4)
12  PRINT  CHR$ (4);"BLOAD DHIRES.MOVER"
20  DIM R$(79)
22  DIM A$(79)
24  LET N = 0
99  HOME
100  PRINT "          PART A - LIFE SCIENCE"
101  PRINT
102  PRINT "                    #1"
105  PRINT
110  PRINT "FOR QUICK ENERGY BEFORE A RACE, IT       WOULD BE BEST FOR A R
     UNNER TO HAVE"
115  PRINT
120  PRINT "      A. A HARD-BOILED EGG.                    B. A HOT DOG.
                          C. A CUP OF COFFEE.                        D. A
      CANDY BAR."
125  PRINT
130  INPUT ">";G$
133  GOSUB 10000
200  PRINT "                    #2"
205  PRINT
210  PRINT "FERTILIZATION TAKES PLACE WHEN A SPERM"
215  PRINT
220  PRINT "   A. REACHES A CERTAIN AGE.                B. ENTERS AN EGG.
                         C. BECOMES AN EGG.                        D. BEC
     OMES AN EMBRYO.
225  PRINT
230  INPUT ">";G$
233  GOSUB 10000
235  HOME
300  PRINT "                    #3"
305  PRINT
310  PRINT "WHY CAN LARGE BODIES OF WATER CLEAN      THEMSELVES FROM THE P
     OLLUTION OF        ORGANIC MATTER SUCH AS BODY WASTES AND  DEAD ORGA
     NISMS?"
315  PRINT
320  PRINT "   A. FISH EAT THE ORGANIC MATTER.          B. ALGAE DECOMPOSE
      THE ORGANIC                MATTER."
322  PRINT "   C. THE ORGANIC MATTER SETTLES TO THE       BOTTOM AND IS N
     OT CHANGED.           D. BACTERIA DECOMPOSE THE ORGANIC          MAT
     TER."
325  PRINT
330  INPUT ">";G$
333  GOSUB 10000
335  HOME
400  PRINT "                    #4"
405  PRINT
410  PRINT "WHICH OF THE FOLLOWING STATEMENTS IS     TRUE ABOUT SEEDS?"
415  PRINT
420  PRINT "   A. ALL PLANTS PRODUCE SEEDS.             B. ALL SEEDS ARE G
     OOD TO EAT.           C. ALL FRUITS CONTAIN A LARGE NUMBER       OF
     SEEDS."
422  PRINT "   D. EVERY SEED CONTAINS A YOUND PLANT,      STORED FOOD, AN
     D A SEEDCOAT."
425  PRINT
430  INPUT ">";G$
433  GOSUB 10000
445  HOME
500  PRINT "                    #5"
505  PRINT
510  PRINT "WHICH OF THE FOLLOWING SUBSTANCES IS     ADDED TO DRINKING WAT
     ER TO HELP PREVENT TOOTH DECAY?"
515  PRINT
520  PRINT "   A. FLUORIDE.                                B. CHLORINE.
                         C. CALCIUM.                               D. IOD
```

```
     INE."
 525 PRINT
 530 INPUT ">";G$
 533 GOSUB 10000
 600 PRINT "                    #6"
 605 PRINT
 610 PRINT "WHICH ONE OF THE FOLLOWING IS PREPARED  FROM THE SEEDS OF PLA
     NTS?"
 615 PRINT
 620 PRINT "   A. TEA.                                          B. FLOUR.
                        C. SALT.                                        D. SUG
     AR."
 625 PRINT
 630 INPUT ">";G$
 633 GOSUB 10000
 635 HOME
 700 PRINT "                    #7"
 705 PRINT
 710 PRINT "WHAT IS THE SECOND STAGE IN THE LIFE    CYCLE OF A HOUSEFLY?"
 715 PRINT
 720 PRINT "   A. ADULT.                                        B. EGG.
                        C. LARVA.                                       D. PUP
     A."
 725 PRINT
 730 INPUT ">";G$
 733 GOSUB 10000
 800 PRINT "                    #8"
 805 PRINT
 810 PRINT "WHICH ONE OF THE FOLLOWING FEATURES IS  NOT AN ADAPTATION TO
     LIFE IN THE WATER?"
 815 PRINT
 820 PRINT "   A. STREAMLINED SHAPE.                            B. FINS.
                        C. WEBBED FEET.                                 D. LUN
     GS."
 825 PRINT
 830 INPUT ">";G$
 833 GOSUB 10000
 835 HOME
 900 PRINT "                    #9"
 905 PRINT
 910 PRINT "WHICH GAS PRODUCED DURING PHOTOSYNTHESISIS USEFUL TO ANIMALS?
     "
 915 PRINT
 920 PRINT "   A. CARBON DIOXIDE.                               B. OXYGEN.
                        C. CARBON MONOXIDE.                             D. NIT
     ROGEN."
 925 PRINT
 930 INPUT ">";G$
 933 GOSUB 10000
1000 PRINT "                    #10"
1005 PRINT
1010 PRINT "WHICH ONE OF THE FOLLOWING IS OFTEN    CONSIDERED TO BE THE
     SIMPLEST BIOLOGICALUNIT OF STRUCTURE?"
1015 PRINT
1020 PRINT "   A. THE ORGANISM.                                 B. THE TISSUE.
                        C. THE ORGAN.                                   D. TH
     E CELL."
1025 PRINT
1030 INPUT ">";G$
1033 GOSUB 10000
1035 HOME
1100 PRINT "                    #11"
1105 PRINT
1110 PRINT "WHAT IS THE CHIEF REASON GLASS AND     PLASTIC WASTE ARE PA
     RTICULARLY          TROUBLESOME?"
```

```
1115  PRINT "
1120  PRINT "    A. THEY FORM UGLY LITTER.                B. THEY ARE EASIL
     Y CHANGED INTO            POISONOUS SUBSTANCES."
1122  PRINT "    C. THEY FLOAT ON TOP OF BODIES OF          WATER.
                          D. THEY RESIST BEING CHANGED BY            NA
     TURAL PROCESSES."
1125  PRINT
1130  INPUT ">";G$
1133  GOSUB 10000
1135  HOME
1200  PRINT "                    #12"
1205  PRINT
1210  PRINT "TO WHICH BODY SYSTEM DO THE LUNGS       BELONG?"
1215  PRINT
1220  PRINT "    A. SENSORY.                              B. RESPIRATORY.
                          C. CIRCULATORY.                          D. DI
     GESTIVE."
1225  PRINT
1230  INPUT ">";G$
1233  GOSUB 10000
1235  HOME
1300  PRINT "                    #13"
1305  PRINT
1310  PRINT "TODAY, ALMOST NO ONE GETS POLIO BECAUSE"
1315  PRINT
1320  PRINT "    A. BAD WATER, WHICH USED TO CAUSE          POLIO, HAS BEE
     N CLEANED UP.          B. DOCTORS HAVE FOUND NEW DRUGS WHICH      CU
     RE POLIO WHEN IT HAPPENS."
1322  PRINT "    C. PEOPLE EAT BETTER FOOD AND GET          MORE EXERCISE,
      SO THEY ARE              HEALTHIER.                          D. PE
     OPLE ARE GIVEN A VACCINE WHICH       KEEPS THEM FROM GETTING POLIO.
     "
1325  PRINT
1330  INPUT ">";G$
1333  GOSUB 10000
1335  HOME
1400  PRINT "                    #14"
1405  PRINT
1410  PRINT "WHICH ONE OF THE FOLLOWING IS A          CHARACTERISTIC OF AL
     L BIRDS BUT OF NO   OTHER ANIMAL?  BIRDS"
1415  PRINT
1420  PRINT "    A. TEND TO MIGRATE.                      B. LAY EGGS.
                          C. FLY.                                  D. HA
     VE A BODY COVERED BY FEATHERS."
1425  PRINT
1430  INPUT ">";G$
1433  GOSUB 10000
1500  PRINT "                    #15"
1505  PRINT
1510  PRINT "THE ORGANISMS IN A FOOD CHAIN          RESPONSIBLE FOR CONV
     ERTING LIGHT ENERGY TO A USEABLE FORM ARE CALLED"
1515  PRINT
1520  PRINT "    A. DECOMPOSERS.                          B. HERBIVORES.
                          C. PRODUCERS.                            D. CO
     NSUMERS."
1525  PRINT
1530  INPUT ">";G$
1533  GOSUB 10000
1535  HOME
1575  PRINT "                  PART B "
1576  PRINT
1577  PRINT "      THE NEXT 14 QUESTIONS FOCUS              ON EARTH/SCIEN
     CE CONTENT.
       ONE MOMENT PLEASE."
1580  PRINT  CHR$ (4);"CHAIN PART2"
9999  END
```

```
10000  REM  TAKE RESPONSE AND CHECK FOR MISMATCH
10002  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     10035
10020  INPUT "OOPS! MISTYPED RESPONSE.                YOUR ONLY CHOICES A
     RE A,B,C,D.                    TRY AGAIN.>";G$: GOTO 10002
10025  HOME
10035  LET R$(N) = G$
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.  ";Q$
10180  POKE 49164,0
10185  POKE 49164,0
10195  RETURN



10 D$ =  CHR$ (4)
12  PRINT  CHR$ (4);"BLOAD DHIRES.MOVER"
99  HOME
1600  PRINT "           PART B - EARTH/SPACE  "
1601  PRINT
1603  PRINT "                    #16"
1605  PRINT
1610  PRINT "HOW IS DEW FORMED?"
1615  PRINT
1620  PRINT "   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."
1623  PRINT "   D. IT FORMS FROM MELTED FROST."
1625  PRINT
1630  INPUT ">";G$
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. LI
     MESTONE."
1725  PRINT
1730  INPUT ">";G$
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 L
     IKE IT IN MOST OTHER      WAYS. "
1821  PRINT "   B. SCIENTISTS KNOW MORE ABOUT THE           SURFACE OF VEN
     US THAN THEY DO           ABOUT MARS."
1822  PRINT "   C. IT IS ABOUT THE SAME SIZE AS THE         EARTH.
                          D. VENUS HAS MANY SATELLITES."
1825  PRINT
1830  INPUT ">";G$
1833  GOSUB 10000
1835  HOME
1900  PRINT "                    #19"
1905  PRINT
```

