Development of a Computer-Assisted Instruction Courseware Package in Statistics and a Comparative Analysis of Three Management Strategies for This Courseware.

Preston Dinkins
Louisiana State University and Agricultural & Mechanical College

Follow this and additional works at: https://digitalcommons.lsu.edu/gradschool_disstheses

Recommended Citation
https://digitalcommons.lsu.edu/gradschool_disstheses/4124

This Dissertation is brought to you for free and open access by the Graduate School at LSU Digital Commons. It has been accepted for inclusion in LSU Historical Dissertations and Theses by an authorized administrator of LSU Digital Commons. For more information, please contact gradetd@lsu.edu.
INFORMATION TO USERS

This reproduction was made from a copy of a manuscript sent to us for publication and microfilming. While the most advanced technology has been used to photograph and reproduce this manuscript, the quality of the reproduction is heavily dependent upon the quality of the material submitted. Pages in any manuscript may have indistinct print. In all cases the best available copy has been filmed.

The following explanation of techniques is provided to help clarify notations which may appear on this reproduction.

1. Manuscripts may not always be complete. When it is not possible to obtain missing pages, a note appears to indicate this.

2. When copyrighted materials are removed from the manuscript, a note appears to indicate this.

3. Oversize materials (maps, drawings, and charts) are photographed by sectioning the original, beginning at the upper left hand corner and continuing from left to right in equal sections with small overlaps. Each oversize page is also filmed as one exposure and is available, for an additional charge, as a standard 35mm slide or in black and white paper format.*

4. Most photographs reproduce acceptably on positive microfilm or microfiche but lack clarity on xerographic copies made from the microfilm. For an additional charge, all photographs are available in black and white standard 35mm slide format.*

*For more information about black and white slides or enlarged paper reproductions, please contact the Dissertations Customer Services Department.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Dinkins, Preston

DEVELOPMENT OF A COMPUTER-ASSISTED INSTRUCTION COURSEWARE PACKAGE IN STATISTICS AND A COMPARATIVE ANALYSIS OF THREE MANAGEMENT STRATEGIES FOR THIS COURSEWARE

The Louisiana State University and Agricultural and Mechanical Col. Ph.D. 1985

University
Microfilms
International 300 N. Zeeb Road, Ann Arbor, MI 48106

Copyright 1986 by Dinkins, Preston All Rights Reserved
PLEASE NOTE:

In all cases this material has been filmed in the best possible way from the available copy. Problems encountered with this document have been identified here with a check mark √.

1. Glossy photographs or pages _____
2. Colored illustrations, paper or print _____
3. Photographs with dark background _____
4. Illustrations are poor copy _____
5. Pages with black marks, not original copy _____
6. Print shows through as there is text on both sides of page _____
7. Indistinct, broken or small print on several pages _____
8. Print exceeds margin requirements _____
9. Tightly bound copy with print lost in spine _____
10. Computer printout pages with indistinct print _____
11. Page(s) ___________ lacking when material received, and not available from school or author.
12. Page(s) ___________ seem to be missing in numbering only as text follows.
13. Two pages numbered _______. Text follows.
14. Curling and wrinkled pages _____
15. Dissertation contains pages with print at a slant, filmed as received _______
16. Other ____________________________________________________________

University Microfilms International

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
DEVELOPMENT OF A COMPUTER-ASSISTED INSTRUCTION
COURSEWARE PACKAGE IN STATISTICS AND A COMPARATIVE
ANALYSIS OF THREE MANAGEMENT STRATEGIES FOR THIS COURSEWARE

A Dissertation

Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy

in

The Interdepartmental Program of Education

by

Preston Dinkins
B.S., Southern University, Baton Rouge, 1966
M.A., University of Oklahoma, 1968
M.S., Louisiana State University, 1984

December, 1985
ACKNOWLEDGEMENTS

The writer wishes to express his sincere and grateful appreciation to Dr. Richard G. Lomax, who served in the role of major professor. He also wishes to express his thanks to the other members of his committee: Dr. Sam Adams, Dr. Hubert Butts, Dr. Joseph W. Licata, Dr. S. Kim MacGregor, and Dr. Barry Moser.

This work is dedicated to my loving daughter, Erica LaRonica Dinkins, whose devotion and understanding helped to sustain me to this end.
<table>
<thead>
<tr>
<th>TABLE OF CONTENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
<tr>
<td>ACKNOWLEDGEMENTS</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
</tr>
<tr>
<td>ABSTRACT</td>
</tr>
</tbody>
</table>

CHAPTER

1. INTRODUCTION ........................................ 1

   Statement of the Problem ......................... 3
   Rationale ......................................... 4
   Hypotheses ........................................ 6
   Definition of Terms ................................ 7
   Significance of the Study ......................... 9
   Constraints ........................................ 10

2. REVIEW OF RELATED LITERATURE ..................... 11

   Computers as an Instructional Tool in Higher
   Education ........................................ 11
      Types of CAI ..................................... 11
      Benefits of Computers for Instruction ........ 15
      The Computer as an Instructional Tool ........ 17
      Summary .......................................... 21
   Computer Use in the Teaching of Statistics
   in Higher Education ................................ 22
      Reasons for Using CAI in Statistics ........... 22
      Computer Approaches in the Teaching of
      Statistics ....................................... 32
      Summary .......................................... 34
   Designing Educational Software ................... 35
      Learning Theories ................................ 35
      Text ............................................. 40
      Feedback ......................................... 41
      Graphics ......................................... 42
      Color and Sound .................................. 44
      Flowcharting and Screen Mapping ............... 44
      Summary .......................................... 45
   Evaluation of CAI Materials ....................... 46
   Evaluation in Courseware Development ............ 47
CHAPTER

Levels of Evaluation for Courseware ... 48
Summary ..................................... 51
Management Strategies for CAI ... 51
Summary ...................................... 58

3. METHOD ........................................... 60
Subjects ........................................ 60
Development and Design ....................... 61
Courseware Objectives ....................... 61
Design Strategies for NORSTAN ............ 63
Evaluation of NORSTAN .................... 67
Instrumentation ................................ 69
Procedure ..................................... 70
Summary ....................................... 71

4. ANALYSIS OF DATA ............................... 72
Pilot Test ..................................... 72
  Student Performance ....................... 72
  Student Evaluations ....................... 75
  Expert Evaluations ....................... 79
Factorial Design Experiment ................. 81

5. SUMMARY, CONCLUSIONS, AND
RECOMMENDATIONS .............................. 93
Summary ....................................... 94
Conclusions .................................. 96
Recommendations ............................. 99

BIBLIOGRAPHY ............................................ 102

APPENDICES .................................................. 111

A. LEARNER-CONTROL VERSION OF NORSTAN .... 111
B. AREAS AND ORDINATES OF THE UNIT NORMAL
  DISTRIBUTION ................................. 252
C. STUDENT EVALUATION FORM ..................... 258
D. THE NORMAL DISTRIBUTION FAMILY AND STANDARD
  SCORES POSTTEST .............................. 262

VITA ......................................................... 267
**LIST OF TABLES**

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Internal Processes of Learning and the External Instructional Events Which</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>May Be Used to Support Them</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Number of Observations, Mean, and Standard Deviation of the Pretest and</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>Posttest Scores for the Pilot Experiment</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Number of Exercises Per Unit, Mean, and Standard Deviation of the Exercises</td>
<td>74</td>
</tr>
<tr>
<td></td>
<td>for the Pilot Experiment</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Number of Review Problems Per Unit, Mean, and Standard Deviation of the</td>
<td>76</td>
</tr>
<tr>
<td></td>
<td>Review Problems for the Pilot Experiment</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Mean and Standard Deviation On-Line Learning Time Per Unit for the Pilot</td>
<td>77</td>
</tr>
<tr>
<td></td>
<td>Experiment</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Number of Observations, Mean, and Standard Deviation of the Posttest Scores</td>
<td>82</td>
</tr>
<tr>
<td></td>
<td>for the 2 x 3 Factorial Design Experiment</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Analysis of Variance Summary Table for the Dependent Variable of Posttest</td>
<td>84</td>
</tr>
<tr>
<td></td>
<td>Mean Score Using the Factors of Treatment and Aptitude</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Number of Exercises, Time on Text and Exercises, Number of Review Problems,</td>
<td>85</td>
</tr>
<tr>
<td></td>
<td>Time on Review Problems, Means, and Standard Deviations, for the High-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Aptitude Learner-Control Group in the 2 x 3 Factorial Design Experiment</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Number of Exercises, Time on Text and Exercises, Number of Review Problems,</td>
<td>86</td>
</tr>
<tr>
<td></td>
<td>Time on Review Problems, Means, and Standard Deviations, for the Low-Apti-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>tude Learner-Control Group in the 2 x 3 Factorial Design Experiment</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Number of Exercises, Time on Text and Exercises, Number of Review Problems,</td>
<td>88</td>
</tr>
<tr>
<td></td>
<td>Time on Review Problems, Means, and Standard Deviations, for the High-Apti-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>tude Program-Control with a Mastery Criterion and Advisement Group in the</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 x 3 Factorial Design Experiment</td>
<td></td>
</tr>
</tbody>
</table>
Table

11. Number of Exercises, Time on Text and Exercises, Number of Review Problems, Time on Review Problems, Means, and Standard Deviations, for the Low-Aptitude Program-Control with a Mastery Criterion and Advisement Group in the 2 x 3 Factorial Design Experiment ............. 89

12. Number of Exercises, Time on Text and Exercises, Number of Review Problems, Time on Review Problems, Means, and Standard Deviations, for the High-Aptitude Program-Control with neither a Mastery Criterion nor Advisement Group in the 2 x 3 Factorial Design Experiment ............. 91

13. Number of Exercises, Time on Text and Exercises, Number of Review Problems, Time on Review Problems, Means, and Standard Deviations, for the Low-Aptitude Program-Control with neither a Mastery Criterion nor Advisement Group in the 2 x 3 Factorial Design Experiment ............. 92
ABSTRACT

The purpose of this study was to develop and evaluate a tutorial computer-assisted instruction (CAI) lesson teaching the normal distribution and standard scores. Instruction on the normal curve, the unit-normal curve, z-scores, areas under the normal curve, and standard scores was given in this study. This CAI courseware was created in order to teach or review these concepts to graduate students in education.

An evaluation of this CAI lesson was conducted. It consisted of a small scale pilot test, and a 2 x 3 factorial design experiment. The pilot test study was conducted so that reaction data to this software package could be collected and utilized in revising this software. The 2 x 3 factorial design experiment was conducted to determine which of three management strategies for this CAI lesson is most effective for a given level of aptitude. The two quantitative aptitude levels were low-aptitude and high-aptitude levels. The participants' median score on the quantitative portion of the Graduate Record Examination (GRE) was used to determine low-aptitude and high-aptitude. The three management strategies were learner-control, program-control with a mastery criterion and advisement, and program-control with neither a mastery criterion nor advisement.
The following conclusions were drawn on the basis of the findings in this study.

1. The mean of the posttest scores for the group of participants in the pilot test study was significantly higher than the mean of their pretest scores.
2. High-aptitude learner-control students had a significantly higher posttest mean score than low-aptitude learner-control students in the 2 x 3 factorial design experiment.
3. The data collected in this study indicated a trend of assigning low-aptitude students to a program-control management strategy.
4. Gagne's cognitive theory of learning was effectively utilized in the development of this courseware.

An analysis of the data collected in this study, including the statistical comparison of pretest and posttest scores, indicated that this CAI package was effective in teaching its defined objectives.
CHAPTER 1

INTRODUCTION

The microcomputer with its various capabilities and relatively low cost is an important technological advancement. The advent of the microcomputer into the educational arena has made it possible for the increased use of computer-assisted instruction (CAI) in colleges and universities. In general, the cost of computer hardware, software, and courseware has decreased over the years. Consequently, more and more institutions of higher learning are now purchasing computers to be used in a classroom setting. Some colleges and universities are now requiring that all incoming freshman students have access to a microcomputer to facilitate teaching by CAI.

The microcomputer has various applications in the classrooms of higher education. Instructors now have an interactive medium, the microcomputer, which can be used to simulate a real situation, to provide for drill and practice, or to give tutorial instruction. Microcomputers can also be used to give classroom examinations and to check student responses which facilitates grading of these examinations.

The graphical capability of a computer has made it possible to draw accurate graphs in a relatively short period of time. This is a welcome addition to any class which
utilizes graphic displays in the presentation of instructional lessons. Many professors are less than enthusiastic when it comes to drawing a detailed graph on a blackboard and simply sketch a graph that only vaguely resembles the correct graph. A well constructed CAI courseware package that utilizes graphics will give the learner an attractive and correct graph.

The computer has facilitated the teaching of statistics through the use of statistical packages, tutorials, simulations, and by other means. The computer's graphic capability and its ability to perform fast numerical calculations have made the computer especially adaptable to teach the normal distribution and standard scores. The normal distribution or normal curve is one of the most fundamental distributions in all of statistics. Many of the problems in statistics can be solved if one is allowed to assume that a given set of data is normally distributed. A thorough understanding of the normal distribution and its properties is necessary in order to understand many of the more advanced topics in statistics, particularly in hypothesis testing. Also, standard scores should be easier to explain and understand given a graphical interpretation of their meaning.

The future of CAI in higher education in general and
statistics in particular is uncertain in many ways because CAI has yet to realize its full potential value in the classrooms of higher education. CAI has proved to be effective in many educational settings. As more and more qualified and conscientious programmers enter this arena, and collaborate with content area specialists, CAI in statistics should become even more challenging and rewarding.

Statement of the Problem

In this study, the researcher was concerned with:
1. developing a computer-assisted instruction (CAI) courseware package in statistics, and
2. comparatively analyzing the effectiveness of three management strategies for this courseware at two quantitative aptitude levels.

This courseware provided instruction on the normal curve, the unit-normal curve, z-scores, areas under the normal curve, and standard scores. A graphical interpretation of these concepts was provided, when practical, in order to enhance clarification of the topics discussed. The purpose of this CAI lesson was to review or teach these concepts to graduate students in education.

An evaluation of this CAI lesson was conducted. A small scale pilot test by graduate students in education and a team
of experts constituted one portion of the evaluation. The team of experts consisted of a statistical expert and an expert in CAI lesson design.

The research portion of the evaluation consisted of a 2 x 3 factorial design experiment. This experiment was conducted in order to compare three management strategies of this software package to determine which learning strategy, if any, is the most effective for a given aptitude level. The three strategies were learner-control (Group 1), program-control with a mastery criterion and advisement (Group 2), and program-control with neither a mastery criterion nor advisement (Group 3). Two quantitative aptitude levels were also used in this study. They were low-aptitude learners (Level 1) and high-aptitude learners (Level 2).

**Rationale**

The normal distribution (also called the Gaussian curve, the normal curve, and the normal probability curve) is the most fundamentally important distribution in statistics because many statistics are based on or assume the normal distribution. It is used extensively in many statistics textbooks in the development of other statistical concepts, particularly in hypothesis testing (Glass and Hopkins, 1984). The graphical capabilities of a microcomputer can be
effectively utilized in plotting this curve, calculating and shading areas under the curve, and it can assist the learner in visualizing what effect the changing of a single parameter in the normal distribution formula will have on the shape of a normal curve. The precise and timely manner in which these properties are unfolded should be clarifying and motivational to the student.

Since standard scores are so important in the interpretation of raw scores, it is necessary that prospective users of standard scores have more than just a surface level understanding of the contents of this topic. A graphical interpretation of standard scores should reinforce the underlying concepts discussed in this lesson.

In essence, the microcomputer performed at least three functions in the development of this study which were beneficial to the learner. It generated accurate and attractive graphs of a normal curve, it illustrated concepts of the normal distribution and standard scores that were discussed in the lessons, and it performed tedious calculations required in the plotting of graphs and determining the areas of shaded regions under a normal curve. The ability of a microcomputer to draw attractive graphs (Anderson, 1984; Collis, 1983), to clarify key concepts (Collis, 1983; Andrew, 1973), and to give individualized
instruction (Wassertheil, 1979; Skavaril, 1974) made it especially attractive to be used in this study.

The 2 x 3 factorial design experiment conducted in this study sought to answer the question as to whether a particular management strategy for this CAI program would be more effective for a given learning aptitude. Fry (1972) concluded from his research that students high in both aptitude and inquisitiveness should be placed in a student-control instructional treatment and that low-aptitude students tend to learn the least under a high degree of student-control when compared to other strategies. Some research studies have demonstrated that when the learner controls the amount of CAI he receives, he often terminates the lesson prematurely and fails to learn what he should (Felixbrod & O'Leary, 1974).

**Hypotheses**

1. The mean posttest score of the group of participants in the pilot test study will be significantly higher than the mean of their pretest scores.
2. High-aptitude learner-control students will have a significantly higher posttest score than low-aptitude learner-control students during the research portion of this study.
3. Low-aptitude students will perform better under a program-control strategy with a mastery criterion and advisement than under a learner-control strategy.

**Definition of Terms**

**Adaptive CAI.** CAI that includes strategies for assessing both the learner's cognition and memory (e.g., aptitudes, prior achievement, on-task learning progress) and the characteristics of the learning task (e.g., difficulty level and content structure) so that the CAI lesson can be continuously adjusted to meet the on-task learning needs of the learner (Johansen & Tennyson, 1984).

**Courseware.** Software and printed materials which support instruction in a complete course of study or a definable subset of a course (MicroSIFT, 1981).

**Computer-Assisted Instruction (CAI).** Instruction that is assisted or aided through the use of the computer (Harrod and Ruggles, 1983).

**Software Design.** Defining the order of material to be presented and the interaction of computer and student (Kosel, 1980).