```
1910  PRINT "WHAT DOES THE STATEMENT THAT THE RELATIVE HUMIDITY IS 50% ME
      AN?"
1915  PRINT
1920  PRINT "    A. THE ATMOSPHERE WOULD BE SATURATED        WITH WATER IF
      THE AIR TEMPERATURE        WERE 50 DEGREES CELSIUS."
1921  PRINT "    B. THE ATMOSPHERE CONTAINS HALF AS          MUCH WATER AS
      IT COULD CONTAIN           AT ITS PRESENT TEMPERATURE."
1922  PRINT "    C. THE ATMOSPHERE CONTAINS 50 g OF          WATER PER CUBI
      C METRE."
1923  PRINT "    D. THE CHANCE OF RAIN IS 50%."
1925  PRINT
1930  INPUT ">";G$
1933  GOSUB 10000
1935  HOME
2000  PRINT "  THE NEXT QUESTION HAS TWO PARTS -           1ST, A PICTURE
                              2ND, THE QUESTION."
2003  PRINT
2005  PRINT "      ONE MOMENT PLEASE."
2045  PRINT D$;"BLOAD NUMBER20,A$2000"
2048  CALL 768
2050  GOSUB 10151
2053  PRINT "                        #20"
2055  PRINT
2060  PRINT "WHAT EFFECT CAN THE CROP DUSTER, CATTLE,SALT STORED IN PILES
      OUTDOORS, AND THE  FARMER SPREADING FERTILIZER ALL HAVE?"
2065  PRINT
2070  PRINT "  A. IMPROVE THE SOIL.                        B. KILL INSECTS TH
      AT ATTACK CROPS.       C. MAKE PLANTS GROW BIGGER AND FASTER.  D. MAK
      E THE STREAM WATER IMPURE."
2075  PRINT
2077  PRINT "       (TYPE THE LETTER 'P' AND PRESS          RETURN TO SEE
      THE PICTURE AGAIN.)"
2080  INPUT ">";G$
2083  IF G$ = "P" THEN  PRINT "       JUST A MOMENT.": GOTO 2045
2085  GOSUB 10010
2087  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
      2090
2088  GOTO 2083
2090  HOME
2100  PRINT "                        #21"
2105  PRINT
2110  PRINT "THE MOON IS THE BRIGHTEST OBJECT IN THE NIGHT SKY BECAUSE IT
      -
2115  PRINT
2120  PRINT "    A. IS FLUORESCENT.                          B. PRODUCES ITS O
      WN LIGHT.              C. REFLECTS LIGHT FROM THE SUN.          D. RE
      FLECTS LIGHT FROM NEARBY STARS."
2125  PRINT
2130  INPUT ">";G$
2133  GOSUB 10000
2135  PRINT
2200  PRINT "                        #22"
2205  PRINT
2210  PRINT "CRUDE OIL COMES FROM"
2215  PRINT
2220  PRINT "    A. MINES LIKE COAL.                         B. A FACTORY.
                           C. THE JUICES OF PLANTS.                 D. WE
      LLS IN THE EARTH."
2225  PRINT
2230  INPUT ">";G$
2233  GOSUB 10000
2235  HOME
2300  PRINT "                        #23"
2305  PRINT
2310  PRINT "WHICH ONE OF THE FOLLOWING IS TRUE?"
2315  PRINT
```

```
2320  PRINT "   A. SOME PLANETS REVOLVE AROUND THE          SUN IN ONE DIR
     ECTION OR ANOTHER.      B. ONLY THE EARTH REVOLVES AROUND THE       SU
     N.                                C. PLANETS DO NOT REVOLVE AROUND
     THE       SUN."
2323  PRINT "   D. ALL PLANETS REVOLVE AROUND THE           SUN IN THE SAM
     E DIRECTION."
2325  PRINT
2330  INPUT ">";G$
2333  GOSUB 10000
2335  HOME
2400  PRINT "                      #24"
2410  PRINT "WHICH STATEMENT BEST DESCRIBES HOW THE  EARTH'S SURFACE CHAN
     GES OVER BILLIONS OFYEARS?"
2415  PRINT
2420  PRINT "   A. A FLAT SURFACE IS GRADUALLY PUSHED         UP INTO STEE
     PER AND STEEPER             MOUNTAINS UNTIL THE WORLD IS
     COVERED WITH MOUNTAINS."
2421  PRINT "   B. VERY STEEP MOUNTAINS GRADUALLY             WEAR DOWN UN
     TIL MOST OF THE             WORLD IS WORN DOWN TO SEA LEVEL."
2422  PRINT "   C. VERY STEEP MOUNTAINS AND FLAT              PLAINS STAY
     SIDE BY SIDE FOR            BILLIONS OF YEARS WITH LITTLE
     CHANGE."
2423  PRINT "   D. VERY STEEP MOUNTAINS GRADUALLY             WEAR DOWN IN
     TO FLAT SUFRACES            THAT MAY BE AGAIN PUSHED UP INTO
     MOUNTAINS, AND SO ON OVER AND          OVER AGAIN."
2425  PRINT
2430  INPUT ">";G$
2433  GOSUB 10000
2435  HOME
2500  PRINT "                      #25"
2505  PRINT
2510  PRINT "FOR WHICH OF THE FOLLOWING ARE EARTH    SATELLITES NOT USED?
     "
2515  PRINT
2520  PRINT "   A. TO REFLECT RADIO AND T.V. SIGNALS        BACK TO EARTH.
                         B. TO HELP PREDICT WEATHER."
2523  PRINT "   C. TO CAPTURE SOLAR ENERGY TO PROVIDE       POWER FOR CITI
     ES.                 D. TO HELP MAKE MAPS BY PHOTOGRAPHING      TH
     E EARTH."
2525  PRINT
2530  INPUT ">";G$
2533  GOSUB 10000
2535  HOME
2600  PRINT "                      #26"
2605  PRINT
2610  PRINT "WHICH ONE OF THE FOLLOWING IS PRESENTLY HELPING TO SHAPE THE
     SURFACE OF THE     MOON?"
2615  PRINT
2620  PRINT "   A. GLACIERS.                                B. PLANTS.
                         C. METEORITES.                              D. ST
     REAMS."
2625  PRINT
2630  INPUT ">";G$
2633  GOSUB 10000
2635  HOME
2650  PRINT "I HAVE TO LOAD UP SOME MORE QUESTIONS"
2655  PRINT
2660  PRINT "             JUST A SECOND."
2675  PRINT  CHR$ (4);"CHAIN PART3"
9999  END
10000  REM  TAKE RESPONSE AND CHECK FOR MISMATCH
10002  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     10035
10005  INPUT "OOPS!  MISTYPED RESPONSE.              YOUR ONLY CHOICES A
     RE A,B,C,D.                 TRY AGAIN.>";G$: GOTO 10002
10010  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "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 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
10195  RETURN



10 DS =  CHRS (4)
12  PRINT  CHRS (4);"BLOAD DHIRES.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 AI
     R, 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 SUCHAS 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 FORTHE 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."
2923  PRINT "   D. EARTH HAS A MAGNETIC FIELD."
2925  PRINT
2930  INPUT ">";GS
2933  GOSUB 10000
2935  HOME
3000  PRINT
3005  PRINT "       PART C - PHYSICS/CHEMISTRY"
3007  PRINT
```

```
3010  PRINT       THE FIRST QUESTION IN THIS SECTION  AGAIN HAS A PICTURE
    AND A QUESTION."
3013  PRINT
3015  PRINT "                 ONE MOMENT."
3020  PRINT  CHR$ (4);"BLOAD NUMBER30,A$2000"
3025  CALL 768
3030  GOSUB 10151
3035  HOME
3050  PRINT "                      #30"
3055  PRINT
3060  PRINT "FROM THE PREVIOUS PICTURE, WHICH DIAGRAMSHOWED TWO CELLS IN
    SERIES?"
3065  PRINT
3070  PRINT "   A. A                                          B. B
                           C. C                                          D. E"

3075  PRINT
3080  PRINT "     (TYPE THE LETTER 'P' AND RETURN            TO SEE THE PI
    CTURE AGAIN.)"
3083  INPUT ">";G$
3085  IF G$ = "P" THEN  PRINT "     I'LL GET IT FOR YOU.": GOSUB 3020
3088  GOSUB 10010
3089  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
    3095
3090  GOTO 3085
3092  HOME
3095  PRINT "      #31 USES THE SAME PICTURE."
3096  PRINT D$;"BLOAD NUMBER31,A$2000"
3097  CALL 768
3098  GOSUB 10151
3100  PRINT "                      #31"
3101  PRINT
3103  PRINT
3105  PRINT
3110  PRINT "IN WHICH CURCUIT WILL THE LIGHT BULB(S) NOT WORK?"
3115  PRINT
3120  PRINT "   A. A                                          B. B
                           C. C                                          D. D"

3125  PRINT
3128  PRINT "     (TYPE THE LETTER 'P' AND RETURN            TO SEE THE PI
    CTURE AGAIN.)"
3130  INPUT ">";G$
3135  IF G$ = "P" THEN  PRINT "     I'LL GO BACK AND GET IT.": GOTO 3096
3136  IF G$ = "P" THEN  PRINT "     I'LL GO BACK AND GET IT.": GOTO 3150
3140  GOSUB 10010
3142  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
    3199
3145  GOTO 3135
3199  HOME
3200  PRINT "                      #32"
3205  PRINT "
3210  PRINT "WHEN A LIGHT BEAM HITS A MIRROR SURFACE AT A CERTAIN ANGLE"
3215  PRINT
3220  PRINT "   A. IT BOUNCES AWAY AT THE SAME ANGLE.   B. IT ALWAYS BOUN
    CES BACK ALONG THE        SAME ANGLE."
3223  PRINT "   C. IT BOUNCES AWAY AT A GREATER            ANGLE.
                           D. IT BOUNCES AWAY AT A SMALLER            AN
    GLE."
3225  PRINT
3230  INPUT ">";G$
3233  GOSUB 10000
3235  HOME
3250  PRINT "         GUESS WHAT, ANOTHER PICTURE.
                                    ANOTHER MOMENT."
3310  PRINT D$;"BLOAD NUMBER33,A$2000"
```

```
3315  CALL 768
3320  GOSUB 10151
3350  PRINT "                    #33"
3355  PRINT
3360  PRINT "WHICH DIAGRAM BEST SHOWS WHAT HAPPENS   WHEN LIGHT HITS A CA
      MERA LENS?"
3365  PRINT
3370  PRINT "   A. A                                          B. B
                           C. C                                          D. D"
3375  PRINT
3380  PRINT "     (TYPE THE LETTER 'P' AND RETURN            TO SEE THE PI
      CTURE AGAIN.)"
3385  INPUT ">";G$
3388  IF G$ = "P" THEN  PRINT "     COMPUTERS ARE SLOW AREN'T THEY.": GOTO
      3310
3390  GOSUB 10010
3392  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
      3395
3393  GOTO 3388
3395  HOME
3400  PRINT "                    #34"
3405  PRINT
3410  PRINT "MOST OF THE CHEMICAL ENERGY OF THE      GASOLINE BURNED IN A
      CAR IS NOT USED TO MOVE THE CAR.  INTO WHAT IS IT CHANGED?"
3415  PRINT
3420  PRINT "   A. HEAT.                                      B. ELECTRICITY.
                           C. LIGHT.                                     D. MA
      GNETISM."
3425  PRINT
3430  INPUT ">";G$
3433  GOSUB 10000
3435  HOME
3450  PRINT "    I'M PREPARING SOME MORE QUESTIONS."
3455  PRINT  CHR$ (4);"CHAIN PART4"
9999  END
10000  REM  TAKE RESPONSE AND CHECK FOR MISMATCH
10002  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
      10035
10005  INPUT "OOPS!  MISTYPED RESPONSE.                YOUR ONLY CHOICES A
      RE A,B,C,D.                    TRY AGAIN. >";G$: GOTO 10002
10010  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
      10035
10015  INPUT "OOPS!   MISTYPED RESPONSE.               SELECT A,B,C,D, OR
      (P FOR PICTURE)      THEN PRESS RETURN.
       TRY AGAIN.>";G$: RETURN
10035  LET R$(N) = G$
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 Q$
10180  POKE 49233,0
10185  POKE 49164,0
10189  HOME
10195  RETURN
```

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

```
3500  PRINT "                    #35"
3505  PRINT
3510  PRINT "SUGAR IS ADDED TO WATER AT A TEMPERATUREOF 85 DEGREES CELSIU
      S UNTIL NO MORE WILLDISSOLVE.  THE SUGAR AND WATER SOLUTION IS ALLOW
      ED TO COOL.?"
3512  PRINT "      WHICH OF THE FOLLOWING IS MOST     LIKELY TO OCCUR NEXT
      ?"
3515  PRINT
3520  PRINT "    A. MORE SUGAR WILL DISSOLVE IN THE          WATER WHEN THE
      WATER REACHES ROOM        TEMPERATURE."
3522  PRINT "    B. THE SUGAR WILL SLOWLY RISE TO THE        SURFACE OF THE
      LIQUID IN THE             CONTAINER. "
3523  PRINT "    C. CRYSTALS OF SUGAR WILL BEGIN TO          APPEAR AROUND
     THE SIDES OF THE           CONTAINER."
3524  PRINT "    D. THE SOLUTION WILL GRADUALLY              BECOME CLOUDY
     AS THE SUGAR REACTS        WITH THE WATER."
3525  PRINT
3530  INPUT ">";G$
3533  GOSUB 10000
3535  HOME
3550  PRINT "        BE SURE NOT TO PRESS                    ANY KEYS UNTI
      L THE                     PICTURE IS ON THE SCREEN."
3610  PRINT D$;"BLOAD NUMBER36,A$2000"
3615  CALL 768
3620  GOSUB 10151
3650  PRINT "                    #36"
3655  PRINT
3660  PRINT "USING THE PICTURE YOU JUST SAW, WHICH   SPRING BALANCE WILL
      SHOW THE GREATER    READING?"
3665  PRINT
3666  PRINT "    A. #1.                                   B. #2.
                          C. BOTH WILL SHOW THE SAME.              D. ON
      E CANNOT PREDICT WHICH WILL SHOW      THE GREATER READING."
3668  PRINT
3670  PRINT "      (TYPE THE LETTER 'P' AND RETURN              TO SEE THE
      PICTURE.)"
3675  INPUT ">";G$
3680  IF G$ = "P" THEN  PRINT "   PICTURE FOR PROBLEM #36 COMING UP.": GOTO
      3610
3685  GOSUB 10010
3686  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
      3690
3688  GOTO 3680
3690  HOME
3700  PRINT "                    #37"
3705  PRINT
3710  PRINT "WHEN A GUITAR STRING IS TIGHTENED THE   STRING MAKES A HIGHE
      R PITCHED SOUND     BECAUSE THE TIGHTER STRING VIBRATES....."
3715  PRINT
3720  PRINT "    A. SLOWER.                               B. FASTER.
                          C. CLOSER.                               D. FU
      RTHER."
3725  PRINT
3730  INPUT ">";G$
3733  GOSUB 10000
3735  HOME
3800  PRINT "                    #38"
3805  PRINT
3810  PRINT "IT IS POSSIBLE TO PASS WHITE LIGHT      THROUGH A PIECE OF G
      LASS CALLED A PRISM AND PRODUCE A SPECTRUM (A SHORT PIECE OFA RAINBO
      W).  WHAT DOES THE PRISM DO TO  THE LIGHT?"
3815  PRINT
3820  PRINT "    A. IT SUBTRACTS COLORS FROM THE LIGHT       PASSING THROUG
      H.                        B. IT ADDS COLORS TO THE LIGHT             PA
      SSING THROUGH."
3823  PRINT "    C. IT BREAKS IT UP INTO THE COLORS          FROM WHICH IT
      IS MADE.                  D. IT ABSORBS THE LIGHT FROM THE           SO
      URCE."
```

```
3825  PRINT
3830  INPUT ">";G$
3833  GOSUB 10000
3835  HOME
3900  PRINT "                    #39"
3905  PRINT
3910  PRINT "WHICH OF THE FOLLOWING WOULD BE THE MOSTIMPORTANT FACTOR IN
     IMPROVING THE SPEED OF A PAIR OF ROLLER SKATES?"
3915  PRINT
3920  PRINT "   A. MAKING THE WHEELS ROUNDER.          B. REDUCING FRICT
     ION BY BALL BEARINGS   C. DESIGNING BETTER-FITTING BOOTS.      D. PU
     TTING BIG TREADS ON THE WHEELS."
3925  PRINT
3930  INPUT ">";G$
3933  GOSUB 10000
4000  PRINT "                    #40"
4005  PRINT
4010  PRINT "WHEN A LIGHT BEAM PASSES THROUGH AIR ANDTHEN INTO WATER IN A
     N AQUARIUM, IT      BENDS.  WHAT IS THIS BENDING CALLED?"
4015  PRINT
4020  PRINT "   A. SPECTURM.                                B. REFRACTION.
                        C. REFLECTION.                              D. DI
     FFUSION."
4025  PRINT
4030  INPUT ">";G$
4033  GOSUB 10000
4035  HOME
4106  PRINT "                STOP HERE!                        REMOVE THE 1ST
     FLOPPY DISK              AND INSERT THE 2ND DISK. "
4107  PRINT "                                                        THEN PRE
     SS RETURN."
4108  INPUT Z$
4109  PRINT  CHR$ (4);"CHAIN PART4.5"
4295  HOME
9999  END
10000  REM  TAKE RESPONSE AND CHECK FOR MISMATCH
10002  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     10035
10005  INPUT "OOPS!   MISTYPED RESPONSE.              YOUR ONLY CHOICES A
     RE A,B,C,D.                TRY AGAIN.>";G$: GOTO 10002
10010  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     10035
10015  INPUT "OOPS!   MISTYPED RESPONSE.              SELECT A,B,C,D, OR
     (P FOR PICTURE).     THEN PRESS RETURN.                        T
     RY AGAIN. >";G$: RETURN
10035  LET R$(N) = G$
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 Q$
10180  POKE 49233,0
10185  POKE 49164,0
10189  HOME
10195  RETURN



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

```
99  HOME
4110  PRINT D$;"BLOAD NUMBER41,A$2000"
4115  CALL 768
4120  GOSUB 10151
4125  HOME
4150  PRINT "                    #41"
4155  PRINT
4160  PRINT "ONLY ONE OF THE CHOICES WAS A BOBBO,     WHICH ONE WAS IT?"
4165  PRINT
4170  PRINT "   A. A                                          B. B
                          C. C                                          D. D"
4175  PRINT
4177  PRINT "      (TYPE THE LETTER 'P' AND RETURN            TO SEE THE P
     ICTURE AGAIN.)"
4180  INPUT ">";G$
4183  PRINT
4185  IF G$ = "P" THEN  PRINT "       I'LL GO FIND SOME BOBBOS AGAIN.": GOT(
     4110
4190  GOSUB 10010
4191  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     4195
4192  GOTO 4185
4195  HOME
4200  PRINT "          PATIENCE IS A VIRTUE.                    (ANOTHER
     PICTURE.)"
4210  PRINT D$;"BLOAD NUMBER42,A$2000"
4215  CALL 768
4220  GOSUB 10151
4250  PRINT "                    #42"
4255  PRINT
4260  PRINT "HAVING VIEWED THE PREVIOUS CHART, WHICH SHAPE IS MISSING FRO
     M SPACE 1?"
4265  PRINT
4270  PRINT "   A. A                                          B. B
                          C. C                                          D. D"
4275  PRINT
4278  PRINT "      (TYPE THE LETTER 'P' AND RETURN            TO SEE THE
     CHART AGAIN.)"
4280  PRINT
4283  INPUT ">";G$
4285  IF G$ = "P" THEN  PRINT "          ONE CHART COMING UP.": GOTO 4210
4290  GOSUB 10010
4291  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     4295
4293  GOTO 4285
4295  HOME
4297  PRINT "       SETTING UP NEXT PICTURE."
4310  PRINT D$;"BLOAD NUMBER43,A$2000"
4315  CALL 768
4320  GOSUB 10151
4355  PRINT
4360  PRINT "IN THE PREVIOUS DIAGRAM, WHICH ONE       REPRESENTED A ROCK L
     OUSE?"
4365  PRINT
4370  PRINT "   A. A                                          B. B
                          C. C                                          D. D"
4372  PRINT
4373  PRINT "      (TYPE THE LETTER 'P' AND RETURN            TO SEE THE
     BUGS AGAIN.)"
4376  PRINT
4377  INPUT ">";G$
4380  PRINT
```

```
4385  IF G$ = "P" THEN  PRINT "      IN SEARCH OF A ROCK LOUSE.": GOTO 43
      10
4390  GOSUB 10010
4391  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "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 (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
      10035
10005  INPUT "OOPS!   MISTYPED RESPONSE.              YOUR CHOICES ARE ON
      LY A,B,C,D.                    TRY AGAIN. >";G$: GOTO 10002
10010  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
      10035
10014  PRINT
10015  INPUT "OOPS!   MISTYPED RESPONSE.              SELECT A,B,C,D, OR
      (P FOR PICTURE).     THEN PRESS RETURN.
       TRY AGAIN.>";G$: RETURN
10035  LET R$(N) = G$
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 Q$
10180  POKE 49233,0
10185  POKE 49164,0
10189  HOME
10195  RETURN
```

```
10 D$ =  CHR$ (4)
12  PRINT  CHR$ (4);"BLOAD DHIRES.MOVER"
99  HOME
4400  PRINT "                    #44"
4410  PRINT "THE FOLLOWING IS AN IDENTIFICATION KEY  FOR EIGHT STUDENTS I
     N A CLASS.  USE THISKEY, STEP BY STEP, TO FIND THE NAME OF  THE BLUE
     -EYED BLOND GIRL."
4414  PRINT
4415  PRINT "STEP 1. SEX-BOY      GO TO STEP 2                SEX-GIRL
      GO TO STEP 5       STEP 2.   EYES BLUE    GO TO STEP 3
       EYES BROWN   GO TO STEP 4"
4417  PRINT "STEP 3. HAIR BLOND   LESLIE                      HAIR DARK
      LYNN               STEP 4.   HAIR BLOND   NICKY
       HAIR DARK    BOBBY"
4419  PRINT "STEP 5. EYES BLUE    GO TO STEP 6                EYES BROWN
      GO TO STEP 7       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, BLONDGIRL?
       A. PAT        C. LESLIE                B. LEE        D. TERRY"
4430  INPUT ">";G$
4433  GOSUB 10000
4435  HOME
4490  PRINT "   THESE PICTURES ARE 'SLOWWW' GOOD."
4510  PRINT D$;"BLOAD NUMBER45,A$2000"
4515  CALL 768
4520  GOSUB 10151
4550  PRINT "                    #45"
```

```
4555  PRINT
4560  PRINT "ONLY ONE OF THE PREVIOUS CHOICES WAS A  LILY.  WHICH ONE WAS
      THE LILY?"
4565  PRINT
4570  PRINT "   A. A                                          B. B
                              C. C                                          D. D"

4575  PRINT
4580  PRINT "      (TYPE THE LETTER'P' AND RETURN              TO SEE THE L
     ILIES AGAIN.)"
4585  INPUT ">";G$
4587  PRINT
4588  IF G$ = "P" THEN  PRINT "          16 LILIES ON THE WAY.": GOTO 4510

4590  GOSUB 10010
4591  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     4595
4593  GOTO 4588
4595  HOME
4600  PRINT "        ORGANIZING A PICTURE."
4610  PRINT D$;"BLOAD NUMBER46,A$2000"
4615  CALL 768
4620  GOSUB 10151
4650  PRINT "                    #46"
4655  PRINT
4660  PRINT "FOR WHICH PART OF THE GRAPH IS IT TRUE  THAT MAKING THE LIGH
     T BRIGHTER HARDLY   CHANGES THE RATE OF MAKING SIMPLE SUGAR?"
4665  PRINT
4670  PRINT "   A. BETWEEN O AND U.                    B. BETWEEN V AND
     Y.                    C. BETWEEN W AND X.                    D. BE
     TWEEN U AND W."
4675  PRINT
4680  PRINT "      (TYPE THE LETTER 'P' AND RETURN           TO SEE THE DI
     AGRAM AGAIN.)"
4685  INPUT ">";G$
4687  IF G$ = "P" THEN  PRINT "  SO YOU WANT TO SEE THE GRAPH AGAIN?
                  O.K.": GOTO 4610
4690  GOSUB 10010
4691  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     4695
4693  GOTO 4687
4695  HOME
4700  PRINT "                    #47"
4705  PRINT
4710  PRINT "YOU MAY REFER BACK TO THE PREVIOUS GRAPHTO AID YOU IN ANSWER
     ING THIS QUESTION."
4715  PRINT
4717  PRINT "   ACCORDING TO THE GRAPH, PLANTS MAKE  THE MOST SIMPLE SUGA
     R WHEN THE LIGHT IS"
4719  PRINT
4720  PRINT "   A. VERY DIM.                                B. VERY BRIGHT.
                         C. NOT TOO BRIGHT AND NOT TOO DIM.      D. ST
     RONG AT ANY TIME OF DAY."
4725  PRINT
4728  PRINT "    (TYPE THE LETTER 'P' TO REVIEW           THE PICTURE OF
     THE GRAPH.)"
4729  INPUT ">";G$
4730  IF G$ = "P" THEN  PRINT "     RECALLING THE GRAPH.": GOTO 4740
4731  GOSUB 10010
4735  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     4795
4740  PRINT D$;"BLOAD NUMBER46,A$2000"
4745  CALL 768
4747  GOSUB 10151
4750  GOTO 4700
4795  HOME
```