**Formative Evaluation.** The collection of the opinions, suggestions, and criticisms of project participants for the purposes of revision and improvement. (Reeves and
Lent, 1982).

**Graphics.** Images displayed on a video screen or printer which are generated by a computer program. (MicroSIFT, 1981).

**Hardware.** Equipment, including computers, disk drives, cassette players, cables, and monitors (MicroSIFT, 1981).

**Internal Review.** The process of reviewing the content and instructional processes before it is put into operation (Reeves and Lent, 1982).

**Learner-Control CAI.** CAI in which the learner maintains a direct role in decision making (Johansen & Tennyson, 1984).

**Microcomputer.** A computer system, including peripheral hardware such as disk drive and monitor, based on a microprocessor (or "chip"), and having a typewriter-like keyboard. (MicroSIFT, 1981).

**Normal Distribution.** A distribution that can be approximated by the formula:

\[
y = \frac{1}{\sigma \sqrt{2\pi}} e^{-\frac{(X - u)^2}{2\sigma^2}},
\]

where \( y \) is the height of the curve directly above any given value of \( X \) in the plotted frequency distribution, \( \pi \) is the ratio of the circumference of any circle to its diameter and is equal to 3.14159..., \( e \) is the base of the system of natural logarithms and is equal to 2.71828..., and \( u \) and \( \sigma \)
are the mean and standard deviation of the given population, respectively. (Glass and Hopkins, 1984).

**Operating System.** A program or set of programs which controls and coordinates the operations of the components of a computer system (MicroSIFT, 1981).

**Operational Testing.** The process of collecting information for improving instruction during and after its implementation (Reeves and Lent, 1982).

**Program.** A computer program, written in BASIC, Pascal, machine code or other computer programming language (MicroSIFT, 1981).

**Software.** Programs, including application programs, operating systems, and languages (MicroSIFT, 1981).

**Tutorial CAI.** CAI that assumes the place of the teacher and gives independent instruction on a one-to-one basis. Tutorial CAI presents the concepts and roles of the subject matter, evaluates the student's comprehension, and gives practice through branching in the specific skills and concepts taught. Cognitive objectives of the tutorial CAI are knowledge acquisition and comprehension (Manion, 1985).

**Significance of the Study**

This research study provided knowledge as to how to best effect learning concepts in statistics by means of CAI. This
is a significant educational research problem because it is important to know which is the most efficient method at a given quantitative aptitude level to learn statistics by means of CAI. Some studies have demonstrated that when the learner is allowed to control the amount of instruction, he often terminates prematurely, and fails to learn what he should (Tennyson & Buttry, 1980; Felixbrod & O'Leary, 1974). This study sought to determine if knowledge acquisition through CAI is affected by the design management strategy used in the development of CAI lessons in statistics. The answer to this question is important so that the most effective CAI strategy might be assigned to fit the specific characteristics of the learner.

**Constraints**

This CAI lesson was designed to run on the IBM Personal Computer (PC) with Color/Graphics Monitor Adapter. The computer language used in this program was Advanced BASIC (Beginners All-Purpose Symbolic Instruction Code). This courseware consisted of instruction on the normal distribution and standard scores, and was designed for graduate students in education.
The review of the literature will be divided into five sections. These are: (1). Computers as an Instructional Tool in Higher Education, (2). Computer Use in the Teaching of Statistics in Higher Education, (3). Designing Educational Software, (4). Evaluation of CAI Materials, and (5). Management Strategies for CAI. A summary of each section will be provided at the end of each section.

Computers as an Instructional Tool in Higher Education

The number of computers on college and university campuses has increased tremendously in the last decade with the advent of microcomputers into the educational system. Faculty members in higher education are now using the computer in the teaching of such courses as statistics, mathematics, English, engineering, chemistry, and physics. This section will discuss the types of computer-assisted instruction (CAI), the benefits of CAI, and computer use as an instructional tool in higher education.

Types of CAI

This section will discuss the types of CAI and provide an example of the most common types of CAI. The three most
common types of CAI instruction are drill and practice, tutorial, and simulation. The purpose of drill and practice is to provide practice for skills already learned. It is possible to teach new skills by this technique, but such learning would be more of "trial and error" than of directed learning, and would not constitute an efficient use of learner's time (Gagne', Wager, & Rojas, 1981).

Stockburger (1982) reports on the utilization of a drill and practice program at a Midwestern university to evaluate what effect participating in three computer exercises would have on the performance of students enrolled in an introductory statistics class. Stockburger states that the exercises were performed on a Polymorphic 88 microcomputer. One exercise, called "means," presented the student with 10 estimation problems. Each estimation problem presented the student with 10 to 100 randomly generated numbers with a mean between 1 and 100 and a standard deviation between 1.0 and 20.0. Criteria were given for a correct score which involved both student reaction time and student response. One conclusion reached by Stockburger was that this exercise improved the ability of the student to estimate the mean and standard deviation of a collection of numbers.

In the tutorial mode (Manion, 1985), CAI assumes the place of the teacher and provides independent instruction on
a one-to-one basis. A tutorial program presents the concepts and rules of the subject matter, evaluates the students' comprehension, and provides practice through branching in the specific skills taught. Manion also states that the cognitive objectives of the tutorial mode are knowledge acquisition and comprehension. Gagne' et al. (1981) state that a tutorial program is usually considered to be "primary" instruction as opposed to "supplementary" instruction. That is, a good tutorial program ought to be able to stand alone.

Agbor-Etang (1979) reports on the development of CAI tutorial units in calculus for students at the university level. These CAI units were designed to provide instruction and related practice problems for mathematics, engineering, and science students who were enrolled in Mathematics 121 at Iowa State University. The PLATO terminals at Iowa State University were used in this study. Agbor-Etang states that twenty CAI units were used in this study. Each unit contained an explanation of the concepts involved, examples, and provided several practice problems.

CAI simulation programs imitate a real situation and/or they model the underlying characteristics of a real phenomenon (Manion, 1985). Students must interact with and become part of the simulated reality. While simulations may incorporate many features of games, their real power comes
from their "capacity to teach about problem-solving" (Harrod and Ruggles, 1983, p. 5). They are effective in helping students learn such diverse concepts as driving a car, trading on the stock market, or the effects of stress on the heart. In essence, simulations provide "highly accessible laboratories" (Appel and Hurley, 1984, p.3).

Kosinski (1984) reports on a simulation exercise to be used in a biology laboratory in higher education. This program is called ALIEN and it is a simulation of cardiopulmonary physiology. Kosinski states that ALIEN starts with a screen showing a stylized extraterrestrial with an animated heart beat. The extraterrestrial is subjected to various simulated conditions on his heart and the learner is asked both quantitative and qualitative questions concerning the proper treatment of the extraterrestrial's condition. After the student responds, ALIEN provides feedback to the learner regarding the appropriateness of the response.

Other types of CAI programs include educational gaming and problem-solving (Manion, 1985; Bohrer, 1981). Bohrer states that educational gaming can be thought of as drill and practice using skill and/or strategy. A student may compete or cooperate with another student or with the computer, for a score or other result indicating his level of achievement. In the problem-solving mode (Manion, 1985), the student
combines previously learned rules into a new, yet higher level rule that will, in turn, solve a problem.

Benefits of Computers for Instruction

This section concerns itself with some of the reasons for using the computer as an instructional tool. According to a search of the literature done by McMurray and Hoover (1984), the following benefits relative to the use of a computer as an instructional tool were found:

1. The computer is accepted as an instructional medium that may stimulate interest or motivation (Fisher, Johnson, Porter, Bleich, & Slack, 1977; Hebenstreit, 1980; Witschi et al., 1976).

2. The computer can provide the advantage of individualized instruction which moves at the pace of the user (Charp, Bozeman, Altschuler, D'Orazio, & Spuck; 1982; West, 1983; Fisher et al., 1977).

3. The computer can provide immediate application of facts and feedback that may enhance learning (Kulhavy, 1976).

4. Information for the computer can be standardized and free from biases such as facial expressions and tone of voice. Abstract information may be simplified through visual analogies (Schwartz & Hanson, 1982).
5. The use of a computer can be as effective as or superior to traditional instructional methods (Aiken & Braun, 1980; Dence, 1980).

6. Computers can simulate experiences that would be difficult, expensive, or impossible to have in everyday life, and they can provide practice so that learners gain competency in real-life situations. The computer user becomes an active participant, rather than a passive observer, and this creates a positive learning environment (Van Cura, Jensen, Greist, Lewis, & Frey, 1975).

Other reasons for utilizing the computer as an instructional tool are given in the research study done by Chambers and Sprecher (1980). These are as follows:

1. The use of CAI can reduce learning time when compared to the regular classroom instruction (Deignan & Duncan, 1978; Kearsley, 1976; Magidson, 1978; Sakamoto, 1978; Splittgerber, 1979; Taylor, 1974).

2. The use of CAI can improve student attitudes toward the use of computers in the learning situation (Kearsley, 1976; Magidson, 1978; Murphy and Appel, 1977; Splittgerber, 1979; Taylor, 1974).

3. The development of CAI courses following specified guidelines can result in portability and their
acceptance and use by other faculty (Laurillard, 1977; McKenzie, Elton, & Lewis, 1978).

The Computer as an Instructional Tool

In this section, the use of the computer as an instructional tool will be discussed. A review of the literature has indicated that some colleges and universities are now requiring that all or part of their student body have access to a personal computer (Magarrell, 1982; Smith et al., 1984). Smith et al. state that starting with the class in the fall of 1983, Drexel University, in Philadelphia, Pa., is requiring every incoming freshman to own a microcomputer. Some of the desired goals to be achieved by student ownership of a microcomputer at Drexel are to provide stand-alone computational power, to provide access to larger computer systems, and to enable the introduction of computer-based instruction into the curriculum. Magarrell (1982) states that starting with the fall class of 1983, freshmen at the Stevens Institute of Technology are required to have personal computers. Magarrell also states that plans for equipping all students with personal computers have been announced at Carnegie-Mellon University and Clarkston College of Technology.

A visit made to 14 universities, including the
University of Alabama, Brigham Young University, The University of California-Davis, Colorado State University, University of Pennsylvania, Florida State University, University of Nebraska-Lincoln, Pennsylvania State University, Utah State University, and Virginia Polytechnic Institute, revealed that most of these universities had a considerable interest in microcomputers (Bedient, 1981). Bedient states that the interest ranged from word processing, to management of data, to CAI applications.

A survey was conducted at the University of Georgia by Jackson, Clements, and Jones (1984), in order to determine the various uses of computers among faculty members. This survey indicated that the interest in computers was high. Faculty members were using micros, minis, and mainframes for both instruction and research in all academic units of the university and many faculty members indicated an interest in learning more about the various uses of the computers.

Two multi-million dollar computer systems developed for instructional purposes are the Programmed Logic for Automatic Teaching Operation (PLATO) system and the Time-shared Interactive Computer-Controlled Information Television (TICCIT) system. Although there are substantial differences between the two systems, both use computer technology to provide individualized instruction, with two-way
communication between student and machine. The development of these systems was funded by the National Science Foundation (NSF) (Chambers and Sprecher, 1980; Magarrell, 1976).

The PLATO system (Chambers and Sprecher, 1980; Magarrell, 1976; Suppes and Machen, 1978; Suppes, 1981) is housed at the University of Illinois under the direction of Donald Bitzer. With the PLATO system, a single computer can give individualized instruction to as many as 500 students at once, maintaining two-way communication with each of them. PLATO terminals are also operational on the campuses of the Universities of Arizona, Colorado, Delaware, Florida State, Quebec, and Minnesota. At the University of Delaware, the PLATO terminal emphasizes support for music education, while at Florida State, installation support is provided to select Florida high schools for PLATO-based remedial studies in mathematics.

TICCIT was developed at the University of Texas and Brigham Young University under the direction of Victor Bunderson (Chambers and Sprecher, 1980; Magarell, 1976; Wilson, 1984). This system was designed to provide basic undergraduate instruction in mathematics and English. On standardized tests in English and mathematics, students taught by TICCIT have done just as well as those who had
the best human teachers.

At the University of California, Irvine, a CAI project has been under way for a number of years under the direction of Alfred Bork. This project has produced a significant amount of courseware of a fairly complex nature supporting instruction in physics. Also, entire CAI courses are now offered in Russian and mathematics at Stanford under the direction of Patrick Suppes (Chambers and Sprecher, 1980).

Herbert Simon and his colleagues at Carnegie-Mellon University (Newell and Simon, 1972) have used the computer as a model of what kinds of information-processing activities can be accomplished, and they have tried to represent the variety of problem-solving tasks that can be done by means of a computer program. These researchers believe that there is a parallel when comparing what the computer has to do in order to solve a problem, and what the human beings say they are doing in solving the same problems. However, Gagne' believes that there is some question about how much valid information one can get from having people attempt to report their own mental processing (Lipsitz, 1982). Gagne' also states that in some cases this process works, and gives some very interesting and important information about how human cognitive activity takes place.
Summary

The three most common types of CAI are drill and practice, tutorial, and simulation. The literature supports the fact that CAI has various applications in the classrooms of higher education. Generally speaking, CAI can be motivational, provide individualized instruction, and in many cases can reduce significantly the amount of time needed for instruction.

Several colleges and universities are now requiring that all or part of their student body have access to a personal computer. This list includes Drexel University, Stevens Institute of Technology, Carnegie-Mellon University and Clarkston College of Technology. The microcomputer can give computer-based instruction as well as provide for access to larger terminals. Also, large scale CAI systems, such as PLATO and TICCIT, are being used at various colleges and universities to teach courses such as mathematics, English, physics, and Russian.
Computer Use in the Teaching of Statistics in Higher Education

This section has been divided into three parts: (1). Reasons for Using CAI in Statistics, (2). Approaches to Using CAI in Statistics, and (3). Summary. The summary will consist of a brief synthesis of the other parts discussed in this section.

Reasons for Using CAI in Statistics

Over the last decade, the use of the computer in the research, application, and teaching of statistics has been on the increase. The availability of sophisticated statistical packages, quality software and courseware, high powered computers, and the advent of the microcomputer have all made it possible for statisticians and students to perform complicated tasks with ease. Computers can be very useful in the teaching of both descriptive and inferential statistics.

Among the major reasons for teaching statistics with the aid of a computer are the following:


2. Easy performance of routine numerical calculations (The Committee on the Undergraduate Program in Mathematics (CUPM), 1975; Collis, 1983; Anderson, 1984; Andrew, 1973; Mausner et al., 1983).

4. Promotion of active student participation in the acquisition of statistical concepts (CUPM, 1975; Skavaril, 1974).

5. Individualization of instruction (Wassertheil, 1979; Mausner et al., 1983; Skavaril, 1974).

6. CAI in statistics can save students classroom time (Wassertheil, 1979; Skavaril, 1974).

7. CAI in statistics is motivational (Caffarella, 1882-83; Andrew, 1973; Scalzo and Hughes, 1976).

8. CAI can free the teacher from tedious, time consuming tasks (Wassertheil, 1979).

In her study, Collis (1983) gives three functions that a microcomputer can perform in a unit on statistics: the easy generation of attractive graphs; the illustration of concepts; and the performance of routine and tedious calculations. One of the computer programs mentioned in Collis' study was WORD COUNT STATISTICS. This program performed various descriptive statistical tests on a portion of written text. Descriptive data given on a passage of text by this program included the number of words, number of sentences, mean length of word, and standard deviation of length of word. Collis states that this program has the
option of listing all the words of a certain length and presenting a simple frequency distribution of the lengths of words. This program also allows for an attractive histogram to be generated of the data for length. Other options in this program, says Collis, permit the drawing of skewed distributions, and a discussion of the concepts of "peakedness" or "kurtosis" for a distribution.

Collis believes that the WORD COUNT STATISTICS program effectively teaches basic statistical concepts such as simple frequency distributions, histograms and line graphs. The graphics display, Collis states, can also be used to reinforce graph-reading skills and to illustrate the nature of a "linear trend" that can be visualized from the graph.

Scalzo taught an undergraduate course involving elementary statistics at Queensborough Community College of the City University of New York (Scalzo and Hughes, 1976). The course, Mathematics 36: Elementary Computer-Assisted Statistics, lasted for one semester. Seven units were covered in this course: Understanding the Use of Computers; Descriptive Statistics; Sets, Permutations, and the Binomial Theorem; Elementary Probability Concepts; Random Variables and Normal Distribution; Hypothesis Testing; and Additional Statistical Techniques. There were 14 prepackaged programs integrated in the topic units. Some of the units were STAT1:
Ungrouped Data, STAT2: Grouped Data, STAT3: Counting Program, STAT4: The Binomial Experiment and STAT9: Computing the observed Z-score or observed t-score for differences between a Sample Mean and a Population. Each of these statistical programs included an instruction sheet, a flowchart, coding in BASIC and a problem set. In the STAT9 package, the student inputs a given set of data, and the computer would print out the observed Z-score and the observed T-score. No tutorial assistance was provided by these statistical packages.

Scalzo and Hughes also state that a large majority of the student participants indicated an enthusiasm for learning elementary statistics via CAI. These authors believe that in a basic course which emphasizes statistical concepts, the computer may assist in obtaining an understanding of these concepts. They also concluded that students appeared to have a better understanding of statistical concepts offered in this CAI course than did those students in a traditional or standard non-computer elementary statistics course.

Skavaril (1974) describes in detail the instruction of an introductory statistics course using the computer not only for tutorial CAI support, but also for the generation of statistical exercises and answers and for its capabilities as a tool to help students complete data analyses. The course,
Genetic 650, is a one quarter introductory statistics course taught in the Department of Genetics at The Ohio State University. The computers utilized in the teaching of this course were the IBM 370/165 and the IBM 370/158 central computers together with terminals and various other processing equipment. The software components of the computer base for this course consist of twenty-nine modules, nine exercise generating programs, 21 data analysis programs, and various programs supplied by the central administration of the University. The CAI modules were written in the Coursewriter III, Version 3, author language. Topics in the CAI modules included the central limit theorem, t-distribution, F-distribution, one-way analysis of variance, linear regression, and correlation. Students accessed the modules from the terminals using a central computer in a student, interactive, on-line mode.

Skavaril found that the students using computer-based materials completed the course in much less time than by other students to complete the same course. He also found that students can proceed through the CAI module at a pace that is consistent with their abilities and time commitments. The Skavaril study indicated that the concentration required of a student at a computer terminal during CAI precluded inattention; thus such a student achieved a degree of
efficiency that would be difficult to match even in the best-organized classroom environment.

In her paper, Wassertheil (1969) successfully incorporates CAI into the laboratory portion of an introductory statistics course. The laboratory was used in conjunction with a standard statistics text plus lectures. The laboratory was called the Computer-Assisted Instruction Problem Laboratory in Statistics. It was used in an introductory statistics course at the State University College at New Paltz, New York in the Division of Biological Science and Mathematics during the fall quarter of 1966. The text used in the course was Probability and Statistics, third edition, Alder and Roessler, published by Freeman, and the "Stats Workbook of Problems" published by IBM. The first ten chapters in the textbook as well as a portion of Chapter 12 on Regression and Correlation was covered. In the workbook, the first 8 chapters (including the section on standard scores) were covered.

Wassertheil states that the course was given during a ten week period with three sessions a week. Two of these sessions consisted of lecture and the third session was a problem laboratory session in which homework was discussed and previous materials reviewed.

Wassertheil states that there were 27 student
participants in the course. These students were divided into two groups. Fourteen students (one subsequently withdrew) volunteered for the experimental group and received CAI. The others did not volunteer and were placed in the control group. All students in both groups were given workbooks and required to complete one chapter per week. Students in the computer group were asked not to attend the class laboratory period. Rather, they spent an hour a week on the computer terminal receiving computer instruction in the mode called "problem laboratory." Wassertheil found that CAI was able to eliminate one standard 75-minute class period a week without deterioration in performance. Such usage would permit more time for individual contact between student and instructor or would free the instructor for other duties.

In a study at Beaver College, Mausner et al. (1983) discuss the development of a CAI course in statistics using a PDP 11/70/45 computer. In this course, both descriptive and inferential statistics were taught, as well as the most widely used computational techniques, such as ANOVA. Students would interact with the computer and receive immediate feedback. This course was divided into units or modules. At the end of each unit there would be a test to determine mastery of the content covered. A final examination would also be given to cover the entire course.
Students were able to pace themselves, and the weaker students received proddings if they moved too slowly.

Mausner et al. state that the results of this study indicate that CAI units give a great deal of individual attention to weak students, given adequate training of tutors and full participation by an instructor. Mausner et al. also state that CAI frees the strong student to move quickly through the acquisition of the analytical tools necessary to plan and carry out research.

In her paper, Caffarella (1982-83) discusses the introductory graduate level educational statistics course at the University of Maine at Orono which was taught using an interactive computer system. The University of Maine operates a mainframe computer which is an IBM 3031 computer with a VM/370 operating system. The students entered the course with no skill in educational statistics nor any skill in the utilization of computers. By the end of the course, the students were proficient in basic statistical techniques used in educational research and in the use of the computer to calculate various statistics. Student evaluations of the course were very high with many students changing from a negative to positive attitude toward statistics during the semester.

The major computer packages utilized in the Caffarella
study included the Montana State University Interactive Statistical Analysis Program (MSUSTAT) and the Statistical Package for the Social Sciences (SPSS). The MSUSTAT system runs completely interactively and allows the student to calculate simple statistics with relative ease. Caffarella goes on to say that the MSUSTAT system covers such topics as the mean, standard deviation, summary descriptive statistics, and correlations. The SPSS is run in a batch mode system on the University of Maine computer. The student can create an SPSS job, send it to the batch system where it is actually run, and the batch system will route the output back to the interactive system. Using this system, Caffarella states that students study such topics as frequency distributions, t-test, and ANOVA.

Stockburger (1982) reports on an experimental study done at a Midwestern university which evaluated the effect of participation in three computer simulation exercises by a group of students enrolled in an introductory statistics class. The exercises were performed on a Polymorphic 88 microcomputer and they were given by three computer programs. The first computer exercise, "means estimation," required the students to estimate the mean and standard deviation of a set of numbers presented on a Cathode ray tube (CRT). The second program, "normalguess," tested the
ability of students to estimate either the area below a raw-score on a normal curve with a given mean and standard deviation or the raw-score given the area, mean, and standard deviation. No graphing of the normal curve was indicated. The third program, "scattest," presented a 20-point scatterplot on the CRT. The students were then required to estimate the size of the resulting correlation coefficient. For each of these exercises, criteria for a correct response were given which involved both reaction time and student response.

Stockburger also states that one-half of the students in this study were required to participate in these exercises. At a later date, all students were given a paper-and-pencil test of their ability to quickly estimate statistics. Results demonstrated that the students who participated in the exercises attempted significantly more exercises with greater success than those who did not. Stockburger also points out that the estimation exercises were effective in increasing the accuracy and speed with which students estimated statistical parameters. Questionnaire results also indicated that the students felt that the exercises were useful.
Computer Approaches in the Teaching of Statistics

In this section, the various methods that a computer can be utilized in the teaching of statistics will be discussed. In his research, Stockburger (1980) listed five approaches that have been taken concerning the use of computers as an aid in the teaching of statistics: (1) CAI question and answer dialogs, (2) statistics as a tool in the teaching of a computer language, (3) the computer as a computational tool, (4) computer-generated tests and homework, and (5) the computer as simulator.

Anderson (1977) describes a system called CAPS (computer-assisted problem solving system) which utilized the question and answer approach. One part of CAPS asked students to estimate parameters of distributions on the basis of a graphic display. For example, a scatterplot is illustrated on a cathode ray tube (CRT) and the student must guess the correlation coefficient within some specified range. This drill would continue until the student correctly responded to a certain number of estimates.

Tubb and Ringer (1977) in their research found that several programming textbooks, such as Introductory Statistics with FORTRAN by Kirch (1973), used statistics as a vehicle for teaching FORTRAN. These authors state that this textbook attempts to complement and enhance statistical
development. However, Tubb and Ringer state that this textbook overwhelmingly emphasizes the learning of FORTRAN at the expense of the statistical content. This text, Tubb and Ringer state, organizes the introduction of FORTRAN from the simple manipulation of constants to complex operations on arrays.

In his research, Carpenter (1984) did a comparative analysis of 24 statistical packages. One of these, called HSD, has three programs that can be used as a computational tool. One program provides general descriptive statistics (Stats Plus), another provides regression (HSD Regress II), and the third provides analysis of variance (ANOVA II) capabilities. Carpenter states that in addition to the data-handling capabilities and high resolution scatterplots of Stats Plus, Regress II features five regression procedures: simultaneous solution, forward solution, stepwise solution, backward solution, and polynomial regression.

Stockburger (1980) states that he has generated both homework and the problem section of tests on a microcomputer. Relative to the homework assignments, Stockburger states that he selects from a menu of possibilities which appear on a CRT screen. BASIC programs then generate both the problem set and the correct solutions to the problem set. The correct solutions will be provided to the student after his homework
has been submitted and corrected. Stockburger points out that the solution set to the homework problems allows the student to observe the problems worked correctly.

Summary

Whereas CAI has not solved all of the problems in the teaching of statistics, it has been a welcome addition to the classroom by many teachers. CAI in statistics has proved to be of great assistance in providing individualized instruction. The weak student in statistics can now be provided with a great deal of individual attention and the strong student can now progress through the concepts at a much faster pace. Also, with the computer's capability of drawing attractive and precise graphs, graphical interpretations of statistical concepts can now be applied in order to reinforce the learning process.

Other findings in this section indicate that the computer can be used to perform routine numerical calculations, clarify key ideas in statistics, and promote active student participation. CAI can also save students classroom time, can be motivational, and can free the teacher from tedious, time consuming tasks.

Among the approaches that have been used in the teaching of statistics are CAI question and answer dialogs, statistics
as a tool in the teaching of a computer language, the computer as a computational tool, computer generated tests and homework, and the computer as simulator.

Designing Educational Software

In this section, the following topics dealing with software design will be discussed: learning theories, text, feedback, graphics, color and sound, and flowcharting and screen mapping. A summary of this section will be given at the end of this section.

Learning Theories

One important aspect to consider when designing or planning instruction is the applicability of the various educational learning theories. Two main theories of learning in education are the behavior theory of learning and the cognitive theory of learning. B.F. Skinner is one of the foremost proponents of the behavior theory of learning and Robert M. Gagne' has been one of the outspoken advocates of the cognitive theory of learning.

The behavior theory of learning proclaims that all we are and do is shaped through our environment by what Skinner calls "the contingencies of reinforcement." Skinner goes on to say that the contingencies are "the relations that prevail
between behavior on the one hand and the consequences of that behavior on the other" (Green, 1984, p. 23). Skinner claims that what's true for a rat pressing a lever to produce food is true for humans, but on a more complex scale. He believes that we act and think in the ways for which we are reinforced, and cease acting and thinking when reinforcement ceases. Reinforcement comes in many guises, from material rewards such as money and food, to less tangible forms such as approved and "automatic reinforcement" - the inner feeling of mastery or satisfaction.

Skinner has been the developer and the promoter of teaching machines and programmed instruction. With the rise of computer-assisted instruction (CAI), Skinner and his ideas are resurfacing (Green, 1984). Skinner views his teaching machine as an effort to do mechanically what can now be done more effectively with computers. As for the notion of presenting materials and evaluating an answer, Skinner believes that the computer can perform beautifully these activities.

Skinner advocates straightforward CAI with few or no frills (Green, 1984). He says that "the main thing is straight programmed instruction and the design of well-tested programs to teach basic subject matter". He believes that a good program of instruction guarantees a great deal of
success for the learner.

Skinner has this advice for courseware developers (Green, 1984):

1. Break the subject matter into small steps that are easily taken. The steps should progress so that after you have taken one, you are in a better position to take the next.

2. A student should learn immediately whether or not he has been successful through feedback.

3. There should be no penalties attached to failure, and no testing while the lesson is being presented.

4. Present the material, and give the student as much assistance as possible in order to obtain the correct answer to questions asked in the program.

5. Test program and revise it.

These are just some of the suggestions Skinner has for developers of CAI.

Gagne' believes that the major change in learning psychology today (Lipsitz, 1982) was the shift from behaviorist, stimulus-response (S-R) psychology to cognitive learning psychology. The cognitive theory is an information-processing kind of theory. This theory says that the initial stimulation that comes to the senses of the learner becomes transformed first into some neural impulses, and then goes
through more than one phase of additional transformation. Each of these transformations is important to learning. See Table 1 for these internal learning processes (Gagne', Wager, & Rojas, 1981). Gagne' goes on to say that the various processes that are proposed as part of the information-processing theory of learning and memory, are the kinds of processes that one needs to take into account when designing instruction (Lipsitz, 1982). It is important to know the kinds of external events that can effect the internal learning process. Gagne' thinks of instruction as a set of external events — deliberately planned ones — whose purpose is to support internal learning processes. The relation of these events to the internal learning processes is denoted in Table 1. More extensive accounts of these relationships are contained by Gagne' (1977) and Gagne' and Briggs (1979).

One of the first steps in designing CAI, so as to take advantage of principles of learning derived from theory and research, is to categorize the type of learning outcomes (Gagne' et al., 1981). This is usually done by examining the target objectives of a lesson, and identifying what type of performance is expected of the learner following instruction. Gagne' (1977) lists five categories of learning outcomes: (1) verbal information; (2) intellectual skills; (3) cognitive strategies; (4) motor skills; and (5) attitudes. Once the
<table>
<thead>
<tr>
<th>Internal Learning Process</th>
<th>External Instructional Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Alertness</td>
<td>1. Gaining attention</td>
</tr>
<tr>
<td>2. Expectancy</td>
<td>2. Informing learner of</td>
</tr>
<tr>
<td></td>
<td>lesson objective</td>
</tr>
<tr>
<td>3. Retrieval to working</td>
<td>3. Stimulating recall of</td>
</tr>
<tr>
<td>memory</td>
<td>prior learning</td>
</tr>
<tr>
<td>4. Selective perception</td>
<td>4. Presenting stimuli with</td>
</tr>
<tr>
<td></td>
<td>distinctive features</td>
</tr>
<tr>
<td>5. Semantic encoding</td>
<td>5. Guiding learning</td>
</tr>
<tr>
<td>responding</td>
<td></td>
</tr>
<tr>
<td>7. Reinforcement</td>
<td>7. Providing informative</td>
</tr>
<tr>
<td></td>
<td>feedback</td>
</tr>
<tr>
<td></td>
<td>and learning transfer</td>
</tr>
</tbody>
</table>
learning outcomes have been classified, the courseware designer should proceed with a series of displays that stimulate the learner in accordance with the events outlined in Table 1 (Gagne' et al., 1981).

The planning of CAI needs to make potential provisions for the display of frames containing print and diagrams to reflect all of the nine events of instruction given in Table 1 (Gagne' et al., 1981). However all of the different events are not always presented in each display. Sometimes the learning audience or the learning task makes inclusion of an event unnecessary.

Text

In this section, the appropriate use of text on a screen will be discussed. Kosel (1980) found that materials should be organized to allow frequent interaction between the student and the computer. Large blocks of text that do not give students a chance to respond should be avoided. In their research study, Friend and Milojkovic (1984) indicate that for greatest readability, text should be displayed in both upper-case and lower-case letters, and should be double-spaced. Hathaway (1984) in his research also concluded that the displayed text should be double-spaced and should have 80 characters per line consisting of upper- and lower-case
print. Friend and Milojkovic also state that text should not be crowded at the top or at the left of the screen. These authors go on to say that there should ordinarily be no more than 100 words per exercise for adults. Kosel (1980) indicates that scrolling of the screen should be avoided and that the reading speed should be controlled by the student in order to accommodate the learner's reading capability.

Feedback

In this section, some of the theories concerning the effective use of feedback will be discussed. Feedback is defined as the message which follows the response made by the learner (Cohen, 1985). In her research, Cohen found that some proponents of the operant conditioning theory believe that immediate feedback following correct responses could be used to shape behavior and maintain it in strength (Deterline, 1964; Fry, 1963; Skinner, 1968). Others believe that immediate feedback following positive responses does not act in a reinforcing manner (Anderson, Kulhavy, & Andre, 1972; Bardwell, 1981; Barringer & Gholson, 1979; Kulhavy, 1976).

Cohen (1985) found that still others believe the main function of feedback is not to strengthen or reinforce correct responses, but to locate errors and provide
information so that the learner can correct them (Anderson, 1972; Bardwell, 1981; Barringer & Gholson, 1979; Guthrie, 1971).

One particular kind of feedback message is called knowledge of correct results (KCR). KCR is defined as either a "right" or "wrong" feedback message. Anderson et al. (1972) did a study to determine the effects that knowledge of correct results (KCR) would have on student performance. They found that 100 percent KCR is the most effective, no KCR was the least effective and KCR given after wrong responses only was almost as effective as 100 percent KCR.

Graphics

In this section, research done on computer graphics will be discussed. Computer graphics will be defined as non-textual images displayed on a video screen or printer which are generated by a computer program (MicroSIFT, 1981). Computer graphics should not be included in CAI programs for entertainment purposes, but to enhance learning (Green, 1984; Kosel, 1980; Merrill & Bunderson, 1979; Friend and Milojkovic, 1984). In their research, Merrill and Bunderson (1979) found that graphics can be helpful in exposing learners to new concepts, objects, or events for which they
have no labels or corresponding visual images. They also found that interactive, dynamic computer graphics (those graphics controlled or changed based on user input) offer a unique, but largely unknown, training application potential.

Merrill and Bunderson also indicated that of the various forms of graphic art, simple black-and-white line drawings are the most effective for increasing achievement. In his research, Hathaway (1984) found that color graphics were not statistically different from black-and-white graphics. That is, Hathaway found that black-and-white graphics were just as effective on student performance as color graphics.

Bork (1971) found that graphics can be utilized as an alternate conveyor of information, different from the manner information is conveyed through words or numbers, and for motivational purposes. Bork also found that an advantage video graphics has over textbook graphics is that with video graphics, the entire text and the whole picture do not need to be displayed at once. With textbook graphics, there is no sense of information evolving in time to aid the student in understanding the information. Graphics can also be used for reinforcement (Kosel, 1980; Green, 1984) and to illustrate concepts (Kosel, 1980). The national assessments on the topic of graphics indicate that students should use graphics for the purposes of inferring and predicting (Bestgen, 1980).
Color and Sound

In this section, research studies concerned with the correct use of color and sound in the design of CAI will be discussed. According to research (Merrill and Bunderson, 1979; Green, 1984), color has little demonstrated impact on student performance. Even though color can be used to attract student attention (Kosel, 1980), it should not be used randomly without specific educational objectives in mind (Kosel, 1980; Merrill and Bunderson, 1979). In a research study done by Hathaway (1984), it was found that color graphics were not statistically different from black-and-white graphics. That is, graphics in black-and-white had the same effect on learning as color graphics.

In his research study, Kosel (1980) found that the CAI developer should judiciously make use of sound. The author found that the proper use of headphones, when sound is utilized in a CAI program, can prevent the sound from disturbing the rest of the class.