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4800  PRINT "                    #48"
4805  PRINT
4810  PRINT "AGAIN, YOU WILL NEED TO REVIEW THE GRAPHIN ORDER TO ANSWER T
     HIS QUESTION."
4815  PRINT
4817  PRINT "AT WHICH BRIGHTNESS ARE THE PLANTS       MAKING THE GREATEST
     AMOUNT OF SIMPLE    SUGAR?"
4818  PRINT
4820  PRINT "    A. O                                          B. W
                          C. V                                          D. Z"
4825  PRINT
4830  PRINT "      (TYPE THE LETTER 'P' AND RETURN                TO REVIEW
     THE GRAPH.)"
4835  INPUT ">";G$
4836  IF G$ = "P" THEN  PRINT "            LOCATING GRAPH.": GOTO 4860
4837  GOSUB 10010
4838  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     4889
4840  GOTO 4836
4860  PRINT D$;"BLOAD NUMBER46,A$2000"
4865  CALL 768
4870  GOSUB 10151
4875  GOTO 4800
4889  HOME
4890  PRINT "  DON'T LET THIS NEXT PICTURE BUG YOU."
4910  PRINT D$;"BLOAD NUMBER49,A$2000"
4915  CALL 768
4920  GOSUB 10151
4950  PRINT "                    #49"
4955  PRINT
4960  PRINT "FROM THE PREVIOUS DISPLAY, WHICH ONE WASTHE INSECT?"
4965  PRINT
4967  PRINT "    A. A                                          B. B
                          C. C                                          D. D"
4968  PRINT
4970  PRINT "      (TYPE THE LETTER 'P' AND RETURN            TO SEE THE PI
     CTURE AGAIN.)"
4975  INPUT ">";G$
4980  IF G$ = "P" THEN  PRINT "         COLLECTING THE INSECTS.": GOTO 491
     0
4985  GOSUB 10010
4986  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     4990
4988  GOTO 4980
4990  HOME
4995  PRINT "   THIS NEXT DIAGRAM IS ROOMY."
5010  PRINT D$;"BLOAD NUMBER50,A$2000"
5015  CALL 768
5020  GOSUB 10151
5050  PRINT "                    #50"
5055  PRINT
5060  PRINT "WHICH OF THE ROOMS DID SHE ENTER?"
5065  PRINT
5070  PRINT "  A. A                                          B. B
                          C. C                                          D. D"
5075  PRINT
5080  PRINT "      (TYPE THE LETTER 'P' AND RETURN             TO SEE THE
     ROOMS AGAIN.)"
5083  INPUT ">";G$
5085  IF G$ = "P" THEN  PRINT "         REVISITING THE ROOMS.": GOTO 5010
5090  GOSUB 10010
5092  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     5095
5094  GOTO 5085
```

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5095  HOME
5150  PRINT "                    STOP HERE!                                    REMOVE THIS
      DISK AND                              INSERT THE 3RD ONE."
5153  PRINT
5155  PRINT "              THEN PRESS RETURN."
5160  INPUT ZS
5190  PRINT  CHR$ (4);"CHAIN PART6"
9999  END
10000  REM  TAKE RESPONSE AND CHECK FOR MISMATCH
10002  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
      10035
10005  INPUT "OOPS!   MISTYPED RESPONSE.                    YOUR ONLY CHOICES A
      RE A,B,C,D.                          TRY AGAIN. >";G$: GOTO 10002
10010  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
      10035
10015  INPUT "OOPS!   MISTYPED RESPONSE.                    SELECT A,B,C,D, OR
      (P FOR PICTURE .     THEN PRESS RETURN.
       TRY AGAIN.>";G$: RETURN
10035  LET R$(N) = G$
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 Q$
10180  POKE 49233,0
10185  POKE 49164,0
10189  HOME
10195  RETURN



10 D$ =  CHR$ (4)
12  PRINT  CHR$ (4);"BLOAD DHIRES.MOVER"
99  HOME
5100  PRINT "                    #51"
5105  PRINT
5110  PRINT "ALL OF THESE IS AN UNGULATE.                    DEER
                          BUFFALO
                                                                  GOAT
                                    COW"
5112  PRINT
5113  PRINT "NONE OF THESE IS AN UNGULATE.                    RACCOON
                          WOLF
    R                                                             TIGE
                                    RAT"
5115  PRINT
5120  PRINT "   WHICH ONE OF THE FOLLOWING IS AN     UNGULATE?
                          A. DOG
    AR                                                        B. BE
                                    C. SHEEP
        D. BEAVER"
5125  PRINT
5130  INPUT ">";G$
5133  GOSUB 10000
5135  HOME
5140  PRINT "                  ONE MOMENT."
5210  PRINT D$;"BLOAD NUMBER52,A$2000"
5215  CALL 768
5220  GOSUB 10151
5250  PRINT "                    #52"
5255  PRINT
5260  PRINT "ACCORDING TO JIM'S DESCRIPTION, WHICH ISTHE CORRECT DIAGRAM?
"
5265  PRINT
5270  PRINT "   A. A
                                                          B. B
                          C. C
                                                                  D. D"
```

```
5275  PRINT
5280  PRINT "      (TYPE THE LETTER 'P' AND RETURN              TO REVIEW TH
     E PICTURE.)"
5283  INPUT ">";G$
5285  IF G$ = "P" THEN  PRINT "           ONE MOMENT.": GOTO 5210
5290  GOSUB 10010
5292  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     5295
5294  GOTO 5285
5295  HOME
5299  PRINT "            ONE MOMENT, PLEASE."
5310  PRINT D$;"BLOAD NUMBER53,A$2000"
5315  CALL 768
5320  GOSUB 10151
5350  PRINT "                    #53"
5355  PRINT
5360  PRINT "ONLY ONE OF THE CHOICES REPRESENTED A   HEWT.  WHICH ONE WAS
     A HEWT."
5365  PRINT
5370  PRINT "  A. A                                          B. B
                          C  C                                        D. D"
5371  PRINT
5373  PRINT "      (TYPE THE LETTER 'P' AND RETURN               TO SEE TH
     E DIAGRAM.)"
5375  INPUT ">";G$
5380  IF G$ = "P" THEN  PRINT "         HUNTING FOR HEWTS.": GOTO 5310
5385  GOSUB 10010
5386  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     5390
5388  GOTO 5380
5390  HOME
5394  PRINT "          ONE MOMENT, PLEASE"
5400  PRINT D$;"BLOAD NUMBER54,A$2000"
5402  CALL 768
5404  GOSUB 10151
5408  PRINT "                    #54"
5410  PRINT
5412  PRINT "   USE THE PREVIOUS PICTURE AND FOLLOW  THE STEPS TO FIND OU
     T THE NAME OF        CREATURE F."
5413  PRINT
5415  PRINT
5417  PRINT "CREATURE F IS A ..."
5419  PRINT
5420  PRINT "   A. THREAD-WAISTED WASP.                  B. CRANEFLY.
                          C. LEAF BUG.                              D. BR
     ISTLETAIL."
5425  PRINT
5430  PRINT "      (TYPE THE LETTER 'P' AND RETURN              TO REVIEW TH
     E PICTURE.)"
5435  INPUT ">";G$
5440  IF G$ = "P" THEN  PRINT "      IDENTIFING SIX UNKNOWN ANIMALS.": GOTO
     5400
5443  GOSUB 10010
5444  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     5447
5445  GOTO 5440
5447  HOME
5448  PRINT "     ORGANIZING MORE QUESTIONS."
5450  PRINT  CHR$ (4);"CHAIN PART7"
9999  END
10000  REM  TAKE RESPONSE AND CHECK FOR MISMATCH
10002  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     10035
10005  INPUT "OOPS!   MISTYPED RESPONSE.              YOUR ONLY CHOICES A
     RE A,B,C,D.                    TRY AGAIN. >";G$: GOTO 10002
```

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10010  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     10035
10015  INPUT "OOPS!   MISTYPED RESPONSE.                    SELECT A,B,C,D, OR
     (P FOR PICTURE).      THEN PRESS RETURN.
      TRY AGAIN.>";G$: RETURN
10025  HOME
10035  LET R$(N) = G$
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 Q$
10180  POKE 49233,0
10185  POKE 49164,0
10189  HOME
10195  RETURN