Flowcharting and Screen Mapping

In this section, research studies concerned with the effective use of flowchart and screen mapping will be discussed. The preparation of a visual representation of the program's flow is an important step in the design process.
Two techniques used are flowcharting (Hord, 1984) and screen mapping (Hord, 1984; Kosel, 1980). Hord defines flowcharting as a graphic description of the steps the programmer will take in presenting lessons to the learner. Screen mapping, says Hord, depicts what the user will see on the computer monitor, and denotes the logical order in which the screens will appear in the program. To prepare a screen map, Hord and Kosel indicate that one should map out the information that will appear on the computer monitor for each screen. Hord and Kosel also indicate that the screen design should contain information such as the identification of the unit, screen number, and the content of the screen.

Summary

The literature has shown that the designer should always keep in mind the lesson objectives in the design phase of CAI materials. Emphasis should be placed on the proper utilization of the external events of instruction in order to stimulate the internal learning processes. The literature has also shown that proper applications of the learning theories in education should be utilized when designing CAI materials. Two theories of learning and their relation to CAI design were discussed. These theories are the behavior theory of learning and the cognitive theory of
learning.

The literature also revealed that the preparation of a visual representation of the program's flow, and the judicious use of sound, color, and computer graphics, should all be emphasized when designing CAI units. It was also found that computer graphics can be utilized to reinforce the learning process and that black-and-white graphics were just as effective on student learning as color graphics.

Evaluation of CAI Materials

In some sense, judgements will have to be made concerning the quality of a CAI product. One needs to know how "good" is a piece of courseware material that will be used in an educational setting. Unfortunately, no universal set of accepted criteria exists for evaluating educational courseware. However, the literature contains many articles which provide guidelines for assessing the quality of a piece of CAI material.

Walker and Hess (1984) define evaluation of CAI material in three ways: the assessment of the quality of a piece of educational software, the appraisal of the effectiveness of a computer-based program to affect student learning, and the use of the computer's capabilities to assess the progress of a given student through a program of study.
This section will discuss evaluation in courseware development and the levels of evaluation for courseware. A summary for this section will be given at the end of this section.

**Evaluation in Courseware Development**

In this section, evaluation in courseware development will be discussed. It is generally agreed that some type of evaluation should take place in the development stage as well as the implementation stage of the courseware material (Walker and Hess, 1984; Reeves and Lent, 1982; Tennyson, 1978; McPherson-Turner, 1979). Walker and Hess (1984) give five evaluation options that a developer might consider when writing his CAI programs. From these five options, the developer can best choose those best suited to his particular situation. They are informal evaluations by the developer, systematic reviews using formal criteria, open-ended reviews, field trials, and formal evaluations. In informal evaluation, the courseware developer uses his knowledge and judgement to decide what features will be incorporated in the program. Systematic reviews using formal criteria might include such things as quality of content and goals, instructional quality, and technical quality. Open ended-reviews are done by an experienced courseware reviewer while
field trials consist of trial runs by an audience for whom the courseware is intended. Walker and Hess state that a formal evaluation is a controlled formal field test of the educational effectiveness of the program. These authors point out that such studies are not customary in courseware development.

Levels of Evaluation for Courseware

This section concerns itself with four levels of courseware evaluation. Anderson and Ball (1978) state that the purpose of evaluation during the development and implementation of CAI is to provide decision makers with accurate information which will contribute to decisions about the improvement, continuance, and/or expansion of the program. To accomplish this goal, Reeves and Lent (1982) list four levels of evaluation. These are called documentation, formative evaluation, assessment of immediate learner effectiveness, and impact evaluation.

In their study, Reeves and Lent (1982) consider the documentation level as that level which involves keeping records of when and where various project activities occur, the associated cost, and a record of the participant. Administrators could use documentation data to account for the use of project funds. Formative evaluation is the
collection of the opinions, suggestions, and criticisms of project participants. Assessment of immediate learner effectiveness of CAI involves measuring the degree to which the short-term learning objectives of CAI have been accomplished. One of the most common methods of evaluating immediate learner effectiveness of CAI is to include pretests and posttests in the CAI program.

Reeves and Lent (1982) describe impact evaluation as the process of assessing the long-term effects of CAI. One way to achieve impact evaluation is by using interviews and anecdotal records. These can be used to answer questions concerning the transfer of the knowledge and skills learned through CAI to other environments.

Reeves and Lent noted that very few CAI projects have employed more than one or two levels of evaluation. Many researchers concentrate their efforts at the formative level (Fitzpatrick & Howard, 1976; Muston & Wagstaff, 1976; Rubin, Geller, & Hanks, 1977) using the student questionnaire. On the other hand, other researchers concentrate their efforts on assessing the immediate learner effectiveness of their CAI project by using tests and/or quasi-experimental designs (Fletcher & Suppes, 1976; Su & Eman, 1975; Swigger, 1976).

In general, the kind of formative evaluation utilized will depend on whether the courseware is in the development
or implementation phase (Reeves & Lent, 1982). These authors in their research found that there are two major approaches to formative evaluation. They are internal review and operational testing. Internal review is the process of systematically reviewing the content and instructional processes of CAI before the implementation phase. An internal review includes small-scale pilot tests and expert review. Operational testing is obtained by using computer-based questionnaires, personal interviews, observations by designers and other observers, and measures of participant performance. Reeves and Lent (1982) suggest that designers and other observers might use a systematic review package, such as MicroSIFT's Evaluator's Guide for Microcomputer-Based Instructional Packages (MicroSIFT, 1981), in the operational testing phase of the formative evaluation.

From her research, Duquette (1984) developed a student formative evaluation form using the courseware criteria set forth in the research studies done by Roblyer (1981), Jay (1983), and Cohen (1983). The major categories of Roblyer's study are: essential characteristics, aesthetic characteristics, and differential characteristics. Criteria set forth by Jay's study include: memory and attention demands, text characteristics, graphics and visual processing, and feedback.
Summary

A review of the literature indicates that an evaluation of CAI materials is necessary in order to assess the quality of the CAI material. Evaluations are also performed in order to determine if any revision in the CAI material is necessary. Evaluation should be initiated during the development stage and it should be continued even after the CAI courseware has been implemented in order to continually improve the quality of the courseware materials.

Four levels of evaluation were discussed in this section. One of these levels, formative evaluation, is defined as the collection of the opinions, suggestions, and criticisms of project participants. A formative evaluation will consist of two parts: an internal review and operational testing.

Management Strategies for CAI

A problem which naturally arises in the design of CAI is where the locus of control should lie, with the computer program or with the learner. This section will discuss several studies relevant to this particular question.

Research by some has indicated that when students control the amount of CAI, they sometimes terminate too soon and consequently learn less (Felixbrod & O'Leary, 1974).
Tennyson and Buttrey (1980) attempted to answer the question of whether giving learners information during CAI about their progress would improve learner-control systems and program-control systems.

Tennyson and Buttrey used four groups in their research study dealing with advisement and management strategies in CAI. The 139 participants in this experiment were twelfth grade male and female students in psychology at Eisenhower Senior High School in Hopkins, Minnesota. The concepts discussed in this study—positive reinforcement, negative reinforcement, positive punishment, and negative punishment—were taken from the area of psychology (Tiemann, Kroeker, & Markle, 1977). Three subordinate concepts—stimulus, aversive stimulus, and attractive stimulus—were also discussed along with the concept relating to behavior consequences resulting from the stimulus.

Group 1, the learner-control with advisement group, consisted of students who were given control over the amount and sequence of instruction. Advisement was given following the pretest and after each response. Group 2, adaptive-control with advisement, consisted of students for which the amount and sequence of instruction was determined by the program. Students were advised of their progress at the completion of the pretest and after each response. Group 3,
learner-control without advisement, consisted of students who controlled the amount and sequence of instruction. No advisement was extended to this group. Group 4, adaptive-control without advisement, consisted of learners for which the amount and sequence of instruction were controlled by the program and no advisement was extended.

The results of this research indicated that the variable of advisement was significant in providing students in the learner-control with advisement condition with meaningful information which helped them make the correct decisions about learning the concepts. On the posttest, students in the learner-control with advisement condition did as well as students in the two adaptive-control conditions (each group achieved over 80% correct). Students in the learner-control without advisement scored only 58% on the posttest. Students in the learner-control with advisement condition remained on task long enough to obtain mastery. They were on task about 39% longer than the students in the conventional learner-control condition. Participants in the learner-control-with-advisement group on-task time was 22% less and their amount of instruction was 25% less than the program-control adaptive condition, respectively.

To determine the effect of student characteristics and student control on learning, Fry (1972) utilized three
experimental variables (college aptitude, inquisitiveness, and student control) in a 2 x 2 x 4 factorial design. Fry's three-factor experimental design included four levels of instructional treatment, two "inquiry" levels, and two aptitude levels. The instructional treatments were student-controlled instruction (SCI) treatment, expert treatment, random treatment, and control treatment. The subjects consisted of 192 volunteers in an introductory psychology course taught at Michigan State University during the fall term of 1969 and the winter term of 1970. The topic of discussion was "Computers and How They Work."

In the SCI treatment group, each subject was given a deck of cards, and each card contained a question about computers. Corresponding to each card, there was a videotape segment which answered the question on that card. Each subject could decide the sequence in which he wanted the questions answered. In the expert treatment group, a group of six computer-science instructors predetermined the sequence of instruction. The predetermined sequence was presented as a list of questions identical to those on the SCI cards. The subjects in the random treatment group viewed the video tape segment concerning computers in a completely random order, whereas the subjects in the control treatment group received instruction or information relative to the
computer. No other information concerning this latter group was provided.

Levels of inquiry were derived from a battery of tests by Shulman, Loupe, and Piper (1968). A total high score on these tests reflected individuals having a high level of inquisitiveness. Such individuals were considered to be high in cognitive complexity, preferring the ambiguous, the asymmetrical, and the unexpected. These students were also thought to be high in verbal problem solving. The aptitude levels were determined by standardized scores on college aptitude tests (ACT, CQT, or SAT). The distribution of scores for both inquiry and aptitude was divided at the median of the scores, respectively, in order to determine high and low groups.

Fry concluded that students high in both aptitude and inquisitiveness should be placed in a student controlled instructional treatment. Otherwise, the student should be assigned to an "expert-type" instruction. Fry found that low aptitude students learning under a high degree of student control tend to learn the least when compared to the other methods of instruction.

Johansen and Tennyson (1984) investigated whether learner-control can be facilitated by directly affecting perception of learning need. Perception was defined as the
learner's cognitive attitude toward what is to be learned based in part on previously learned information (Lindsay & Norman, 1977). The participants in this experiment were 48 11th-grade students enrolled in English classes at Eisenhower High School, Hopkins, Minnesota. The CAI in this study was taken from the area of English composition. It consisted of literacy terms, rules for footnoting research papers, and punctuation skills.

To evaluate the advisement-learner-control-management-strategy, three management control strategies were employed. The first strategy was the advisement-learner-control condition consisting of two components (a) an introductory component of instruction used to make the first assessment and (b) the learner-control section which contained the advisement information. The second strategy was the partial-learner-control condition including the introductory section of the first strategy but no advisement in the learner-control section. The third strategy was the conventional learner-control section. It consisted of just one section of continuous instruction with complete learner control and no initial assessment or advisement given.

The results of this experiment indicated that the students using the first strategy, the advisement-learner-control condition, performed better on the posttest than the
students in the other two conditions. Johansen and Tennyson concluded that learner-control can be a useful management strategy for CAI when the learner is told of his learning needs relative to a defined level of mastery. This study also indicated that learners can manage their own instruction and develop responsibility for their learning.

Tennyson (1980) utilized 135 male and female undergraduate students at the University of Madrid (Spain) in a research experiment. These participants were enrolled in an introductory physics course. The CAI concepts discussed were force, power, velocity, speed, molecular molecule, and atom structures. Tennyson considered three management strategies (learner-control, adaptive-control, and learner-adaptive control) in this experiment. This experiment demonstrated that students in a computer-based, learner-control condition learned more effectively if they are informed of their progress toward mastery of a given objective and given advice on the instruction needed to obtain mastery.

A review of the literature on the variable of advisement (Tennyson, Christensen, and Park, 1984) has indicated that (a) participants under a learner-control strategy do not stay on-task long enough to master the concepts discussed; (b) a program-control management strategy should be utilized to
keep learners on task before giving them complete learner-
control; and (c) with practice, the learner will gradually
improve his ability to make correct decisions concerning
advisement information.

Summary

In summary, research on management strategies for CAI
indicates that:

a. many students in learner control groups do not stay
   on task long enough to achieve mastery.

b. with practice, learners will gradually improve in
   their ability to make correct decisions from
   advisement information.

c. a program-control management strategy to keep
   learners on task before giving them full learner-
   control options results in better overall
   performance.

d. students high in both aptitude and inquisitiveness
   should be placed in a student-controlled
   instructional treatment.

e. low-aptitude students learning under a high degree of
   student-control tend to learn less when compared to
   other methods of instruction.

The literature also indicates that even though sophisticated
adaptive systems will in many cases eliminate the concern of premature termination by the learner, these systems still ignore the problem of learner responsibility.
CHAPTER 3

METHOD

In this chapter, the methodology used in the development and evaluation of NORSTAN will be discussed. NORSTAN is the name of the computer courseware program that was developed in this study (see Appendix A). The name NORSTAN originated from the two major topics discussed in this study: the normal distribution and standard scores.

Subjects

The student participants in this study were 59 graduate students matriculating in the College of Education at Louisiana State University during the summer and fall semesters of 1985. The number of subjects participating in the pilot field test was 9. There were 50 students who participated in the 2 x 3 factorial design research experiment. They were randomly assigned to one of three treatment groups. Each participant was categorized as either high-aptitude or low-aptitude, depending on whether his quantitative score was above or below the median of this group's quantitative scores on the Graduate Record Examination (GRE).
Development and Design

In this section, the courseware objectives and other design strategies of NORSTAN will be discussed.

Courseware Objectives

NORSTAN was programmed so that at the end of this courseware lesson, the student will be able to perform the following courseware objectives:

1. Give the distinguishing characteristics of a normal curve.
2. Tell what effect increasing the magnitude of the standard deviation or the mean has on the shape of a normal curve.
3. Determine the points of inflection of a normal curve.
4. Give the distinguishing characteristics of the unit normal curve.
5. Give the points of inflection of the unit normal curve.
6. Approximate the ordinate at a given z-value using a table of ordinates.
7. Give the definition of the term "z-score".
8. Transform a raw-score belonging to a normal population into its equivalent z-score.
9. Transform a z-score into its equivalent raw-score, given the mean and standard deviation of the normal raw-score population.

10. Approximate the proportion of the area under a normal curve lying below a given observation.

11. Compute the percentile rank of a given raw-score under the assumption that the population of raw-scores is normally distributed.

12. Approximate the proportion of the area under a normal curve lying above a given observation.

13. Approximate the proportion of area under a normal curve lying between two given observations.

14. Give the percent of area under a normal curve relative to the curve's standard deviation.

15. Approximate the number of observations that belong to a given normal population relative to the population's standard deviation.

16. Approximate the proportion of the area of a normal distribution lying below one observation and above a second observation.

17. Identify the distinguishing characteristics of a standard-score scale.

18. Transform a raw-score into its equivalent T-score.

19. Determine the percentile rank of a given T-score.
20. Transform a z-score into its corresponding standard-score on a given standard-score scale.

21. Compare the relative performances of the same student on two different tests assuming that the test scores are normally distributed.

Design Strategies for NORSTAN

In this section, the design strategies of NORSTAN will be discussed. NORSTAN is a tutorial computer-assisted instruction (CAI) lesson teaching the normal distribution and standard scores. The Normal Distribution and Standard Scores software package consists of the following seven units.

Unit 1  The Normal Curve
Unit 2  The Unit Normal Curve
Unit 3  z-Scores
Unit 4  Area Under a Normal Curve Lying Either Below or Above a Given Observation
Unit 5  Part 1. Area Under a Normal Curve Lying Between Two Observations.
        Part 2. Area Under a Normal Curve Relative to the Curve's Standard Deviation
Unit 6  Total Area Under a Normal Curve Lying Below One Observation and Above a Second Observation

Unit 7  Standard Scores

Graphical interpretations of these concepts were provided, when practical, to enhance clarification of the text presented. The purpose of this CAI lesson was to review or teach these concepts to graduate students in education. The prerequisites for this courseware were an understanding of the statistical concepts of the mean, median, mode, and standard deviation.

The NORSTAN courseware program contains both text and graphics. NORSTAN was designed in order to allow frequent interaction between the student and the computer, as Kosel (1980) advocates. No scrolling of the screen was permitted and the reading speed was controlled by the learner in accordance also with Kosel. The text utilized in this program was displayed in both upper-case and lower-case letters, and was double-spaced. Such a strategy is advocated by Hathaway (1984). The text was centered on each screen as Friend and Milojkovic (1984) advocate. The graphs were done in black-and-white. Hathaway (1984) found that graphics in black-and-white had the same effect on learning as color graphics. Sound was not utilized in this courseware in order
to eliminate any distraction that sound might have on the student participants.

The researcher utilized the cognitive theory of learning in the development of this courseware. The display of screens used in NORSTAN reflected the nine events of instruction given by Gagne' (1977). Appropriate use of color, graphs, and highlighting were useful in gaining the learner's attention. The learners were informed of the objectives of the lesson at the beginning of each unit. As the learner worked through the lesson, he was required to utilize the concepts learned in the earlier units. Color, graphs, and highlighting were also used to present stimuli with distinctive features.