10 D$ =  CHR$ (4)
12  PRINT  CHR$ (4);"BLOAD DAIRES.MOVER"
99  HOME
5510  PRINT D$;"BLOAD NUMBER55,A$2000"
5515  CALL 768
5520  GOSUB 10151
5550  PRINT "                        #55"
5555  PRINT
5560  PRINT "JIM SAID, 'THE RAILWAY IS BEHIND ME AND ON JOHN'S RIGHT'.  U
     SE THE PREVIOUS      PICTURE TO ANSWER WHERE WAS THE TREE?"
5565  PRINT
5570  PRINT "    A. BEHIND JOHN.                                  B. BEHIND JIM.
                        C. IN FRONT OF JOHN.                              D. ON
     JIM'S RIGHT."
5575  PRINT
5577  PRINT "      (TYPE THE LETTER 'P' AND RETURN              TO VIEW THE S
     CENE AGAIN.)"
5580  INPUT ">";G$
5583  IF G$ = "P" THEN  PRINT "                    LOCATING PICTURE.": GOTO 5510
5584  GOSUB 10010
5585  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     5590
5587  GOTO 5583
5590  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 E
     FFECT ON THE GROWTH OF BREAD MOLD.  SHE GREW THE MOLD IN    NINE CON
     TAINERS, EACH WITH THE SAME      AMOUNT AND TYPE OF NUTRIENTS."
5611  PRINT
5612  PRINT "    THREE CONTAINERS WERE KEPT AT                  0 DEGREES CELS
     IUS."
5613  PRINT "    THREE CONTAINERS WERE KEPT AT ROOM             TEMPERATURE (A
     BOUT 21 DEGREES C.)"
5614  PRINT "    THREE CONTAINERS WERE KEPT AT                  90 DEGREES CEL
     SIUS."
5615  PRINT
5617  PRINT "THE CONTAINERS WERE EXAMINED AT THE END OF FOUR DAYS."
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5618  PRINT
5620  PRINT "       (PRESS RETURN TO VIEW                    THE QUESTIO
      N.)"
5622  INPUT QS
5623  HOME
5625  IF SMALLC = 56 THEN  GOTO 5650
5627  IF SMALLC = 57 THEN  GOTO 5700
5629  IF SMALLC = 58 THEN  GOTO 5800
5650  PRINT "                    #56"
5655  PRINT
5660  PRINT "HAVING JUST READ THE INFORMATION, WHAT  IS THE FACTOR WHICH
      SARAH WILL LOOK FOR?"
5665  PRINT
5670  PRINT "   A. CHANGES IN THE AMOUNT OF NUTRIENTS       IN EACH CONTAI
      NER.                  B. THE AMOUNT OF GROWTH OF THE BREAD       MO
      LD."
5673  PRINT "   C. NUMBERS OF CONTAINERS AT EACH            TEMPERATURE.
                            D. DIFFERENCES IN THE TEMPERATURE OF       TH
      E CONTAINERS."
5675  PRINT
5678  PRINT "     (TYPE THE LETTER 'P' AND RETURN          TO SEE THE INF
      ORMATION AGAIN.)"
5680  INPUT ">";G$
5685  IF G$ = "P" THEN  GOTO 5605
5690  GOSUB 10010
5691  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
      5700
5692  GOTO 5685
5695  HOME
5700  HOME
5701  PRINT "                    #57"
5703  LET SMALLC = 57
5705  PRINT
5710  PRINT "WHAT DID SARAH MAKE DIFFERENT BETWEEN   HER CONTAINERS."
5715  PRINT
5720  PRINT "   A. THE NUMBER OF CONTINERS AT EACH          TEMPERATURE.
                            B. THE AMOUNT OF NUTRIENTS IN EACH         CO
      NTAINER."
5722  PRINT "   C. THE GROWTH OF THE BREAD MOLD IN          THE CONTAINERS
      .                     D. THE TEMPERATURE OF THE CONTAINERS."
5725  PRINT
5728  PRINT "     (TYPE THE LETTER 'P' AND RETURN          TO REVIEW THE
      INFORMATION.)"
5730  INPUT ">";G$
5734  IF G$ = "P" THEN  GOTO 5605
5740  GOSUB 10010
5742  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
      5745
5743  GOTO 5734
5745  HOME
5800  PRINT "                    #58"
5802  LET SMALLC = 58
5805  PRINT
5810  PRINT "WHICH IS THE MOST IMPORTANT REASON SARAHUSED THREE CONTAINER
      S AT EACH           TEMPERATURE?"
5815  PRINT
5820  PRINT "   A. SHE PUT DIFFERENT KINDS OF                NUTRIENT IN
      EACH CONTAINER.       B. SHE KNEW THAT AVERAGES ARE THE
      BEST DATA IN GROWTH EXPERIMENTS"
5822  PRINT "   C. SHE WAS AFRAID SOME CONTAINERS            MIGHT BREAK
      .                     D. SHE HAD NO GOOD REASON FOR DOING
      THIS."
5825  PRINT
5830  PRINT "     (TYPE THE LETTER 'P' AND RETURN          TO CHECK THE
      INFORMATION.)"
5835  INPUT ">";G$
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5840  IF G$ = "P" THEN  GOTO 5900
5845  GOSUB 10010
5846  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
      5850
5848  GOTO 5840
5850  HOME
5860  PRINT "                    ONE MOMENT."
5910  PRINT D$;"BLOAD NUMBER59,A$2000"
5915  CALL 768
5920  GOSUB 10151
5950  PRINT "                         #59"
5955  PRINT
5960  PRINT "FORM THE PRIOR DIAGRAM, WHAT IS THE BESTESTIMATE FOR THE TOT
      AL NUMBER OF ANTS ONONE SQUARE METRE?"
5965  PRINT
5970  PRINT "    A. 400                                          B. 500
                           C. 700                                          D. NO
      NE OF THE ABOVE."
5975  PRINT
5980  PRINT "      (TYPE THE LETTER 'P' AND RETURN              TO SEE THE D
      IAGRAM AGAIN.)"
5985  INPUT ">";G$
5988  IF G$ = "P" THEN  PRINT "      RETRIEVING SQUARE METRE OF ANTS.": GOTO
      5910
5990  GOSUB 10010
5992  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
      5995
5995  HOME
6000  PRINT "                         #60"
6005  PRINT
6010  PRINT "WHICH OF THE FOLLOWING PROBLEMS WOULD BEEASIEST TO ANSWER FR
      OM A SINGLE          EXPERIMENT?"
6015  PRINT
6020  PRINT "    A. DO LIGHT AND SALT IN THE WATER             AFFECT THE G
      ROWTH OF PLANTS?        B. WHICH FACTORS AFFECT THE GROWTH
      OF PLANTS?"
6022  PRINT "    C. DO LIGHT AND NO WATER AFFECT THE           SPROUTING OF
       PLANT SEEDLINGS?       D. DOES LIGHT AFFECT THE GROWTH OF
      BEAN SEEDLINGS?"
6030  INPUT ">";G$
6033  GOSUB 10000
6035  HOME
6050  PRINT "                STOP HERE!                                INSERT D
      ISK #4.
        THEN PRESS RETURN."
6055  INPUT Z$
6090  PRINT  CHR$ (4);"CHAIN PART8"
9999  END
10000  REM  TAKE RESPONSE AND CHECK FOR MISMATCH
10002  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
      10035
10005  INPUT "OOPS!   MISTYPED RESPONSE.              YOUR ONLY CHOICES A
      RE A,B,C,D.                    TRY AGAIN. >";G$: GOTO 10002
10010  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
      10035
10015  INPUT "OOPS!   MISTYPED RESPONSE.              SELECT A,B,C,D, OR
      (P FOR PICTURE).      THEN PRESS RETURN.
       TRY AGAIN.>";G$: RETURN
10035  LET R$(N) = G$
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
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10175  INPUT Q$
10180  POKE 49233,0
10185  POKE 49164,0
10189  HOME
10195  RETURN



10 D$ =  CHR$ (4)
12  PRINT  CHR$ (4);"BLOAD DHIRES.MOVER"
99  HOME
6010  PRINT D$;"BLOAD NUMBER61,A$2000"
6015  CALL 768
6020  GOSUB 10151
6050  PRINT "                    #61"
6055  PRINT
6060  PRINT "USING THE PREVIOUS PICTURE, WHAT        OBSERVATION DID YOU
     MAKE?"
6065  PRINT
6070  PRINT "   A. A PERSON IS HOLDING POWDER FORM           THE BOX IN T
     HE SPOON.              B. A PERSON IS STIRRING BAKING SODA
     INTO WATER."
6073  PRINT "   C. A PERSON IS TAKING SOMETHING FROM         THE MEASURIN
     G CUP ON THE TABLE.    D. A PERSON IS HOLDING A SPOON WITH
     SOMETHING IN THE SPOON."
6075  PRINT
6078  PRINT "     (TYPE THE LETTER 'P' AND RETURN           TO SEE THE PI
     CTURE AGAIN.)"
6080  INPUT ">";G$
6083  IF G$ = "P" THEN  PRINT "         I'M HURRING - SORT OF.": GOTO 6010

6087  GOSUB 10010
6088  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     6095
6090  GOTO 6083
6095  HOME
6200  PRINT "                    #62"
6205  PRINT
6210  PRINT "   MOLLY SUSPECTED THAT 'VEGETABLES     CONTAIN WATER'.  IN
     ORDER TO TEST THIS  IDEA SHE DECIDED TO TEST FIVE DIFFERENT VEGETABL
     ES: 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 TU
     BE WITH MEAT IN IT."
6222  PRINT "   C. HEAT AN EMPTY TEST TUBE.             D. HEAT A TEST TU
     BE WITH CEREAL IN         IT."
6230  INPUT ">";G$
6233  GOSUB 10000
6235  HOME
6300  PRINT "                     #63"
6305  PRINT
6307  PRINT "   THE TREELINE IS THE HIGHEST ALTITUDE AT WHICH TREES CAN G
     ROW.  THE FOLLOWING TABLE RELATES TREELINE TO DISTANCE FROM THE EQUA
     TOR."
6309  PRINT
6310  PRINT "     DISTANCE FROM                                  EQUATOR
           TREELINE
6313  PRINT "        1000 KM              4000 M                 2500 KM
           3500 M"
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6314  PRINT "          5000 KM                3000 M                  6500 KM
          1500 M"
6317  PRINT
6320  PRINT "   ACCORDING TO THE TABLE ABOVE, THE     FARTHER YOU ARE FROM
      THE EQUATOR"
6325  PRINT
6327  PRINT "   A. THE HIGHER THE TREELINE.                B. THE LOWER THE
     TREELINE.              C. THE TALLER THE TREES.                  D. TH
     E SMALLER THE TREES."
6330  INPUT ">";G$
6333  GOSUB 10000
6335  HOME
6345  PRINT "                ONE MOMENT."
6410  PRINT D$;"BLOAD NUMBER64,A$2000"
6415  CALL 768
6420  GOSUB 10151
6450  PRINT "                      #64"
6455  PRINT
6460  PRINT "   EACH PLANNED TO TAKE A MEASUREMENT   EVERY DAY FOR FIVE D
     AYS.  HOWEVER, ON   THE THIRD DAY THE SCHOOL WAS CLOSED."
6461  PRINT
6462  PRINT "   WHICH GRAPH GAVE THE POOREST ESTIMATEFOR THE THIRD DAY?"
6470  PRINT
6472  PRINT "   A. A                                          B. B
                          C. C                                        D. D"
6475  PRINT
6477  PRINT "     (TYPE THE LETTER 'P' AND RETURN          TO REVIEW THE
     PICTURE AGAIN.)"
6480  INPUT ">";G$
6485  IF G$ = "P" THEN  PRINT "         FOUR GRAPHS ON THE WAY.": GOTO 641
     0
6490  GOSUB 10010
6492  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     6495
6494  GOTO 6485
6495  HOME
6499  PRINT "          ANOTHER GRAPH QUESTION."
6510  PRINT D$;"BLOAD NUMBER65,A$2000"
6515  CALL 768
6520  GOSUB 10151
6550  PRINT "                      #65"
6555  PRINT
6560  PRINT "   IN THE EXPERIMENT, WHAT WAS THE THE  FACTOR WHICH THE EXP
     ERIMENTER WISHED TO OBSERVE?"
6565  PRINT
6570  PRINT "   A. WHICH TYPE OF ACTIVITY PRODUCES         120 HEARTBEATS
     PER MINUTE.          B. THE TYPE OF ACTIVITY."
6573  PRINT "   C. IF WALKING IS GOOD FOR A PERSON.     D. THE NUMBER OF
     HEARTBEATS PER            MINUTE."
6575  PRINT
6578  PRINT "     (TYPE THE LETTER 'P' ;AND RETURN          TO SEE THE P
     ICTURE AGAIN.)"
6582  INPUT ">";G$
6585  IF G$ = "P" THEN  PRINT "     BRINGING BACK HEARTBEAT EXPERIMENT.":
     GOTO 6510
6590  GOSUB 10010
6592  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
    6594
6593  GOTO 6585
6594  HOME
6595  PRINT "          THE SAME GRAPH BUT,                  A DIFFERENT
     QUESTION."
6596  PRINT D$;"BLOAD NUMBER66,A$2000"
6597  CALL 768
6598  GOSUB 10151
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6600  PRINT "                    #66"
6605  PRINT
6610  PRINT "    WHAT FACTOR WAS CHANGED IN ORDER TO  GET THE DATA?"
6615  PRINT
6620  PRINT "    A. THE NUMBER OF HEARTBEATS PER            MINUTE.
                          B. THE TYPE OF ACTIVITY."
6623  PRINT "    C. THE SPEED AT WHICH PEOPLE WALK.       D. HOW FAST PEOPL
     E SWIM."
6625  PRINT
6627  PRINT "      (TYPE THE LETTER 'P' AND RETURN              TO SEE THE
     PICTURE.)"
6630  INPUT ">";G$
6632  IF G$ = "P" THEN  PRINT "              O.K.": GOTO 6596
6640  GOSUB 10010
6642  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     6650
6644  GOTO 6632
6650  HOME
6690  PRINT "ANOTHER QUESTION USING THE SAME GRAPH."
6695  PRINT D$;"BLOAD NUMBER67,A$2000"
6696  CALL 768
6697  GOSUB 10151
6700  PRINT "                    #67"
6705  PRINT
6710  PRINT "    WHAT HYPOTHESIS WAS THE EXPERIMENTER LIKELY TESTING?"
6715  PRINT
6720  PRINT "    A. TYPE OF ACTIVITY AFFECTS HEARTBEAT          RATE.
                          B. THE FASTER A PERSON MOVES FROM
     PLACE TO PLACE, THE FASTER HIS          HEART BEATS."
6723  PRINT "    C. ACTIVITY IMPROVES A PERSON'S                HEALTH.
                          D. IF YOU CHANGE THE HEARTBEAT RATE
     YOU MAKE PEOPLE CHANGE THEIR            ACTIVITY."
6725  PRINT
6730  PRINT "      (TYPE THE LETTER 'P' AND RETURN               TO REVIEW
     THE GRAPH.)"
6735  INPUT ">";G$
6740  IF G$ = "P" THEN  PRINT "             O.K. AGAIN.": GOTO 6695
6745  GOSUB 10010
6746  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     6749
6748  GOTO 6740
6749  HOME
6760  PRINT "      PULLING TOGETHER MORE QUESTIONS."
6790  PRINT  CHR$ (4);"CHAIN PART9"
9999  END
10000  REM  TAKE RESPONSE AND CHECK FOR MISMATCH
10002  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     10035
10005  INPUT "OOPS!   MISTYPED RESPONSE.              YOUR ONLY CHOICES A
     RE A,B,C,D.                TRY AGAIN. >";G$: GOTO 10002
10010  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     10035
10015  INPUT "OOPS!   MISTYPED RESPONSE.              SELECT A,B,C,D, OR
     (P FOR PICTURE).     THEN PRESS RETURN.
      TRY AGAIN.>";G$: RETURN
10020  PRINT "DID YOU KNOW THAT YOU TYPED'";G$;"'?"
10021  PRINT "YOUR CHOICES ARE A,B,C, OR D.  (ALSO,THE'CAPS LOCK' KEY MUS
     T BE DOWN.)"
10024  INPUT "           TRY AGAIN >";G$
10025  HOME
10030  GOTO 10002
10035  LET R$(N) = G$
10038  LET N = N + 1
10040  RETURN
10150  REM  BRING UP DIAGRAM
10151  POKE 49153,0
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10155  POKE 49239,0
10160  POKE 49237,0
10165  POKE 49232,0
10175  INPUT Q$
10180  POKE 49233,0
10185  POKE 49164,0
10189  HOME
10195  RETURN



10 D$ =  CHR$ (4)
12  PRINT  CHR$ (4);"BLOAD DHIRES.MOVER"
99  HOME
6800  PRINT "  THE FOLLOWING INFORMATION WILL BE      REPEATED FOR QUESTIO
     NS 68, 69, AND 70."
6803  LET SMALLC = 68
6805  PRINT
6810  PRINT "   SUE WANTED TO FIND OUT WHAT MIGHT     AFFECT THE LENGTH OF
      BEAN SEEDLINGS."
6812  PRINT "SHE PLACED A BEAN WRAPPED IN MOIST       TISSUE PAPER IN EACH
      OF TEN IDENTICAL   TEST TUBES.  SHE PUT FIVE TEST TUBES IN A RACK I
     N A SUNNY WINDOW."
6814  PRINT "SHE PUT FIVE TEST TUBES IN A RACK IN A  DARK REFRIGERATOR."
6818  PRINT "   SHE MEASURED THE LENGTH OF BEAN       SEEDLINGS IN EACH GR
     OUP AFTER ONE WEEK."
6820  IF SMALLC = 68 GOTO 6825
6821  IF SMALLC = 69 GOTO 6900
6822  IF SMALLC = 70 GOTO 7000
6825  PRINT
6827  PRINT " --------------- #68 -----------------"
6828  PRINT "     WHICH OF THE FOLLOWING FACTORS DID SUE TEST FOR THEIR E
     FFECT ON THE LENGTH OF THE BEAN SEEDLINGS?"
6829  PRINT
6830  PRINT "   A. MOISTURE AND LENGTH OF TEST TUBE.     B. LIGHT AND TEMP
     ERATURE."
6833  PRINT "   C. LIGHT AND AMOUNT OF TIME.             D. TEMPERATURE AN
     D MOISTURE."
6845  INPUT ">";G$
6850  GOSUB 10000
6855  HOME
6860  LET SMALLC = 69
6870  GOTO 6810
6900  PRINT
6901  PRINT " ---------------- #69 ----------------"
6910  PRINT "   WHAT WAS THE MOST IMPORTANT REASON   SUE USED FIVE TEST T
     UBES AT EACH         TEMPERATURE?"
6920  PRINT "   A. SHE WISHED TO TEST FIVE DIFFERENT        CONDITIONS."
6922  PRINT "   B. AVERAGES PROVIDE BETTER DATA IN          GROWTH EXPERIM
     ENTS."
6924  PRINT "   C. SHE WAS AFRAID SHE MIGHT BREAK           SOME TEST TUBE
     S."
6926  PRINT "   D. SHE HAD NO GOOD REASON FOR DOING         THIS."
6940  INPUT ">";G$
6950  GOSUB 10000
6960  LET SMALLC = 70
6965  HOME
6970  GOTO 6810
7000  PRINT " ---------------- #70 ----------------"
7010  PRINT "SUE FOUND THAT THE SEEDLINGS GREW BETTERIN THE RACK ON THE S
     UNNY WINDOW.  WHY   MIGHT MICHAEL CRITICIZE HER EXPERIMENT?"
7020  PRINT "  A. THERE IS NO REASON TO CRITICIZE HER     EXPERIMENT."
7022  PRINT "  B. SHE SHOULD HAVE PUT DIFFERENT           AMOUNTS OF WATE
     R IN THE TEST TUBES"
7024  PRINT "  C. SHE CANNOT TELL IF THE BETTER           GROWTH IS A RES
     ULT OF TEMPERATURE       OR OF LIGHT OR OF BOTH."
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7026  PRINT "  D. SHE DID NOT NEED TO USE SO MANY          TEST TUBES."
7028  INPUT ">";G$
7035  GOSUB 10000
7040  HOME
7050  PRINT "               ONE MOMENT."
7110  PRINT D$;"BLOAD NUMBER71,A$2000"
7115  CALL 768
7120  GOSUB 10151
7150  PRINT "                    #71"
7155  PRINT
7160  PRINT "THE PREVIOUS GRAPH SHOWED THAT"
7165  PRINT
7170  PRINT "   A. THE BEETLE WAS LOOKING FOR FOOD.      B. THE BEETLE CHA
      NGES DIRECTION EVERY       HALF MINUTE."
7173  PRINT "   C. THE BEETLE WAS TRYING TO CLIMB THE       WALL.
                         D. THE BEETLE'S MOVEMENTS WERE NOT          ST
      EADY."
7175  PRINT
7180  PRINT "     (TYPE THE LETTTER 'P' AND RETURN          TO SEE THE PI
      CTURE AGAIN.)"
7182  INPUT ">";G$
7185  IF G$ = "P" THEN  PRINT "       RECALLING BEETLE GRAPH.": GOTO 7110

7190  GOSUB 10010
7192  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
      7195
7194  GOTO 7185
7195  HOME
7200  PRINT "                    #72"
7205  PRINT
7210  PRINT "WHEN WE SAY THAT A SCIENTIST HAS FORMED A HYPOTHESIS ABOUT A
      N EXPERIMENT WE MEANTHAT HE HAS"
7215  PRINT
7220  PRINT "   A. DESIGNED EQUIPMENT NEEDED FOR THE          EXERIMENT."
7221  PRINT "   B. INDICATED WHICH MEASUREMENTS WILL          BE MADE AND
      HOW THEY SHOULD BE          CARRIED OUT."
7223  PRINT "   C. DESCRIBED HOW THE EXPERIMENT MIGHT         TURN OUT BY
      STATING HOW ONE             FACTOR MIGHT AFFECT ANOTHER."
7224  PRINT "   D. OBSERVED ALL THE THINGS THAT               HAPPENED DUR
      ING THE EXPERIMENT?"
7225  PRINT
7230  INPUT ">";G$
7233  GOSUB 10000
7240  HOME
7295  PRINT
7296  PRINT
7300  PRINT "                    #73"
7305  PRINT
7310  PRINT "WHEN ACTING LIKE A SCIENTIST, IT WOULD  NOT BE RIGHT TO"
7315  PRINT
7320  PRINT "   A. DO SOMEONE ELSE'S EXPERIMENT             AGAIN.
                         B. LET YOUR FEELINGS AFFECT THE             RE
      SULTS."
7323  PRINT "   C. ANNOUNCE RESULTS DIFFENENT FROM          THOSE IN YOUR
      TEXTBOOK.              D. TAKE A GREAT MANY MEASUREMENTS."
7325  PRINT
7330  INPUT ">";G$
7333  GOSUB 10000
7335  HOME
7400  PRINT "                    #74"
7405  PRINT
7410  PRINT "WHICH OF THE FOLLOWING IS A THEORY      RATHER THAN AN OBSER
      VATION?"
7415  PRINT
7420  PRINT "   A. THE CENTER OF THE EARTH IS                LIQUID."
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7421  PRINT      B. THE AVERAGE TEMPERATURE OF THE                SOUTH POLE I
     S LOWER THAN THE              AVERAGE TEMPERATURE AT THE
     TROPIC OF CAPRICORN."
7422  PRINT "    C. A SHIP CAN START FROM A POINT,                SAIL AROUND
     THE EARTH, AND                RETURN TO THE SAME POINT."
7424  PRINT "    D. THE TEMPERATURE AT THE BOTTOM OF A          VERY DEEP WE
     LL IS HIGHER THAN             THE TEMPERATURE AT THE SURFACE."
7425  PRINT
7430  INPUT ">";G$
7433  GOSUB 10000
7440  HOME
7450  PRINT "          ORGANIZING QUESTIONS."
7490  PRINT  CHR$ (4);"CHAIN PART10"
9999  END
10000  REM  TAKE RESPONSE AND CHECK FOR MISMATCH
10002  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     10035
10005  INPUT "OOPS!    MISTYPED RESPONSE.                YOUR ONLY CHOICES A
     RE A,B,C,D.                    TRY AGAIN. >";G$: GOTO 10002
10010  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     10035
10015  INPUT "OOPS!   MISTYPED RESPONSE.                SELECT A,B,C,D, OR
     (P FOR PICTURE).      THEN PRESS RETURN.
      TRY AGAIN.>";G$: RETURN
10035  LET R$(N) = G$
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 Q$
10180  POKE 49233,0
10185  POKE 49164,0
10189  HOME
10195  RETURN
```