The "RULEG" method was used by the programmer to guide student learning. This method requires that the programmer presents the rules to the learner, works some examples to illustrate the concepts in the given rules, and then asks the learner to work a similar problem. The learner was required to answer several questions in this courseware. Feedback was given when the student responded to a given question. The learner was first informed as to whether his answer was right or wrong. If the learner's response was incorrect, the researcher's program would branch in accordance with the remediation necessary for the learner. If the learner's response was correct, he would be allowed to continue to the
next screen. One of the ways the programmer employed to enhance retention and learning transfer was to require the learner to determine the value of a variable in a given formula utilizing the concepts discussed in this lesson.

The text utilized in this study was synthesized from chapter 6 in Glass and Hopkins (1984), chapter 3 in Hopkins and Stanley (1981), and chapter 6 in Glass and Hopkins (1978). Subroutines were incorporated into this program which draw the normal curve, approximate the ordinates of the unit normal curve (Appendix B), shade in the area under a unit normal curve, approximate the area under the normal curve lying below a given z-value (Appendix B), and approximate the area under the unit normal curve lying above a given z-value (Appendix B).

In this study, three management strategies and two aptitude levels were incorporated in a 2 x 3 factorial design in order to determine which strategy was most effective for a given level. The two aptitude levels were low-aptitude learners and high-aptitude learners. Both low-aptitude and high-aptitude learners were determined by the participants' median score on the quantitative portion of the GRE. The first strategy, learner-control (Group 1), consisted of two sections in each of the seven units discussed in this program. Section one consisted of text, examples, and
exercises. Section two consisted of ten review problems of which the learner had complete control over the number of review problems he desired to work. The second strategy, program-control with a mastery criterion and advisement (Group 2), also contained two sections in each of the seven units. Section one of this strategy was identical to section one of strategy one. Section two consisted of five review problems that the learner was given if he answered less than 80% of the exercises in section one. Section two of a given unit was omitted if the learner's score was at least 80%. The third strategy, program-control with neither a mastery criterion nor advisement (Group 3), consisted of only one section, which was identical to section one of the other two strategies.

At the end of each unit, NORSTAN provided the learner with a summary of his results. The summary consisted of the number of correct and incorrect responses in each section, the identity of the questions answered correctly and those answered incorrectly, the response given to each question, and the on-line learning time for each section.

**Evaluation of NORSTAN**

In this section, an evaluation of the CAI courseware (NORSTAN) developed in this study will be discussed. Three
of the four levels of evaluation advocated by Reeves and Lent (1982) were conducted: documentation, formative evaluation, and assessment of immediate learner effectiveness.

A small scale pilot test using 9 graduate students in education constituted one portion of this evaluation. These students were given a pretest and a posttest to ascertain learner performance on this courseware. The pretest and the posttest were identical, consisting of twenty multiple choice questions. A student evaluation form (see Appendix C), synthesized from an evaluation form given in a research paper by Duquette (1985), was administered to the student to ascertain student reaction data to NORSTAN. Another portion of the pilot test review consisted of a review by a team of experts. This team consisted of a statistical expert and an expert in CAI lesson design. This team utilized the courseware evaluation form developed by MicroSIFT (MicroSIFT, 1981) while conducting its evaluation. In their evaluations, the experts and the student participants considered such questions as:

1. Is the instructional content of the statistical program accurate?
2. Are the principles and applications of effective CAI utilized in NORSTAN?
3. Does the lesson cover all of the planned behavioral objectives?

4. Is NORSTAN interesting and motivating?

These portions of the evaluation process aided in diagnosing and remedying problems within the courseware before the third stage of the evaluation. Subsequently, NORSTAN was revised after taking these recommendations into account.

The second phase of the evaluation consisted of determining which of three management strategies for NORSTAN was the most effective for a given level of aptitude. Fifty graduate students studying in the College of Education at Louisiana State University were used in this phase of the evaluation. The student's posttest scores were used to ascertain which learning strategy was the most effective.

Instrumentation

This CAI lesson was designed to run on the IBM Personal Computer (PC) with Color/Graphics Monitor Adapter and printer. The computer language used in this program was Advanced BASIC (Beginners All-Purpose Symbolic Instruction Code).

The pretest and posttest (see Appendix D) instruments were both 20 item multiple choice criterion-referenced tests. For the pilot study, the pretest and the posttest
instruments were identical.

A complete table of areas and ordinates for the unit normal distribution was derived by the researcher, with the aid of the microcomputer, for the participants in this study (see Appendix B). The researcher was unable to find such a complete table in the literature.

**Procedure**

The 9 participants for the pilot test of this software package reported to the IBM Open Laboratory in Peabody Hall, room 114, during the summer semester of 1985. The learner was seated at a terminal and was given the pretest. After the pretest, the student was given a printed introduction to the program, which included the contents of the program, how to load the program, and what summary information the program would print. After running the program, the participants were given the posttest. Subsequent to taking the posttest, the learner was given a student evaluation form in order to react to the entire experiment. The participant was then permitted to leave.

The two experts who evaluated this software also reported to the IBM Open Laboratory during the summer semester of 1985. They were given the same information as the participants in the pilot study. To evaluate this
program, however, they were given the courseware evaluation form developed by MicroSIFT (MicroSIFT, 1981).

The 50 students who participated in the 2 x 3 factorial design research experiment were first randomly assigned to one of three management strategies for this software. Each student was later classified as either low-aptitude or high-aptitude depending on his/her quantitative score on the GRE. These learners were given a written introduction to this software package but they were not given a pretest, nor were they asked to evaluate the program. However, each student was given a posttest after running the program in order to determine which version was the most effective for a given level.

Summary

In this chapter, the methodology used in the development and evaluation of NORSTAN were discussed. NORSTAN is a tutorial computer-assisted instruction (CAI) lesson teaching topics on the normal distribution and standard scores. The evaluation of NORSTAN consisted of a small-scale pilot test, a review by a team of experts, and a 2 x 3 factorial design research experiment.
CHAPTER 4

ANALYSIS OF DATA

In this chapter, an analysis of the data collected during the pilot test and the 2 x 3 factorial design experiment will be discussed.

Pilot Test

This section will discuss student performance data, student evaluations, and expert evaluations conducted during the pilot test.

Student Performance

Nine graduate students matriculating in the College of Education at Louisiana State University participated in this pilot study. The means of the pretest and posttest scores were 13.14 and 18.67, respectively (Table 2). At the .01 level of significance, there was a significant difference between pretest and posttest mean scores. The test statistic utilized in this analysis was the dependent t-test. The calculated value of t was 3.838.

The questions presented in this lesson to the learner were of two types. There were exercises incorporated into each unit along with the text, and there was a section of review problems at the end of each unit. Descriptive statistics for each unit are shown in Table 3. The student
Table 2

<table>
<thead>
<tr>
<th></th>
<th>Pretest</th>
<th>Posttest</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>M</td>
<td>13.44</td>
<td>18.67</td>
</tr>
<tr>
<td>SD</td>
<td>4.16</td>
<td>1.32</td>
</tr>
</tbody>
</table>

*a Maximum number of questions on the pretest and the posttest was 20.

Note. N denotes the number of participants, M denotes the mean, and SD denotes the standard deviation.
Table 3

Number of Exercises Per Unit, Mean, and Standard Deviation of the Exercises for the Pilot Experiment

<table>
<thead>
<tr>
<th>Unit of Instruction</th>
<th>a ( n )</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 1</td>
<td>6</td>
<td>( M = 5.22 )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( SD = 0.83 )</td>
</tr>
<tr>
<td>Unit 2</td>
<td>7</td>
<td>( M = 6.00 )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( SD = 1.00 )</td>
</tr>
<tr>
<td>Unit 3</td>
<td>8</td>
<td>( M = 7.67 )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( SD = 0.50 )</td>
</tr>
<tr>
<td>Unit 4</td>
<td>6</td>
<td>( M = 5.22 )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( SD = 0.67 )</td>
</tr>
<tr>
<td>Unit 5</td>
<td>16</td>
<td>( M = 13.56 )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( SD = 1.67 )</td>
</tr>
<tr>
<td>Unit 6</td>
<td>3</td>
<td>( M = 2.33 )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( SD = 0.87 )</td>
</tr>
<tr>
<td>Unit 7</td>
<td>7</td>
<td>( M = 6.00 )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( SD = 0.87 )</td>
</tr>
</tbody>
</table>

Note. The number of participants in the pilot study was 9.

a The letter \( n \) denotes the number of exercises in the given unit.
mean score on the exercises was highest in Unit 3. Unit 5 had at least twice as many exercises as did any of the other units. In this unit, the students answered incorrectly an average of 2.44 exercises out of a possible 16 exercises given. In the remaining units, the students answered incorrectly an average of 1 exercise or fewer.

Relative to the review exercises, the students' mean score was higher in Unit 1 and Unit 2 than in any of the remaining units (Table 4). The students on the average answered incorrectly one review problem or fewer in each of the units given.

Of the seven units included in this lesson, the students spent the most time on Unit 5 and the least time on Unit 6 (Table 5). The time t denotes the total time spent on the text, exercises, and review problems. Overall, the lesson took an average time of 1 hour and 50 minutes to complete.

**Student Evaluations**

All of the student participants during the pilot test study either agreed or strongly agreed that the objectives and the pretest were helpful in understanding what they were to learn from this program and identifying those parts of the software package they were probably familiar with. The
Table 4
Number of Review Problems Per Unit, Mean, and Standard Deviation of the Review Problems for the Pilot Experiment

<table>
<thead>
<tr>
<th>Unit of Instruction</th>
<th>a n</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 1</td>
<td>5</td>
<td>M = 4.78</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD = 0.44</td>
</tr>
<tr>
<td>Unit 2</td>
<td>5</td>
<td>M = 4.78</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD = 0.44</td>
</tr>
<tr>
<td>Unit 3</td>
<td>5</td>
<td>M = 4.67</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD = 0.50</td>
</tr>
<tr>
<td>Unit 4</td>
<td>5</td>
<td>M = 4.11</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD = 0.60</td>
</tr>
<tr>
<td>Unit 5</td>
<td>4</td>
<td>M = 3.22</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD = 1.20</td>
</tr>
<tr>
<td>Unit 6</td>
<td>3</td>
<td>M = 2.67</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD = 0.71</td>
</tr>
<tr>
<td>Unit 7</td>
<td>5</td>
<td>M = 4.00</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SD = 0.50</td>
</tr>
</tbody>
</table>

The letter n denotes the number of review problems.
Table 5

Mean and Standard Deviation On-Line Learning Time Per Unit for the Pilot Experiment

<table>
<thead>
<tr>
<th>Unit</th>
<th>t (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 1</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>12.00</td>
</tr>
<tr>
<td>SD</td>
<td>4.32</td>
</tr>
<tr>
<td>Unit 2</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>9.17</td>
</tr>
<tr>
<td>SD</td>
<td>4.28</td>
</tr>
<tr>
<td>Unit 3</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>10.95</td>
</tr>
<tr>
<td>SD</td>
<td>5.72</td>
</tr>
<tr>
<td>Unit 4</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>16.92</td>
</tr>
<tr>
<td>SD</td>
<td>5.53</td>
</tr>
<tr>
<td>Unit 5</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>38.98</td>
</tr>
<tr>
<td>SD</td>
<td>12.01</td>
</tr>
<tr>
<td>Unit 6</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>7.08</td>
</tr>
<tr>
<td>SD</td>
<td>3.60</td>
</tr>
<tr>
<td>Unit 7</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>15.15</td>
</tr>
<tr>
<td>SD</td>
<td>5.97</td>
</tr>
<tr>
<td>Overall</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>110.27</td>
</tr>
<tr>
<td>SD</td>
<td>37.50</td>
</tr>
</tbody>
</table>

Total number of participants was 9.
learners also indicated that this lesson was given in a logical order, that the language was easy to understand, and that there were enough examples and questions during the lesson to help understand the concepts that were taught. The students also agreed that feedback was effectively employed.

Relative to the technical quality of the program, the participants indicated that the screens were easy to read, that there were not too many words on the screens, and that the colors were not distracting. They strongly agreed that the graphics in this program helped to reinforce the concepts discussed.

Overall, the participants indicated that the posttest was generally fair. However, two participants felt that one question on the posttest was ambiguous and needed clarification. This question was subsequently reworded to remove this ambiguity.

All of the student evaluators expressed their approval of this program. They specifically indicated a fondness for the graphics in this program as well as the real-life examples and exercises. However, a few suggestions were made by the student evaluators which were used in the revision of this courseware. Some of the students believed that some of the units had too many similar exercises and that some of these exercises should be eliminated. The students were most
helpful in pointing out a few typing and grammatical errors, and making general suggestions which improved the overall quality of this program. NORSTAN was subsequently revised in order to incorporate these suggestions. All of the learners believed that this program would be very useful for any student desiring to learn or review the concepts discussed in this lesson.

Expert Evaluations

Two experts were selected to evaluate this software program. One is a teaching expert in statistics and the other is an expert in CAI lesson design. Both experts utilized the MicroSIFT Courseware Evaluation Form produced by the Northwest Regional Laboratory to evaluate this software.

Both experts agreed that the content of this program was accurate and had educational value. They also agreed that the purpose of this program was well defined, that the program achieved its defined purpose, that the presentation was clear and logical, and that both graphics and color were used for appropriate instructional reasons. They further agreed that the use of this program was motivational.

With regard to the technical characteristics, both experts indicated that the user support materials were comprehensive, and that teachers should easily be able to
employ this program. The experts also indicated that the intended user should easily and independently be able to operate this program.

On a scale of 1 to 5, with 5 being high and 1 as low, the experts rated this program a 5 with respect to content characteristics. Both experts agreed to recommend the use of this program with few suggested changes to be made. One of the experts indicated that Unit 5 was disproportionately longer than the other units in length, and should be streamlined in order to approximate the others in length. Efforts were made to implement this suggestion, as well as others.

While writing this program, two other experts made valuable suggestions concerning the screen layouts and lesson content of the program. One of these is an expert in statistics and the other is an expert in CAI lesson design. Their suggestions were implemented before the pilot test was initiated.
Factorial Design Experiment

The participants in this 2 x 3 factorial design were matriculating in the college of education at Louisiana State University during the fall semester of 1985. The number of participants was 50 (Table 6). The cell sizes were approximately equal, with each cell consisting of either 8 or 9 students. A one-factor ANOVA was conducted on the participants' GRE quantitative aptitude scores. No significant differences were found among the three treatment groups (F(2,47) = 0.23; Group 1 mean = 530.35, Group 2 mean = 520.00, Group 3 mean = 507.06). Relative to the dependent variable of posttest scores, note that for Level 1, Group 1 cell had the highest mean for all of the cells and that for Level 2, Group 1 cell had the lowest. The independent t-test revealed a significance difference between these two cell means at the .05 level of significance. This finding was consistent with the research hypothesis of a significant difference between the posttest scores of high-aptitude learner-control subjects and low-aptitude learner-control subjects.

It should be noted that in Level 1, the group having the highest mean was Group 1. In Level 2, the group having the highest mean was Group 2. These findings were consistent with the review of the literature which advocated a learner-
Table 6

Number of Observations, Mean, and Standard Deviation of the Posttest Scores for the 2 x 3 Factorial Design Experiment

<table>
<thead>
<tr>
<th></th>
<th>Group 1</th>
<th>Group 2</th>
<th>Group 3</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level 1</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Group</strong></td>
<td>N = 9</td>
<td>8</td>
<td>8</td>
<td>25</td>
</tr>
<tr>
<td>M</td>
<td>17.44</td>
<td>16.38</td>
<td>16.25</td>
<td>16.72</td>
</tr>
<tr>
<td>SD</td>
<td>2.50</td>
<td>3.46</td>
<td>4.03</td>
<td>3.26</td>
</tr>
<tr>
<td><strong>Level 2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Group</strong></td>
<td>N = 8</td>
<td>8</td>
<td>9</td>
<td>25</td>
</tr>
<tr>
<td>M</td>
<td>12.50</td>
<td>15.88</td>
<td>14.33</td>
<td>14.24</td>
</tr>
<tr>
<td>SD</td>
<td>4.75</td>
<td>4.29</td>
<td>2.45</td>
<td>3.98</td>
</tr>
<tr>
<td><strong>Overall</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>17</td>
<td>16</td>
<td>17</td>
<td>50</td>
</tr>
<tr>
<td>M</td>
<td>15.12</td>
<td>16.12</td>
<td>15.24</td>
<td>15.48</td>
</tr>
<tr>
<td>SD</td>
<td>4.41</td>
<td>3.77</td>
<td>3.33</td>
<td>3.81</td>
</tr>
</tbody>
</table>

**Note.** Maximum posttest score = 20

a  Student-Control Group

b  Program-Control with a Mastery Criterion and Advisement

c  Program-Control with neither a Mastery Criterion nor Advisement

d  High-Aptitude Learners

e  Low-Aptitude Learners
control strategy for high-aptitude students and a program-
control strategy for low-aptitude subjects.

Table 6 also indicates that Level 1 overall posttest
mean was higher than Level 2 overall posttest mean. An ANOVA
on the posttest dependent variable indicated that this
difference was significant at the .05 level of significance
(Table 7). Group 2 had the highest overall mean and Group 1
had the lowest overall mean. An ANOVA on the treatment
factor revealed that there was no main effect for the
treatment variable (Table 7). Interaction of the aptitude
factor and the treatment factor was not significant at the
.05 level.

Relative to the exercises, the students' mean score
performance for the High-Aptitude Learner-Control Group was
the highest for Unit 2 and the lowest for Unit 1 (Table 8).
They spent the most time on the text and exercises in Unit 5
and the least amount of time in Unit 7. Overall, the learner
took an average time of about 1 hour and 26 minutes to
complete the text and exercises. These students requested a
greater number of review problems toward the beginning of the
program and a lesser number of review problem toward the end.

The average learner in the Low-Aptitude Learner-Control
Group took about 1 hour and 58 minutes (Table 9) in order to
complete the text and the exercises, whereas the average
Table 7

Analysis of Variance Summary Table for the Dependent Variable of Posttest Mean Score Using the Factors of Treatment and Aptitude

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>F-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Error</td>
<td>44</td>
<td>582.47</td>
<td></td>
</tr>
<tr>
<td>Treatment</td>
<td>2</td>
<td>11.58</td>
<td>0.44</td>
</tr>
<tr>
<td>Aptitude</td>
<td>1</td>
<td>75.03</td>
<td>5.67</td>
</tr>
<tr>
<td>Aptitude x</td>
<td>2</td>
<td>42.75</td>
<td>1.61</td>
</tr>
</tbody>
</table>

* $p < .05$
Table 8

Number of Exercises, Time on Text and Exercises, Number of Review Problems, Time on Review Problems, Means, and Standard Deviations, for the High-Aptitude Learner-Control Group in the 2 x 3 Factorial Design Experiment

<table>
<thead>
<tr>
<th>Exercises</th>
<th>t(min)</th>
<th>Review Problems</th>
<th>t(min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Text and Exer.</td>
<td></td>
<td>Review</td>
</tr>
<tr>
<td>n = 6</td>
<td>4.44</td>
<td>11.65</td>
<td>5.55</td>
</tr>
<tr>
<td>Unit 1</td>
<td>0.88</td>
<td>2.89</td>
<td>4.36</td>
</tr>
<tr>
<td>n = 7</td>
<td>7</td>
<td>7.18</td>
<td>3.33</td>
</tr>
<tr>
<td>Unit 2</td>
<td>0</td>
<td>2.03</td>
<td>4.15</td>
</tr>
<tr>
<td>n = 8</td>
<td>7.89</td>
<td>9.36</td>
<td>3.11</td>
</tr>
<tr>
<td>Unit 3</td>
<td>0.33</td>
<td>2.24</td>
<td>3.69</td>
</tr>
<tr>
<td>n = 6</td>
<td>5.22</td>
<td>11.41</td>
<td>2.89</td>
</tr>
<tr>
<td>Unit 4</td>
<td>0.67</td>
<td>2.95</td>
<td>3.62</td>
</tr>
<tr>
<td>n = 11</td>
<td>10.33</td>
<td>20.92</td>
<td>2.56</td>
</tr>
<tr>
<td>Unit 5</td>
<td>0.71</td>
<td>5.76</td>
<td>4.06</td>
</tr>
<tr>
<td>n = 8</td>
<td>7.67</td>
<td>13.84</td>
<td>1.77</td>
</tr>
<tr>
<td>Unit 6</td>
<td>0.71</td>
<td>6.96</td>
<td>3.67</td>
</tr>
<tr>
<td>n = 7</td>
<td>6.44</td>
<td>12.00</td>
<td>1.78</td>
</tr>
<tr>
<td>Unit 7</td>
<td>0.53</td>
<td>3.86</td>
<td>3.56</td>
</tr>
<tr>
<td>n = 53</td>
<td>49</td>
<td>86.35</td>
<td>21.00</td>
</tr>
<tr>
<td>Overall</td>
<td>2.60</td>
<td>21.33</td>
<td>24.96</td>
</tr>
</tbody>
</table>

Note. n denotes the number of exercises in the given unit

The learner had the option of working from 0 to 10 review problems. Each number in parenthesis represents the average number of review problem requested.
### Table 9

<table>
<thead>
<tr>
<th>Exercises</th>
<th>t(min)</th>
<th>Review Problems</th>
<th>t(min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Text and Exer.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>n = 6</td>
<td>M = 4.12</td>
<td>14.36</td>
<td>4.38</td>
</tr>
<tr>
<td></td>
<td>SD = 1.25</td>
<td>5.18</td>
<td>4.50</td>
</tr>
<tr>
<td>n = 7</td>
<td>M = 6.00</td>
<td>9.80</td>
<td>3.25</td>
</tr>
<tr>
<td></td>
<td>SD = 1.20</td>
<td>2.98</td>
<td>3.88</td>
</tr>
<tr>
<td>n = 8</td>
<td>M = 6.38</td>
<td>18.27</td>
<td>1.88</td>
</tr>
<tr>
<td></td>
<td>SD = 1.68</td>
<td>7.11</td>
<td>2.47</td>
</tr>
<tr>
<td>n = 6</td>
<td>M = 4.50</td>
<td>15.38</td>
<td>2.12</td>
</tr>
<tr>
<td></td>
<td>SD = 1.20</td>
<td>4.98</td>
<td>2.75</td>
</tr>
<tr>
<td>n = 11</td>
<td>M = 8.25</td>
<td>25.95</td>
<td>0.88</td>
</tr>
<tr>
<td></td>
<td>SD = 2.38</td>
<td>4.90</td>
<td>1.64</td>
</tr>
<tr>
<td>n = 8</td>
<td>M = 6.00</td>
<td>16.97</td>
<td>0.13</td>
</tr>
<tr>
<td></td>
<td>SD = 1.41</td>
<td>4.38</td>
<td>0.35</td>
</tr>
<tr>
<td>n = 7</td>
<td>M = 4.25</td>
<td>16.99</td>
<td>1.12</td>
</tr>
<tr>
<td></td>
<td>SD = 2.05</td>
<td>4.13</td>
<td>2.47</td>
</tr>
<tr>
<td>n = 53</td>
<td>M = 39.50</td>
<td>117.72</td>
<td>13.75</td>
</tr>
<tr>
<td></td>
<td>SD = 6.70</td>
<td>25.50</td>
<td>13.70</td>
</tr>
</tbody>
</table>

The learner had the option of working from 0 to 10 review problems. This number represents the average number of problems selected.
student in their high-aptitude counterpart spent an average of 32 minutes less to complete this same portion. This group's mean exercise score in each unit is also less than their high-aptitude counterpart. Their best effort was in Unit 2 and their worst effort was in Unit 7. Note also that this group tended to select a greater number of review problems toward the beginning of the program and a lesser number of review problems toward the end, just as their high-aptitude counterpart.

For the High-Aptitude Program-Control with a Mastery Criterion and Advisory Group, all students were above the 80% mastery level in Unit 2, Unit 3, and Unit 6 (Table 10). Only 1 student was required to work the five review problems in Unit 5 and Unit 7. This group needed the most help in Unit 1, where 5 out of the 8 participants were required to work the section of review problems. The average time for the text and exercises was 1 hour and 22 minutes.

For the Low-Aptitude Program-Control with a Mastery Criterion and Advisory Group, all students were above the 80% mastery level in Unit 5 and Unit 6 (Table 11). These students also had the most difficulty in Unit 1, just as their high-aptitude counterpart. Only 1 student needed the review problems for Unit 2. In each of the remaining sections, only two students required the review problems. The average time
Table 10

Number of Exercises, Time on Text and Exercises, Number of Review Problems, Time on Review Problems, Means, and Standard Deviations, for the High-Aptitude Program-Control with a Mastery Criterion and Advisement Group in the 2 x 3 Factorial Design Experiment

<table>
<thead>
<tr>
<th>Unit</th>
<th>n</th>
<th>M</th>
<th>SD</th>
<th>t(min)</th>
<th>Review t(min)</th>
<th>(k)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Exercises</td>
<td>Review Problems</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Text and Exer.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(k = 5)</td>
</tr>
<tr>
<td>Unit 1</td>
<td>6</td>
<td>4.38</td>
<td>0.92</td>
<td>11.42</td>
<td>4.80</td>
<td>1.92</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Review Problems</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.60</td>
</tr>
<tr>
<td>Unit 2</td>
<td>7</td>
<td>6.88</td>
<td>0.35</td>
<td>5.92</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 3</td>
<td>8</td>
<td>7.88</td>
<td>0.35</td>
<td>9.69</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 4</td>
<td>6</td>
<td>5.25</td>
<td>1.04</td>
<td>11.48</td>
<td>3.67</td>
<td>5.16</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 5</td>
<td>11</td>
<td>10</td>
<td>1.20</td>
<td>20.08</td>
<td>2.00</td>
<td>10.23</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 6</td>
<td>8</td>
<td>7.75</td>
<td>0.46</td>
<td>11.63</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 7</td>
<td>7</td>
<td>6.38</td>
<td>1.06</td>
<td>12.00</td>
<td>5.00</td>
<td>7.08</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>53</td>
<td>48.30</td>
<td>3.07</td>
<td>82.20</td>
<td>22.21</td>
<td></td>
</tr>
</tbody>
</table>

Note. The variable k denotes the number of students out of 8 requiring the 5 review problems.

* Students did not require any review problems.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Table 11

Number of Exercises, Time on Text and Exercises, Number of Review Problems, Time on Review Problems, Means, and Standard Deviations, for the Low-Aptitude Program-Control with a Mastery Criterion and Advisement Group in the 2 x 3 Factorial Design Experiment

<table>
<thead>
<tr>
<th>Exercises</th>
<th>t(min)</th>
<th>Review Problems</th>
<th>t(min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Text and Exer.</td>
<td></td>
<td>Review</td>
</tr>
<tr>
<td>n = 6</td>
<td>(k = 5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 1</td>
<td>M = 4.12</td>
<td>15.26</td>
<td>4.60</td>
</tr>
<tr>
<td></td>
<td>SD = 1.12</td>
<td>9.17</td>
<td>0.55</td>
</tr>
<tr>
<td>n = 7</td>
<td>(k = 1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 2</td>
<td>M = 6.50</td>
<td>9.06</td>
<td>5.00</td>
</tr>
<tr>
<td></td>
<td>SD = 1.07</td>
<td>3.01</td>
<td>0.00</td>
</tr>
<tr>
<td>n = 8</td>
<td>(k = 2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 3</td>
<td>M = 7.00</td>
<td>15.83</td>
<td>4.00</td>
</tr>
<tr>
<td></td>
<td>SD = 0.76</td>
<td>2.71</td>
<td>1.41</td>
</tr>
<tr>
<td>n = 6</td>
<td>(k = 2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 4</td>
<td>M = 5.12</td>
<td>14.90</td>
<td>2.50</td>
</tr>
<tr>
<td></td>
<td>SD = 0.83</td>
<td>4.64</td>
<td>2.12</td>
</tr>
<tr>
<td>n = 11</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 5</td>
<td>M = 9.88</td>
<td>30.23</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>SD = 0.83</td>
<td>9.07</td>
<td></td>
</tr>
<tr>
<td>n = 8</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 6</td>
<td>M = 7.87</td>
<td>15.96</td>
<td>*</td>
</tr>
<tr>
<td></td>
<td>SD = 0.35</td>
<td>3.94</td>
<td></td>
</tr>
<tr>
<td>n = 7</td>
<td>(k = 2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unit 7</td>
<td>M = 5.88</td>
<td>18.00</td>
<td>2.50</td>
</tr>
<tr>
<td></td>
<td>SD = 0.99</td>
<td>6.07</td>
<td>0.71</td>
</tr>
<tr>
<td>n = 53</td>
<td>Overall</td>
<td>48.50</td>
<td>119.24</td>
</tr>
<tr>
<td></td>
<td>M = 1.85</td>
<td>32.68</td>
<td></td>
</tr>
</tbody>
</table>

Note. The variable k denotes the number of learners out of 8 requiring the 5 review problems.

* Students did not require any review problems.
spent on the text and exercises was 1 hour and 59 minutes. This was 37 minutes more than their high-aptitude counterpart.

In the High-Aptitude Program-Control with neither a Mastery Criterion nor Advisement Group, the students answered incorrectly 1.5 exercises or fewer in each unit. The students' worst performance was in Unit 1, where they answered only 75% of the exercises correctly, and their best performance was in Unit 2, where they answered 96% of the exercises correctly (Table 12). For the entire lesson, the students in this group answered correctly 48 exercises out of 53. They spent an average time of approximately 1 hour and 41 minutes to complete the entire lesson.

In the Low-Aptitude Program-Control with neither a Mastery Criterion nor Advisement Group, the students' worst performance was in Unit 1, where they answered only 52% of the exercises correctly, and their best performance was in Unit 3, where they answered 86% of the problems correctly (Table 13). For the entire lesson, this group answered an average of 41 exercises out of 53, whereas their high-aptitude counterpart answered an average of 48 exercises out of 53. This group also spent about 2 hours in learning time on this program, which was about 19 minutes more than their high-aptitude counterpart.
Table 12

Number of Exercises, Time on Text and Exercises, Number of Review Problems, Time on Review Problems, Means, and Standard Deviations, for the High-Aptitude Program—Control with neither a Mastery Criterion nor Advisement Group in the 2 x 3 Factorial Design Experiment

<table>
<thead>
<tr>
<th>Unit</th>
<th>M (Exercises)</th>
<th>SD (Exercises)</th>
<th>M (Text and Exercises)</th>
<th>SD (Text and Exercises)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unit 1</td>
<td>4.50</td>
<td>0.92</td>
<td>13.35</td>
<td>2.91</td>
</tr>
<tr>
<td>Unit 2</td>
<td>6.75</td>
<td>0.71</td>
<td>8.14</td>
<td>1.75</td>
</tr>
<tr>
<td>Unit 3</td>
<td>7.38</td>
<td>1.25</td>
<td>12.16</td>
<td>3.05</td>
</tr>
<tr>
<td>Unit 4</td>
<td>5.13</td>
<td>1.25</td>
<td>13.35</td>
<td>3.05</td>
</tr>
<tr>
<td>Unit 5</td>
<td>10.25</td>
<td>1.04</td>
<td>23.68</td>
<td>2.80</td>
</tr>
<tr>
<td>Unit 6</td>
<td>7.63</td>
<td>0.52</td>
<td>14.56</td>
<td>1.61</td>
</tr>
<tr>
<td>Unit 7</td>
<td>6.38</td>
<td>0.92</td>
<td>15.63</td>
<td>2.64</td>
</tr>
<tr>
<td>Overall</td>
<td>48.00</td>
<td>5.24</td>
<td>100.87</td>
<td>14.25</td>
</tr>
</tbody>
</table>

Note. The variable n denotes the number of exercises.
Table 13

Number of Exercises, Time on Text and Exercises, Number of Review Problems, Time on Review Problems, Means, and Standard Deviations, for the Low-Aptitude Program-Control with neither a Mastery Criterion nor Advisement Group in the 2 x 3 Factorial Design Experiment

<table>
<thead>
<tr>
<th>Exercises</th>
<th>t(min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Text and Exercises</td>
</tr>
<tr>
<td><strong>Unit 1</strong></td>
<td></td>
</tr>
<tr>
<td>n = 6</td>
<td></td>
</tr>
<tr>
<td>M = 3.11</td>
<td>13.97</td>
</tr>
<tr>
<td>SD = 1.27</td>
<td>2.26</td>
</tr>
<tr>
<td>n = 7</td>
<td></td>
</tr>
<tr>
<td>M = 5.33</td>
<td>9.19</td>
</tr>
<tr>
<td>SD = 1.22</td>
<td>3.04</td>
</tr>
<tr>
<td>n = 8</td>
<td></td>
</tr>
<tr>
<td>M = 6.89</td>
<td>15.80</td>
</tr>
<tr>
<td>SD = 0.78</td>
<td>5.48</td>
</tr>
<tr>
<td>n = 6</td>
<td></td>
</tr>
<tr>
<td>M = 4.67</td>
<td>16.72</td>
</tr>
<tr>
<td>SD = 0.87</td>
<td>3.30</td>
</tr>
<tr>
<td>n = 11</td>
<td></td>
</tr>
<tr>
<td>M = 8.89</td>
<td>27.86</td>
</tr>
<tr>
<td>SD = 1.62</td>
<td>6.76</td>
</tr>
<tr>
<td>n = 8</td>
<td></td>
</tr>
<tr>
<td>M = 6.67</td>
<td>17.64</td>
</tr>
<tr>
<td>SD = 1.22</td>
<td>3.95</td>
</tr>
<tr>
<td>n = 7</td>
<td></td>
</tr>
<tr>
<td>M = 5.33</td>
<td>19.02</td>
</tr>
<tr>
<td>SD = 1.32</td>
<td>4.30</td>
</tr>
<tr>
<td>n = 53</td>
<td></td>
</tr>
<tr>
<td>M = 40.89</td>
<td>120.20</td>
</tr>
<tr>
<td>SD = 5.49</td>
<td>19.23</td>
</tr>
</tbody>
</table>

**Note.** The variable n denotes the number of exercises.
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This study was concerned with the writing and evaluation of a CAI lesson in statistics, teaching concepts on the normal distribution family and standard scores. The student participants in this study were 59 graduate students matriculating in the College of Education at Louisiana State University during the summer and fall semesters of 1985. The evaluation of this program was essentially conducted in two parts. One part was a small scale pilot test which included a pretest, a posttest, student evaluations, and expert evaluations. The other portion consisted of a 2 x 3 factorial design experiment. One factor, quantitative aptitude, consisted of two levels: low-aptitude and high-aptitude. Low-aptitude and high-aptitude were determined by the students' median score on the quantitative portion of the Graduate Record Examination (GRE). The other factor, management strategy, consisted of three levels: learner-control, program-control with a mastery criterion and advisement, and program-control with neither a mastery criterion nor advisement. The students were randomly assigned to these three levels.
Summary

The following findings pertain to the CAI lesson investigated in this study. The null hypothesis that there would be no significant difference between pretest and posttest mean scores during the pilot test was rejected at the .01 level of significance, indicating that an increase did occur with regard to academic achievement as a result of the CAI lesson. Thus the lesson was effective in teaching the concepts of the normal distribution and standard scores.