```
10 D$ =  CHR$ (4)
12  PRINT  CHR$ (4);"BLOAD DHIRES.MOVER"
99  HOME
7500  PRINT "                    #75"
7505  PRINT
7510  PRINT "  YOU ARE DOING AN INVESTIGATION INTO   THE BOILING TEMPERAT
     URE OF CORN SYRUP   AND FOUND THAT IT BOILED AT 130 DEGREES CELSIUS.
       YOU READ IN YOUR SCIENCE TEXT,HOWEVER, THAT CORN SYRUP BOILS AT 12
     5   DEGREES CELSIUS."
7512  PRINT
7513  PRINT "  WHEN YOU REPORT YOUR RESULTS TO THE   CLASS IN FRONT OF YO
     UR TEACHER YOU      SHOULD"
7515  PRINT
7520  PRINT "    A. ASSUME YOUR THERMOMETER WAS WRONG        AND REPORT 125
      DEGREES CELSIUS          AS YOUR FINDING."
7521  PRINT "    B. REPORT YOUR 130 DEGREES CELSIUS          RESULTS REGARD
     LESS OF WHAT PEOPLE       MIGHT THINK."
7523  PRINT "    C. REPORT ONLY THE 125 DEGREES C.           SINCE THAT IS
     WHAT IT SHOULD BE."
7524  PRINT "    D. REPORT THAT YOU MADE AN ERROR AND        WILL REDO THE
     INVESTIGATION."
7530  INPUT ">";G$
7533  GOSUB 10000
7540  HOME
7600  PRINT "                    #76"
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7605  PRINT
7610  PRINT "THREE OF THE FOLLOWING ARE STATEMENTS OFFACT.  WHICH STATEME
      NT IS A HYPOTHESIS?"
7615  PRINT
7620  PRINT "    A. THE RINGS OF SATURN WERE FORMED          FROM A MOON TH
      AT EXPLODED."
7621  PRINT "    B. THE BOILING POINT OF WATER IS            100 DEGREES C.
      "
7623  PRINT "    C. HYDROGEN WAS FIRST PREPARED BY           CAVENDISH IN 1
      766."
7624  PRINT "    D. A LITRE OF WATER HAS A MASS OF           1 KILOGRAM."
7625  PRINT
7630  INPUT ">";G$
7633  GOSUB 10000
7640  HOME
7700  PRINT "                    #77"
7705  PRINT
7710  PRINT "SCIENTISTS OF TODAY CAN WORK ON MORE    COMPLEX PROBLEMS THA
      N THE SCIENTISTS OF THE PAST BECAUSE THEY"
7715  PRINT
7720  PRINT "    A. ARE MORE INTELLIGENT THAN EARLIER       SCIENTISTS.
                         B. WORK MUCH HARDER THAN EARLIER          SC
      IENTISTS."
7723  PRINT "    C. HAVE MORE IMAGINATION THAN EARLIER      SCIENTISTS.
                         D. BUILD ON THE WORK OF EARLIER           SC
      IENTISTS."
7725  PRINT
7730  INPUT ">";G$
7733  GOSUB 10000
7740  HOME
7800  PRINT "                    #78"
7805  PRINT
7810  PRINT "IN SUMMER, JOHN NOTICED THAT THE AIR IN HIS TIRES BECAME HOT
      TER WHEN HIS CAR WASDRIVEN OVER A LONG DISTANCE."
7815  PRINT
7818  PRINT "    THE STATEMENT ABOVE IS AN EXAMPLE OF"
7819  PRINT
7820  PRINT "    A. A THEORY.                                B. A PRINCIPLE.
                         C. AN OBSERVATION.                        D. A
      LAW."
7823  PRINT
7830  INPUT ">";G$
7833  GOSUB 10000
7840  HOME
7900  PRINT "                    #79"
7905  PRINT
7910  PRINT "MOST THINGS FALL IF THEY ARE NOT HELD UP(LAW OF GRAVITY) BUT
      HELIUM-FILLED      BALLOONS RISE."
7915  PRINT
7918  PRINT "    SCIENTISTS SEEK TO EXPLAIN THIS BY "
7919  PRINT
7920  PRINT "    A. REJECTING THE LAW OF GRAVITY             BECAUSE IT D
      OES NOT SEEM TO WORK        FOR HELIUM BALLOONS."
7921  PRINT "    B. FORGETTING IT BECAUSE THE WORLD IS       UNEXPLAINABL
      E ANYWAY."
7923  PRINT "    C. ASSUMING THAT HELIUM BALLOONS ARE        AN EXCEPTION
      TO THE LAW OF               GRAVITY."
7924  PRINT "    D. LOOKING FOR A SECOND FACTOR              BESIDES GRAV
      ITY ACTING ON HELIUM        BALLOONS."
7925  PRINT
7930  INPUT ">";G$
7933  GOSUB 10000
7940  HOME
8000  PRINT "                    #80"
8005  PRINT
8010  PRINT "WHEN WE SAY THAT A SCIENTIST FORMS A    HYPOTHESIS ABOUT AN
      EXPERIMENT WE MEAN  THAT THE SCIENTIST"
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8015  PRINT
8020  PRINT "    A. DESCRIBES HOW THE EXPERIMENT WAS          CARRIED OUT.
                          B. SUGGESTS HOW TO MAKE EXACT.                 ME
     ASUREMENTS."
8023  PRINT "    C. GIVES DIRECTIONS FOR DOING THE            EXPERIMENTS PR
     OPERLY.                D. MAKES A CAREFUL GUESS ABOUT WHAT          WI
     LL HAPPEN."
8025  PRINT
8030  INPUT ">";G$
8033  GOSUB 10000
8595  HOME
8600  INPUT "PLEASE TYPE YOUR LAST NAME.";LAST$
8603  PRINT
8605  INPUT "NOW YOUR FIRST NAME.";FR$
8610  PRINT
8615  INPUT "WHAT IS TODAY'S DATE?";DAY$
8625  HOME
8650  PRINT "             CALCULATING RESULTS."
8655  PRINT
8660  PRINT "    PLEASE INFORM THE INSTRUCTOR THAT                    YOU AR
     E DONE.
            THANK YOU."
8700  PRINT  CHR$ (4);"CHAIN OWARIMASHIO"
9999  END
10000  REM  TAKE RESPONSE AND CHECK FOR MISMATCH
10002  IF (G$ = "A") OR (G$ = "B") OR (G$ = "C") OR (G$ = "D") THEN  GOTO
     10035
10005  INPUT "OOPS!    MISTYPED RESPONSE.              YOUR ONLY CHOICES A
     RE A,B,C,D.                          TRY AGAIN. >";G$: GOTO 10002
10035  LET R$(N) = G$
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 Q$
10180  POKE 49233,0
10185  POKE 49164,0
10189  HOME
10195  RETURN