The student participants indicated that this CAI lesson was easy to use, effectively covered all of its objectives, that color was effectively utilized, that the graphics helped to reinforce the concepts discussed, and that feedback was effectively used. The students also appreciated the real-life examples, exercises, and review problems contained in this lesson. The student participants did offer a few suggestions which were useful in revising this courseware. The learners were helpful in pointing out typing errors and some grammatical errors. Some of the students indicated that certain units in this courseware contained too many similar exercises. The researcher's program was subsequently revised in order to eliminate some of these exercises.

The expert evaluators agreed that the content of this CAI lesson was accurate, had educational value, and that this
lesson achieved its defined purpose. They particularly felt that the graphics were effectively employed and that color was appropriately utilized. They believed that teachers and students should easily be able to employ this software program.

The following findings pertain to the 2 x 3 factorial design experiment conducted in this study. The high-aptitude learners had a significantly higher posttest score than the low aptitude learners at the .05 level of significance. The null hypothesis of no significant difference in posttest scores for the treatment factor was not rejected at the .05 level of significance. Also, the null hypothesis of no significant difference in posttest scores for the interaction of aptitude and treatment was not rejected at the .05 level of significance. The independent t-test indicated that the mean posttest score of the high-aptitude learner-control students was significantly higher than the mean posttest score of the low-aptitude learner-control students at the .05 level of significance.

The mean on-line total time for high-aptitude learners was significantly lower than the mean on-line total time for low-aptitude learners at the .05 level of significance. There was no significant difference with regard to the mean on-line total time for the three treatment groups.
Furthermore, there was no significant interaction between the treatment factor and the aptitude factor relative to the mean on-line total time. The independent t-test did not indicate that a significant difference in on-line total time existed between the learner-control management strategy and one of the program-control management strategies at any aptitude level at the .05 level of significance.

Conclusions

The following conclusions were drawn on the basis of the data collected in this study.

1. The mean of the posttest scores for the group of participants in the pilot test study was significantly higher than the mean of their pretest scores.

This conclusion indicated that the microcomputer with its graphical, computational, and other capabilities can be effectively utilized to teach the concepts of the normal distribution and standard scores, provided that proper CAI programming guidelines are followed. The microcomputer effectively generated attractive graphs, performed numerical computations, clarified key concepts, promoted active student participation, improved student attitudes toward the use of computers in the learning situation, and individualized instruction. These findings were consistent with the reasons for using CAI which were given in the literature (Anderson,
Stockburger (1982) found that the computer could be effectively used to test the ability of students to estimate either the area below a raw-score under a normal curve with a given mean and standard deviation or the raw-score given the area, mean, and standard deviation. However, Stockburger did not use the graphical capabilities of the computer to teach these concepts. The researcher's courseware program utilized graphics in teaching these concepts which helped to illuminate the concepts discussed.

2. High-aptitude learner-control students had a significantly higher posttest mean score than low-aptitude learner-control students in the 2 x 3 factorial design experiment.

This conclusion was much stronger than that of Fry (1972) who concluded that a learner high in both aptitude and inquisitiveness should be placed in a learner-control instruction treatment. The researcher found that students high in aptitude only can be assigned to a learner-control instruction treatment. This conclusion was further consistent with the findings of Fry (1972), who found that low-aptitude students learned less under a high degree of learner-control and learned more under an "expert type" of instruction. The researcher's finding was inconsistent with that of Johansen and Tennyson (1984) who concluded that
learners can manage their own instruction and develop responsibility for their learning.

3. The data collected in this study indicated a trend of assigning low-aptitude students to a program-control management strategy.

This finding was consistent with the review of the literature done by Tennyson, Christensen, and Park (1984) who found that using a program-control management strategy to keep learners on task before giving them full learner-control options will result in better overall performance. This conclusion was inconsistent with that of Johansen and Tennyson (1984) who found that learners can manage their own instruction.

4. There was no significant difference in on-line total time among the three treatment groups. The high-aptitude learners on-line total time was significantly less than their low-aptitude counterpart. There was no significant difference in on-line total time between the learner-control management strategy and one of the program control management strategies at any level.

Tennyson and Buttrey (1980) found that learners under a program-control with advisement strategy spent the same amount of on-line time as learners did under a program-control without advisement strategy. They also found that students in a learner-control strategy given advisement would master the objective in less time than in a program-control adaptive system. In the present study, the researcher concluded that there was no significant difference in on-line
time among the three treatment groups in either a learner-control strategy, a program-control with a mastery criterion and advisement strategy, or a program-control with neither a mastery criterion nor advisement strategy.

5. Gagne's cognitive theory of learning was effectively utilized in the development of this courseware.

Gagne's nine events of instruction (Gagne', Wager, & Rojas, 1981) were effectively employed in the design of the instruction contained in this courseware. The student participants indicated that this courseware covered all of its objectives, that color and graphics were effectively employed, and that feedback was effectively used. The students also liked the real-life examples, exercises, and review problems given in this courseware. These are just some of the external instructional events used to support the internal learning processes as outlined by Gagne'.

Recommendations

Based on the data collected in this study, the researcher makes the following recommendations. Primary and supplementary CAI should be used in the teaching of concepts on the normal distribution family and standard scores. A learner-control management strategy is recommended for high-aptitude learners and a program-control management strategy is recommended for low-aptitude learners when
teaching statistics by means of CAI. The researcher recommends that the learners be given a pretest, a posttest, and be permitted to utilize this courseware over an extended period of time rather than as a single block of instruction. Additionally, use of the cognitive theory of learning in the development of CAI as advocated by Gagne' (1977) is recommended.

The researcher further recommends the consideration of using a larger sample size and larger cell sizes when performing research experiments of this type. The collection of demographic data, such as gender and age, is also recommended in order to determine if these variables are influenced by the management strategies used in courseware development in any way. A study of the participants' attitudes in studies similar to the researcher's is recommended in order to ascertain which management strategy the learners prefer most.

The researcher recommends a study be conducted to see if this CAI courseware is effective as or superior to traditional instructional methods as claimed by Aiken and Braun (1980), and Dence (1980). This courseware package can be used over a long period of time and in this sense it is quite an economical package, when compared to the traditional methods of instruction. A study similar to the researcher's
should be conducted in other subject areas, such as mathematics and physics, and then compare these findings with the conclusions of this study. The researcher also recommends revising the difficulty level of this courseware package and examining the effectiveness of the software with undergraduate students.

Based upon the results of this study, it appears that it is useful to teach graduate students in education statistics by means of CAI. Furthermore, the microcomputer appears to be a useful medium through which this task can be accomplished. The results of this study also indicate that developers of CAI should consider appropriate management strategies for learners in their courseware design.
BIBLIOGRAPHY


Deignan, G.M., & Duncan, R.E. (1978). CAI in three medical training courses: It was effective! Behavior Research Methods and Instrumentation, 10(2), 228-230.


APPENDIX A

LEARNER-CONTROL VERSION OF NORSTAN

10 'Unit 1
20 COMMON NAMS,NOS
30 KEY OFF
40 SCREEN 8,1: COLOR 15,1,11:CLS
50 LOCATE 7,25: PRINT"The Normal Distribution Family"
60 LOCATE 9,39: PRINT"end"
70 LOCATE 11,32: PRINT"Standard Scores"
80 LOCATE 13,39: PRINT"by"
90 LOCATE 15,32: PRINT"Preston Dinkins"
100 LOCATE 23,58: PRINT"Press the enter key."
110 AS = INKEYS: IF AS = "" THEN 110
120 SCREEN 8,1: COLOR 15,1,11:CLS
130 LOCATE 1,35: PRINT"Screen ii"
140 LOCATE 5,1
150 PRINT** Type in your complete name (e.g., Mary J. Doe) and"n
160 INPUT** press the enter key.";NAMS
170 PRINT**
180 PRINT**
190 PRINT**
200 PRINT** Type in your student number (e.g., 438-96-8289) and"
210 PRINT**
220 INPUT** press the enter key.";NOS
230 'screen 20
240 CLS;LOCATE 1,35: PRINT"Screen iii"
250 LOCATE 3,36
260 PRINT"Contents"
270 LOCATE 5,1
280 PRINT*
290 PRINT* Unit 1 The Normal Curve."
300 PRINT* Unit 2 The Unit Normal Curve."
310 PRINT* Unit 3 Z-Scores."
320 PRINT* Unit 4 Area Under a Normal Curve Lying Below or Above a Given Observation.
330 PRINT* Unit 5 Part 1. Area Under a Normal Curve Lying Between Two Observations.
340 PRINT* Part 2. Area Under a Normal Curve Relative to the Curve’s Standard Deviation.
350 PRINT* Total Area Under a Normal Curve Lying Below One Observation and Above a Second Observation.
360 PRINT* Standard Scores."
370 PRINT* Unit 7 Standard Scores."
380 LOCATE 23,58: PRINT"Press the enter key."
390 AS=INKEYS: IF AS="" THEN 410
400 SCREEN 8,1: COLOR 15,1,11:CLS
410 LOCATE 18,37
420 PRINT"Unit 1"
430 LOCATE 12,32
440 PRINT"The Normal Curve."
450 LOCATE 23,58: PRINT"Press the enter key."
460 AS=INKEYS: IF AS="" THEN 480
470 SCREEN 8,1: COLOR 15,1,11:CLS
480 LOCATE 1,35: PRINT"Unit 1: Screen iv"
490 LOCATE 5,1
500 TIMES = "08:00:00"
510 Print = =
520 PRINT** Objectives: At the end of this unit, the student should be able to:
530 PRINT** 1. Give the distinguishing characteristics of a normal distribution.
540 PRINT** 2. Tell what effect increasing the magnitude of the standard deviation or the mean has on the shape
550 PRINT**
560 PRINT** 111

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
I. Determine the points of inflection of a normal curve.

The graph of a normal distribution is a bell-shaped curve as shown above. Notice that the highest point on this curve occurs at the mean \( m \) of the distribution.

A normal distribution is one which can be approximated by an equation of the form:

\[ y = \frac{N}{\sqrt{2\pi}} \frac{1}{s} \exp\left(-\frac{(X-m)^2}{2s^2}\right) \]

where \( N \) is a parameter determined by the size of the normal distribution, \( \sqrt{} \) square root, \( \times \) multiplication, \( \pi = 3.141593 \), \( \exp = 2.71828 \), \( m \) is the mean of the normal distribution, and \( s \) is the standard deviation of the normal distribution.
A normal distribution is symmetric about the mean \( m \) and has only one mode. The mean, the median, and the mode of a given normal distribution are all equal.

Exercise 1. A normal distribution has a mean of 10 and a standard deviation of 40. The highest point on the graph of this distribution occurs when \( x = ? \)

Type a, b, c, d, or e, and press the enter key;
Exercise 2. The mean of a normal curve determines the:

a. position of the curve
b. size of the curve
c. shape of the curve
d. standard deviation of the curve
e. none of the above

Type a, b, c, d, or e, and press the enter key; B

Your response is incorrect. The correct answer is a.
The normal distribution family can be represented by a family of curves. There is a different normal curve for each distinct pair of mean and standard deviation. Press the enter key for an illustration of this fact.

Example 1. Notice that there is a different normal curve for each different pair of mean and standard deviation. Press the enter key.
of this fact, press the enter key.

PRINT

TOO OF Screen 10

PRINT "Press the enter key." 

PRINT "Example 2. The normal distribution above has a mean of 50 and a standard deviation of 5. Let us hold the standard deviation constant at 5 and vary the value of the mean." 

PRINT "Type in the number 65 (for the mean) and press the enter key."

INPUT "Type in the number 65 (for the mean) and press the enter key.";

IF MS <> "65" GOTO 3160 ELSE 3200

LOCATE 23,58: PRINT "Press the enter key."

AS=INKEY$: IF AS="" GOTO 3220

"screen 11"

SCREEN 2: CLS: LOCATE 1,16:PRINT "Unit 1: Screen 11"

T<10

A<630

PI<3.141593

X<-100: Y<-100

LINE (X,Y)=-(639,Y+2),1

M<10: S<5

GOSUB 3130

GOTO 3220

"screen 11"

COLOR 11,1

PRINT "Example 2. The normal distribution above has a mean of 50 and a standard deviation of 5. Let us hold the standard deviation constant at 5 and vary the value of the mean."

PRINT "Type in the number 65 (for the mean) and press the enter key.";

INPUT "Type in the number 65 (for the mean) and press the enter key.";

IF MS <> "65" GOTO 3160 ELSE 3200

LOCATE 23,58: PRINT "Press the enter key."

AS=INKEY$: IF AS="" GOTO 3220

"screen 11"

SCREEN 2: CLS: LOCATE 1,16:PRINT "Unit 1: Screen 11"

SCREEN 6,1:

PRINT "Let us now hold the mean fixed and allow the standard deviation to vary. As the standard deviation"
117

3590 PRINT** increases, the spread of the normal distributions**
3590 PRINT** becomes flatter.*
3600 PRINT"Press the enter key."
3610 AS«INKEYS: IF AS="** GOTO 3640
3620 'screen 1
3630 SCREEN 2: CLS
3640 LOCATE 1,12:PRINT"Unit 1: Screen 12"
3650 T=10
3660 A=440
3700 PI=3.141593
3710 XC=485:YC=100
3720 LINE (0,YC*2|-(6 39,YC+2I,1
3730 M=80: S=3
3740 GOSUB 3760
3750 GOTO 3850
3760 'DRAW GRAPH
3770 X1=-3*S+M+X1-A*1/(S*SQR(2*PI))*EXP(-( (X1-M)/S)^2/2)
3780 X2=-3*S+M,1:(Y2-A*1/(S*SQR(2*PI))*EXP(-( (X2-M)/S)^2/2)
3790 LINE(XC+T*X1,YC+Y1)-(XC+T*X2,YC+Y2),1
3800 FOR X=3*S*M+.2 TO 3*S*M STEP .2
3810 Y=A*1/(S*SQR(2*PI))*EXP(-( (X-M)/S)^2/2)
3820 LINE - (XC*T*X,YC*Y),1
3830 NEXT X
3840 RETURN
3850 LOCATE 5,1:PRINT"s = standard deviation"
3860 LOCATE 14,1
3870 PRINT" 62 68 74 80 86 92 98 "
3880 FOR X=105 TO 525 STEP 30 : LINE (X,102) - (X,124)
3890 NEXT X
3900 LINE (332,48) - (365,40)
3910 LOCATE 5,48: PRINT"s = 3"
3920 LOCATE 16,1
3930 PRINT** Example 3. The above graph has a mean of 80 and a standard deviation of 3. We will hold the mean constant and allow the standard deviation to vary.
3940 PRINT**
3950 PRINT**
3960 PRINT**
3970 INPUT" Type in the number 5 and press the enter key.; SS
3980 IF SS>"5" GOTO 3990 ELSE 4010
3990 LOCATE 20,1
4000 PRINT**
4100 LOCATE 20,1
4120 GOTO 3970
4130 S=5: GOSUB 3760
4140 LINE (332,67) - (365,57)
4150 LOCATE 7,47: PRINT"s = 5"
4160 LOCATE 21,1
4170 INPUT" Type in the number 7 and press the enter key.; SS
4180 IF SS>"7" GOTO 4200 ELSE 4110
4190 LOCATE 21,1
4200 PRINT**

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Exercise 3. If the mean of a normal curve is held fixed and the standard deviation is allowed to increase, the resulting shapes of the normal curves become more pointed.

Type t if true or f if false and press the enter key.

If BS = "t" or BS = "T" or BS = "f" or BS = "F" THEN 4520 ELSE 4470

Incorrect. The correct answer is f.

Exercise 4. One normal distribution has a mean of 50 and a standard deviation of 10. A second normal distribution has a mean of 80 and a standard deviation of 20.

Press the enter key.
One normal distribution has a mean of 80 and a standard deviation of 10. If the two distributions are approximated by the same normal distribution formula, then:

a. the second graph lies to the right of the first
b. the graphs have the same shape
c. the second graph lies to the left of the first
d. the graphs coincide
e. a and b

Type a, b, c, d, or e and press the enter key.