90  DIM WZ(79)
100  DATA  D,B,D,D,A,B,C,D,B,D,D,B,D,D,C,A,C,C,B,D,C,D,D,D,C,C,C,D,D,B,C,
     A,C,A,C,A,B,C,B,B,B,A,A,A,C,D,C,C,C,A,C,D,D,B,A,B,D,B,B,D,D,C,B,C,D,
     B,A,B,B,C,D,C,B,A,B,A,D,C,D,D
110  FOR N = 0 TO 79
120  READ A$(N)
130  NEXT N
195  HOME
200  PRINT LAST$;", ";FR$
205  PRINT DAY$
210  PRINT
9000  REM  SCORING PROCESS
9002  LET MISS = 0
9003  LET D = 0
9005  LET LS = 0
9010  LET ES = 0
9015  LET PC = 0
9020  LET SA = 0
9025  LET SB = 0
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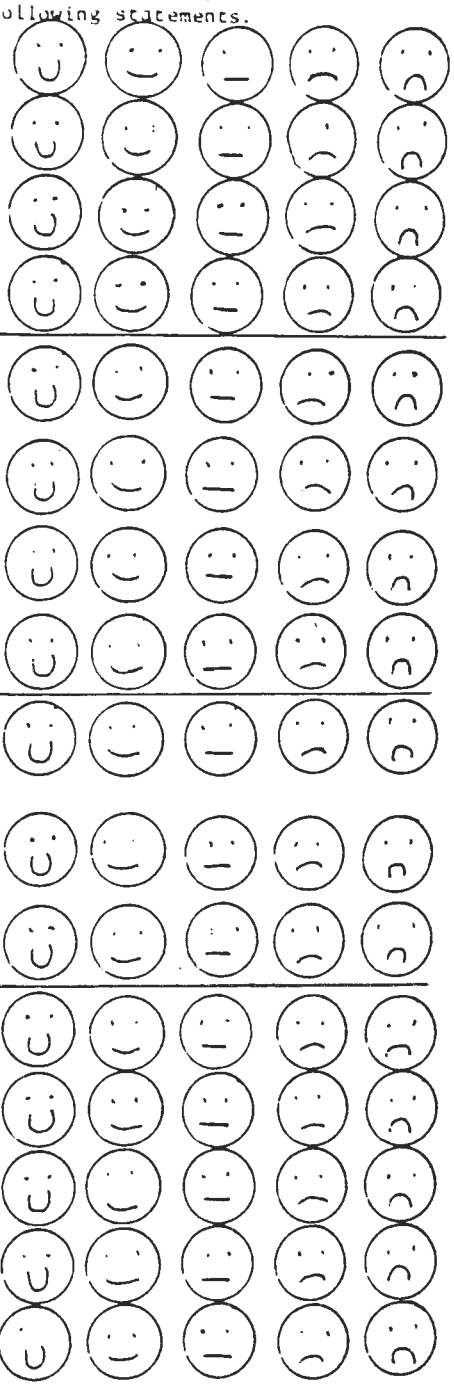
9030  LET NS = 0
9035  LET Z2 = 0
9040  LET C = 0
9045  FOR N = 0 TO 79
9047  LET MISS = MISS + 1
9050  IF A$(N) = B$(N) THEN  GOTO 9060
9055  GOTO 9140
9060  LET S = N + 1
9065  GOTO 9075
9070  IF N >  < 79 THEN  NEXT N
9072  GOTO 9300
9075  IF S =  < 15 THEN LS = LS + 1
9085  IF S > 15 AND S < 30 THEN ES = ES + 1
9095  IF S > 29 AND S < 41 THEN PC = PC + 1
9105  IF S > 40 AND S < 56 THEN SA = SA + 1
9115  IF S > 55 AND S < 73 THEN SB = SB + 1
9125  IF S > 72 THEN NS = NS + 1
9130  IF S =  < 80 THEN Z2 = Z2 + 1
9133  GOTO 9070
9140  LET WZ(D) = MISS
9150  LET D = D + 1
9160  GOTO 9070
9300  IF LS >  = 12 THEN  PRINT "LS      ";LS;"/15         PASS"
9303  IF LS < 12 AND LS > 9 THEN  PRINT "LS      ";LS;"/15      REMEDIATION
"
9310  IF LS <  = 9 THEN  PRINT "LS       ";LS;"/15      REMEDIAITON"
9320  IF ES >  = 11 THEN  PRINT "ES      ";ES;"/14         PASS"
9325  IF ES < 11 AND ES > 9 THEN  PRINT "ES      ";ES;"/14      REMEDIATION
"
9339  IF ES <  = 9 THEN  PRINT "ES       ";ES;"/14      REMEDIATION"
9340  IF PC >  = 10 THEN  PRINT "PC      ";PC;"/11         PASS"
9345  IF PC = 9 THEN  PRINT "PC      ";PC;"/11         PASS"
9350  IF PC < 9 THEN  PRINT "PC       ";PC;"/11      REMEDIATION"
9360  IF SA >  = 12 THEN  PRINT "SA      ";SA;"/15         PASS"
9365  IF SA > 9 AND SA < 12 THEN  PRINT "SA      ";SA;"/15      REMEDIATION
"
9370  IF SA < 10 THEN  PRINT "SA       ";SA;"/15      REMEDIATION"
9380  IF SB >  = 14 THEN  PRINT "SB      ";SB;"/17         PASS"
9385  IF SB < 14 AND SB > 9 THEN  PRINT "SB      ";SB;"/17      REMEDIATION
"
9390  IF SB <  = 9 THEN  PRINT "SB       ";SB;"/17      REMEDIATION"
9395  IF NS >  = 6 THEN  PRINT "NS       ";NS;"/8          PASS"
9398  IF NS < 6 THEN  PRINT "NS       ";NS;"/8       REMEDIATION"
9426  PRINT
9490  PRINT "    SPECIFIC PROBLEMS MISSED."
9500  LET H = 0
9510  LET I = 1
9520  LET J = 2
9530  LET K = 3
9533  LET L = 4
9536  LET M = 5
9540  FOR X = 1 TO (D + 5) / 6
9550  PRINT "  ";WZ(H);"     ";WZ(I);"     ";WZ(J);"     ";WZ(K);"     ";WZ(L
    );"     ";WZ(M)
9560  LET H = H + 6
9570  LET I = I + 6
9580  LET J = J + 6
9590  LET K = K + 6
9592  LET L = L + 6
9593  LET M = M + 6
9595  NEXT X
9999  END
```

Appendix C. The Questionnaire

Circle the face that best describes how you feel about each of the following statements.



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 pictures 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 quesion?
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

Subject _____

Interview

1. Identify Subject minor. _____

2. Identify previous experience. _____

_____

3. Why?

4. why?

5. Additoonal 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?

Weeknesses?

18. Particular like? Dislike?

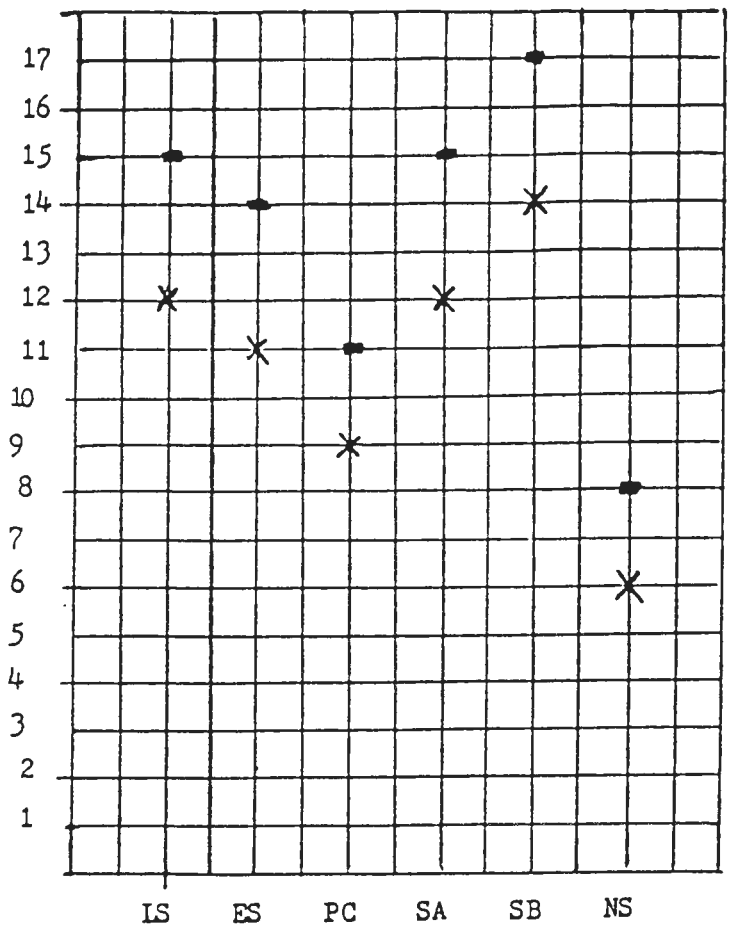
19. How could the test be improved?

Observations -

Appendix E. The Graph used to Report Student Test Results

SCIENTIFIC LITERACY PROFILE

NAME _____



Appendix F. The Questionnaire Results

	
1. I like science.	3 6 3 0 0
2. I enjoy working on computers.	3 8 1 0 0
3. The two practice questions helped me understand how to respond to the test questions.	8 1 3 0 0
4. The pictures were easy to use.	2 4 6 0 0
5. I liked the various brief comments made while the computer organized pictures or more questions.	5 4 3 0 0
6. I would prefer to take this test on a computer rather than in paper and pencil form.	4 5 3 0 0
7. I liked the computer's color picture over a paper's black and white drawing.	6 4 2 0 0
8. The sooner I receive my test results, the better.	9 1 2 0 0
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?	2 2 3 5 0
10. I would like to have gone back later in the test to possibly have changed some previous answers.	3 5 1 2 1
11. How did you feel about pausing for the picture to be displayed on the screen?	3 3 6 0 0
12. How did you feel about waiting for the computer to load more questions?	2 4 5 1 0

13 I felt comfortable knowing that if I pressed the wrong key, I could go back and change it.	7	4	1	0	0
14 How did you feel about removing and inserting the four floppy disks?	4	4	4	0	0
15 Any directions given, were easy to follow.	8	3	0	1	0
16 I'm glad an instructor was present in case problems came up.	8	3	1	0	0

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

B6. 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 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

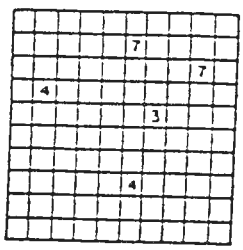
NAME_____

CIRCLE THE CORRECT ANSWER.

For EXAMPLE:

A.
B.
C.
(D.)

(#1) 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 .....____

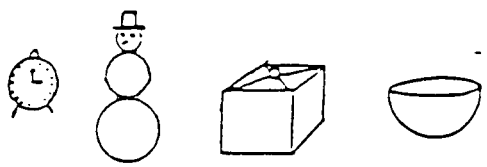
(#2) In summer, John noticed that the air in his tires became hotter when his car was driven over a long distance.

The statement above is an example of

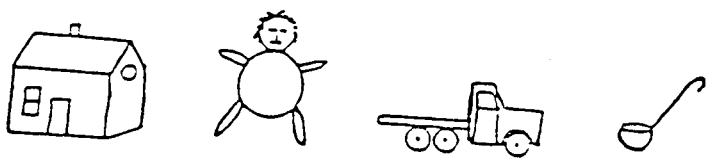
A. a theory.....____
B. a principle.....____
C. an observation.....____
D. a law.....____

(#3) All of these are Bobbos.

None of these is a Bobbo.



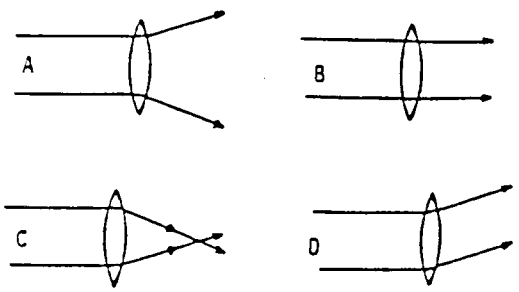
Which ONE of these is a Bobbo?



A B C D

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

(#4) Which diagram below BEST shows what happens when light hits a camera lens?

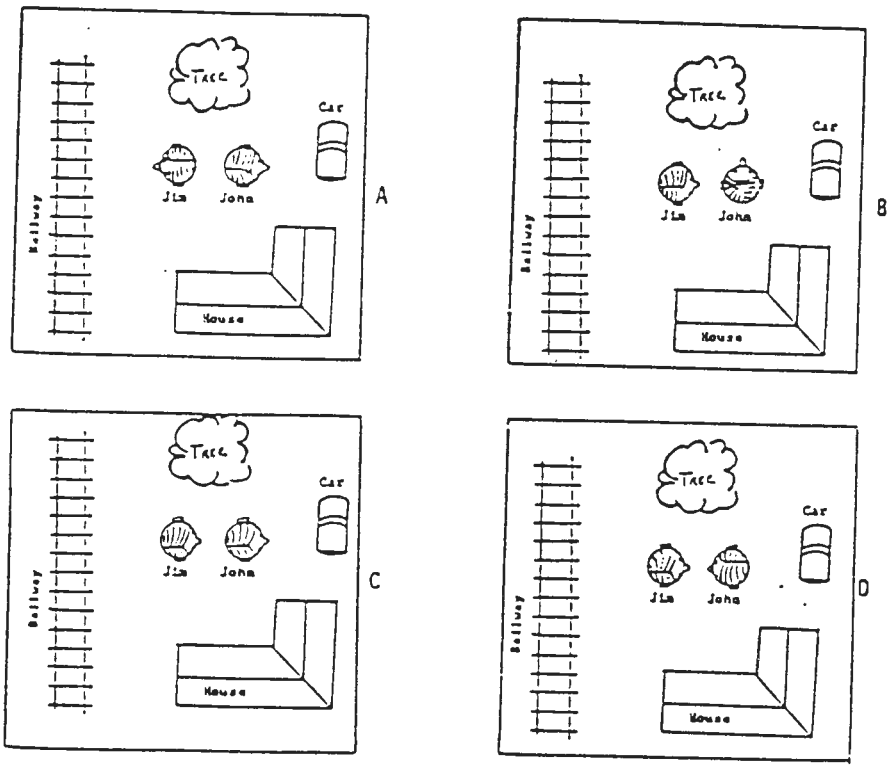


A. .....____
B. .....____
C. .....____
D. .....____

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

A. Glaciers .....____
B. Plants .....____
C. Meteorites .....____
D. Streams .....____

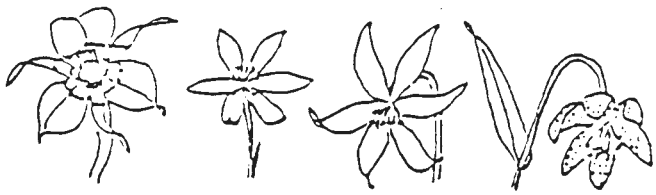
(#6) In the diagrams below you are looking down on a scene from an airplane. Jim says, "The car which is in front of me is behind John and the tree on my left is on his right".



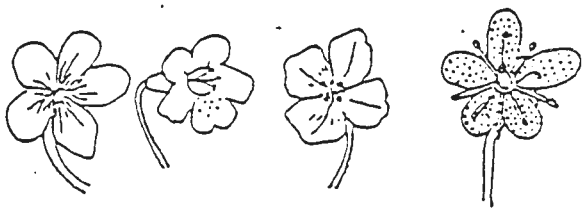
According to Jim's description, which is the correct diagram?

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

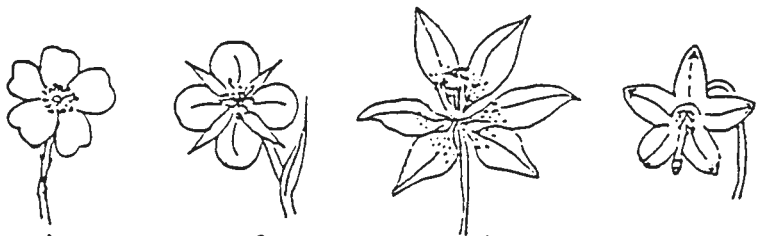
(#7) All of these are lilies.



None of these is a lily.



Which ONE of these is a lily?



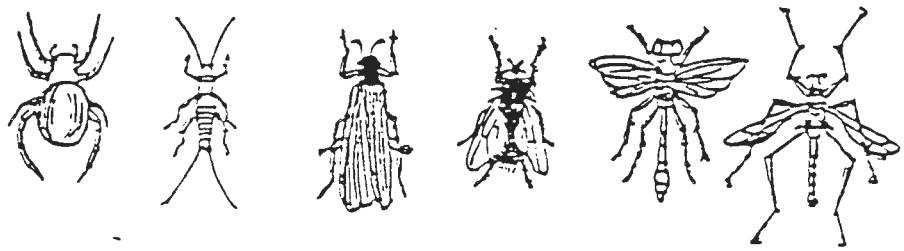
A B C D

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

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

A. Carbon dioxide .....___
B. Oxygen .....___
C. Carbon monoxide .....___
D. Nitrogen .....___

(#9) Here are six unknown animals. Look at them carefully.



A B C D E F

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

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

Creature F is a

A. Thread-waisted Wasp .....____
B. Cranefly .....____
C. Leaf Bug .....____
D. Bristletail .....____

(#10) 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.....___