Correct answer is e.
On each side of the mean of a normal curve, there are points where the direction of the curve changes from turning down to turning up. These points are called inflection points. The inflection points are located exactly one standard deviation from the mean either way. The next screen will illustrate this concept.
5910 LOCATE 14,52  
5920 PRINT "•1s"  
5930 LOCATE 14,65  
5940 PRINT "•2s"  
5950 LOCATE 14,77  
5960 PRINT "•3s"  
5970 "draw graph"  
5980 X1=-3.5:Y1=A/(SQR(2*PI))*EXP(-(X1^2)/2)  
5990 X2=-3.4:Y2=A/(SQR(2*PI))*EXP(-(X2^2)/2)  
6000 LINE(XC+S*X1,YC+Y1)-(XC+S*X2,YC+Y2),1  
6010 FOR X=-3.4 TO 3.5 STEP .2  
6020 Y=A/(SQR(2*PI))*EXP(-(X^2)/2)  
6030 LINE -(XC+S*X,YC+Y),1  
6040 NEXT X  
6050 LOCATE 6,28: PRINT"•"  
6060 LOCATE 6,53: PRINT"•"  
6070 LOCATE 17,1  
6080 PRINT "Example 5. The points of inflection are indicated by an •"  
6090 PRINT "on the above graph."
6100 LOCATE 23,58: PRINT"Press the enter key."  
6110 AS=INKEY$: IF AS="" GOTO 6120  
6120 "screen 18"  
6130 SCREEN 0,1: COLOR 15,1,1:CLS  
6140 LOCATE 1,32:PRINT"•rinit 1: Screen 18"  
6150 LOCATE 5,1:PRINT"Example 6. Given a normal distribution with mean m = 70"  
6160 PRINT "and standard deviation s = 5, the points of"  
6170 PRINT "inflection occur at x = m - s = 70 - 5 = 65 and"  
6180 PRINT "x = m + s = 70 + 5 = 75."
6190 LOCATE 23,58: PRINT"Press the enter key."  
6200 AS=INKEY$: IF AS="" GOTO 6210  
6210 IF J13=1 GOTO 6290  
6220 IF J15=1 GOTO 8540  
6230 "screen 19"  
6240 CLS  
6250 LOCATE 1,32:PRINT"•rinit 1: Screen 19"  
6260 LOCATE 5,1:PRINT"Exercise 6. Given a normal distribution with mean m = 93"  
6270 PRINT "and standard deviation s = 6, the points of"  
6280 PRINT "inflection occur at x = ?"  
6290 PRINT "a. 6 and 93"  
6300 PRINT "b. 87 and 93"  
6310 PRINT "c. 87 and 99"  
6320 PRINT "d. 93 and 99"  
6330 PRINT "e. none of the above"  
6340 PRINT "Type a, b, c, d, or e and press the enter key":BS  
6350 IF :165*THEN A155=BS  
6360 IF :166*THEN B165=BS  
6370 IF BS="a" OR BS="b" OR BS="c" OR BS="d" OR BS="e" OR BS="e" THEN 6310 ELSE 6480  
6380 LOCATE 17,1  
6390 PRINT"Your response is correct."  
6400 LOCATE 17,1: GOTO 6440  
6410 PRINT""  
6420 IF BS="c" OR BS="e" THEN PRINT""  
6430 ELSE 6540
6530 R16=1: GOTO 6590
6540 IF I16=1 GOTO 6580
6550 PRINT" Incorrect. Press the enter key for further explana
6560 tion."
6570 I16=1: R+R=1: GOTO 6540
6580 W10=I1: PRINT" Incorrect. The correct answer is c."
6590 LOCATE 23,58
6620 PRINT"Press the enter key."
6630 AS+INKEYS: IF AS="" GOTO 6620
6640 R1 = R11+R12+R13+R14+R15+R16
6650 W1 = W11+W12+W13+W14+W15+W16
6660 FIRSTL = R1+W1-R
6670 'SCREEN 20
6680 TIMES = "00:00:00"
6690 SCREEN 11,1: COLOR 15,1,11: CLS
6700 LOCATE 2,1: PRINT"Unit 1: Screen 20"
6710 PRINT"This concludes the discussion for Unit 1: The Normal"
6720 PRINT"
6730 PRINT"Curve. You worked correctly":FIRSTL"exercise(s) out of 6."
6740 PRINT"
6750 PRINT"There are 10 review problems for this unit. Would you"
6760 PRINT"
6770 PRINT"like to work some review problems? Type y if yes or n if"
6780 PRINT"
6790 PRINT"no and press the enter key.:";QIS
6800 IF QIS = "y" OR QIS = "Y" OR QIS = "n" OR QIS = "N" THEN 6810 ELSE LOCATE 13,1
6810 PRINT": LOCATE 13,1: GOTO 6790
6820 'SCREEN 21
6830 SCREEN 0,1: COLOR 15,1,11: CLS
6840 LOCATE 1,1: PRINT"Unit 1: Screen 21"
6850 LOCATE 5,1: K1=1
6860 PRINT"Problem 1. Which of the following is not a characteristic of"
6870 PRINT"a normal distribution?"
6880 PRINT"a. has a bell-shaped graph."
6890 PRINT"b. has only one mode."
6900 PRINT"c. is symmetric about the mean."
6910 PRINT"d. the mean and the median are unequal."
6920 PRINT"e. the mode and the median are equal."
6930 PRINT"Input: Type a, b, c, d or e, and press the enter key.:;BS
6940 IF J11=0 THEN C11S = BS
6950 IF J11=1 THEN D11S = BS
6960 PRINT"
6970 IF BS="a" OR BS="A" OR BS="b" OR BS="B" OR BS="c" OR BS="C" OR BS="d" OR BS
6980 = "D" OR BS = "E" OR BS = "E" THEN 7260 ELSE 7010
6990 LOCATE 15,1
7000 PRINT"
7010 PRINT"
7020 'SCREEN 20
7030 LOCATE 5,1
7040 GOTO 6960
7050 PRINT"Your response is correct."
7060 PRINT"Your response is incorrect. Press the enter key for
Problem 2. The highest point on the graph of a normal curve occurs at the?

a. mean
b. points of inflection
c. mode
d. standard deviation.
e. a and c

Type a, b, c, d or e, and press the enter key.

Your response is incorrect. The correct response is e.
7700 \text{GOSUB 7240}
7710 \text{IF Q1S = "y" OR Q1S = "Y" THEN GOTO 7720 ELSE 10910}
7720 'Screen 23
7730 \text{SCREEN 0,1: COLOR 15,1,11: CLS}
7740 \text{LOCATE 1,32:PRINT "Unit 1: Screen 23"}
7750 \text{LOCATE 7,1: K1=3}
7760 \text{PRINT" Problem 3. The tails of a normal curve are asymptotic to the"}
7770 \text{PRINT horizontal axis."
7780 \text{PRINT" Type \text{t} if true or \text{f} if false and press the enter"}
7790 \text{PRINT" key.";BS}
7800 \text{IF J13=0 THEN Cl3S = BS}
7810 \text{IF J13=1 THEN Cl3S = BS}
7820 \text{PRINT" if BS="t" OR BS="T" OR BS="f" OR BS="$F$" THEN 7930 ELSE 7870}
7830 \text{LOCATE 11,1}
7840 \text{PRINT"
7850 \text{PRINT" Your response is correct. Press the enter key.";BS}
7860 \text{IF BS="t" OR BS="T" OR BS="f" OR BS="$F$" THEN 7950 ELSE 7870}
7870 \text{LOCATE 11,1}
7880 \text{PRINT"}
7890 \text{PRINT"}
7900 \text{PRINT"
7910 \text{LOCATE 11,1}
7920 \text{GOTO 7930}
7930 \text{IF BS = "c" OR BS = "t" THEN 7940 ELSE 7960}
7940 P13 = 1
7950 \text{PRINT" Your response is correct. The correct answer is"}
7960 \text{PRINT" t.";BS}
7970 \text{LOCATE 13,58:PRINT "Press the enter key."}
7980 \text{ASKINKEYS: IF AS = "" GOTO 8000}
7990 \text{GOSUB 7240}
8000 \text{IF Q1S = "y" OR Q1S = "Y" THEN GOTO 8100 ELSE 10910}
8010 'Screen 24
8020 \text{SCREEN 3,1: COLOR 15,1,11: CLS}
8030 \text{LOCATE 1,32:PRINT "Unit 1: Screen 24"}
8040 \text{LOCATE 5,1: K1=4}
8050 \text{PRINT" Problem 4. One normal curve A has mean 50 and standard"}
8060 \text{PRINT deviation 10. Another normal curve B has mean 50"}
8070 \text{PRINT" and standard deviation 5. If the two curves are"}
8080 \text{PRINT" approximate \text{y} the same normal distribution"}
8090 \text{PRINT" and curve B is flatter than curve A."}
8100 \text{PRINT" Type t if true or f if false and press the enter"}
8110 \text{PRINT" key.";BS}
8120 \text{IF J14 = 0 THEN Cl4S = BS}
8130 \text{IF J14 = 1 THEN Cl4S = BS}
8140 \text{PRINT"
8150 \text{INPUT"}
8160 \text{PRINT"}
8170 \text{PRINT"}
8180 \text{PRINT"}
8190 \text{PRINT"}
8200 \text{PRINT"}
8210 \text{PRINT"}
8220 \text{PRINT"}
8230 \text{PRINT"}
8240 \text{PRINT"}
8250 \text{PRINT"}
8260 \text{INPUT"}
8270 \text{IF J16 = 0 THEN Cl6S = BS}
8280 \text{IF J16 = 1 THEN Cl6S = BS}
8290 \text{PRINT"
8300 \text{IF BS="t" OR BS="T" OR BS="f" OR BS="$F$" THEN 8370 ELSE 8310}
8310 \text{LOCATE 15,1}
8320 PRINT 
8330 PRINT 
8340 PRINT 
8350 LOCATE 15, 1 
8360 GOTO 8240 
8370 IF BS = "f" OR BS = "F" THEN 8380 ELSE 8400 
8380 P14 = 1 
8390 PRINT " Your response is correct. " : GOTO 8500 
8400 PRINT" Your response is incorrect. Press the enter key " 
8410 PRINT" for further information. " 
8420 AS=INKEYS: IF AS = "" GOTO 8400 
8430 J14=1: P=P+1: GOTO 3510 
8440 Q14 = 1 
8450 PRINT " Your response is incorrect. The correct answer is " 
8460 PRINT" f." 
8470 GOTO 8700: PRINT"Press the enter key."
8480 AS=INKEYS: IF AS = "" GOTO 8510 
8490 GOSUB 7240 
8500 IF Q1S = "y" OR Q1S = "Y" THEN GOTO 8540 ELSE 10910 
8510 "screen 25 
8520 SCREEN 2, 1: COLOR 15, 11, 11: CLS 
8530 LOCATE 2, 1: PRINT"Unit 1: Screen 25" 
8540 PRINT"Problem 5. Given a normal distribution with mean m = 65 " 
8550 PRINT" and standard deviation s = 7, the points of " 
8560 PRINT" inflection occur at x = ? " 
8570 PRINT" a. 7 and 65 " 
8580 PRINT" b. 58 and 72 " 
8590 PRINT" c. 58 and 75 " 
8600 PRINT" d. 65 and 72 " 
8610 PRINT" e. none of the above " 
8620 PRINT" Type a, b, c, d, or e and press the enter key "; BS 
8700 IF J15=0 THEN C155 = BS 
8710 IF J15=1 THEN C155 = BS 
8720 IF BS="a" OR BS="b" OR BS="c" OR BS="d" OR BS=E THEN GOTO 8770 ELSE 8740 
8730 LOCATE 17, 1 
8740 PRINT"Press the enter key."
8750 IF J110-1 GOTO 10570 
8760 IF BS="b" OR BS="c" THEN PRINT" Your response is correct. " 
8770 P15=1: GOTO 8660 
8780 IF :J15=1 GOTO 8650 
8800 PRINT" Incorrect. Press the enter key for further explanation. " 
8810 AS=INKEYS: IF AS="" GOTO 8820 
8820 J110=1 GOTO 10570 
8830 J15=1: P=P+1: GOTO 8440 
8840 J15=1: PRINT " Incorrect. The correct answer is b. " 
8850 GOTO 23, 58 
8860 PRINT"Press the enter key."
8870 AS=INKEYS: IF AS="" GOTO 8880 
8880 GOSUB 7240 
8890 IF Q1S = "y" OR Q1S = "Y" THEN GOTO 8910 ELSE 10910
Problem 6. Which of the following is a characteristic of a normal distribution?

- a. symmetrical
- b. unimodal
- c. asymptotic to the horizontal axis
- d. mode and the mean are equal
- e. all of the above

Type a, b, c, d or e, and press the enter key.

Your response is correct.

Problem 7. The highest point on the graph of a normal curve with mean = 65 and standard deviation = 3 occurs at x = ?

Type a, b, c, d or e, and press the enter key.
9520 LOCATE 17,1
9530 PRINT"
  
9540 PRINT"
  
9550 LOCATE 17,1
9560 GOTO 9470
9570 IF BS="d" OR BS="o" THEN 9580 ELSE 9610
9580 P17=1
9590 PRINT"
Your response is correct."
9600 GOTO 9710
9610 IF J17=1 GOTO 9670
9620 PRINT"
Your response is incorrect. Press the enter key for
9630 PRINT"
  
9640 PRINT"
  further information." 
9650 AS=INKEYS: IF AS="" GOTO 9650
9660 J17=1: P=P+1: GOTO 710
9670 G17 .= 1
9680 PRINT"
  
9690 PRINT"
  
9700 PRINT"
  
9710 LOCATE 23,58: PRINT"Press the enter key."
9720 AS=INKEYS: IF AS="" GOTO 9720
9730 GOSUB 7240
9740 IF QIS = "y" OR QIS = "Y" THEN GOTO 9750 ELSE 10910
9750 'Screen 28
9760 SCREEN 0,1: COLOR 15,1,11: CLS
9770 LOCATE 1,32: PRINT"Unit 1: Screen 28"
9780 LOCATE 7,1: K1»8
9790 PRINT" Problem 8. The tails of a normal curve will eventually touch"
9800 PRINT"
9810 PRINT"
9820 PRINT"
9830 PRINT"
9840 PRINT"
9850 INPUT": BS
9860 IF J18=0 THEN C18S = BS
9870 IF J18=1 THEN D18S = BS
9880 PRINT"
9890 IF BS="t" OR BS="T" OR BS="f" OR BS="F" THEN 9960 ELSE 9900
9900 LOCATE 11,1
9910 PRINT"
  
9920 PRINT"
  
9930 PRINT"
  
9940 LOCATE 11,1
9950 GOTO 9830
9960 IF BS = "f" OR BS = "F" THEN 9970 ELSE 9990
9970 P18 = 1
9980 PRINT"
Your response is correct." : GOTO 10090
9990 IF J18 = 1 GOTO 10050
1000 PRINT"
:J18=1: P=P+1: GOTO 2190
1001 PRINT"
1002 PRINT"
1003 PRINT"
1004 PRINT"
1005 PRINT"
1006 PRINT"
1007 PRINT"
Your response is incorrect. The correct answer is"
Problem 9. One normal curve A has mean 62 and standard deviation 3. Another normal curve B has mean 62 and standard deviation 4. If the two curves are approximated by the same normal distribution formula, then curve A is flatter than curve B.

Type t if true or f if false and press the enter key.

Your response is correct.

For further information.

Your response is incorrect. The correct answer is

Problem 13. Given a normal distribution with mean \( \mu = 91 \) and standard deviation \( \sigma = 5 \), the points of inflection occur at \( x = ? \)

Your response is incorrect. The correct answer is

Problem 10. Given a normal distribution with mean \( \mu = 91 \) and standard deviation \( \sigma = 5 \), the points of inflection occur at \( x = 7 \).
13730 INPUT "Type a, b, c, d, or e and press the enter key"; BS
13740 IF J118=0 THEN C113S = BS
13750 IF J119=1 THEN Q116S = BS
13760 IF BS="a" OR BS="A" OR BS="B" OR BS="C" OR BS="c" OR BS="D" OR BS="d" OR BS="E" OR BS="e" OR BS="E" THEN 10880 ELSE 10770
13770 LOCATE 17,1
13780 PRINT"
13790 LOCATE 17,1: GOTO 10730
13800 PRINT"
13810 IF BS="c" OR BS="C" THEN PRINT" Your response is correct
13820 GOTO 10750
13830 PRINT"
13840 IF BS="a" OR BS="A" OR BS="B" OR BS="C" OR BS="c" OR BS="D" OR BS="d" OR BS="E" OR BS="e" OR BS="E" THEN 10880 ELSE 10770
13850 AS-INKEYS: IF AS="" GOTO 10850
13860 J110-1: P-P-1: GOTO 5440
13870 Q116S = 1: PRINT" Incorrect. Press the enter key for further explanation.";
13880 GOTO 23,50
13890 PRINT"Press the enter key.";
13900 AS-INKEYS: IF AS="" GOTO 10900
13910 'screen 26
13920 CLS: LOCATE 1,13: PRINT"Unit 1: Screen 26";
13930 LOCATE 1,1
13940 PRINT"Turn the printer on and press the enter key.";
13950 AS = INKEYS: IF AS="" GOTO 10950
13960 IF Kl=0 GOTO 11120
13970 P1=1+P1+P14+P15+P16+P17+P18+P19+P10
13980 Q1=Q1+Q12+Q13+Q14+Q15+Q16+Q17+Q18+Q19+Q110
13990 SEC = P1 + Q1 - P
14000 PRINT" The number of correct exercises is”;FIRST1
14010 PRINT" The number of incorrect exercises is”;6-FIRST1
14020 PRINT" The number of correct exercises after remediation i
14030 PRINT" The number of incorrect exercises is”;6-FIRST1
14040 PRINT" The number of incorrect problems is”;SEC1
14050 PRINT" The number of incorrect problems after remediation is
14060 PRINT" Unit 1: The Normal Curve";
14070 LPRINT" :NAHS,N0S,T1S
14080 LPRINT" :FIRST1
14090 LPRINT" :6-FIRST1
14100 LPRINT" ;:SEC1
14110 LPRINT" ;:SEC1
14120 LPRINT" ;:FIRST1
14130 LPRINT" ;:FIRST1
14140 LPRINT" ;:FIRST1
14150 LPRINT" ;:FIRST1
14160 LPRINT" ;:FIRST1
14170 LPRINT" ;:FIRST1
14180 LPRINT" ;:FIRST1
14190 LPRINT" ;:FIRST1
14200 LPRINT" ;:FIRST1
14210 LPRINT" ;:FIRST1
14220 IF Kl=0 GOTO 11120
14230 LPRINT" ;:TIMES
14240 LPRINT" the number of correct problems is”;SEC1
14250 LPRINT" the number of incorrect problems is”;K1-SEC1
14260 LPRINT" the number of incorrect problems is”;K1-SEC1
14270 LPRINT" the number of incorrect problems is”;K1-SEC1

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
The number of correct problems after remediation is:
The number of correct problems after remediation is:

Exercise 1 response was correct.

Exercise 2 response was incorrect.

Exercise 3 response was correct.

Exercise 4 response was incorrect.

Exercise 5 response was correct.

Exercise 6 response was incorrect.

Problem 1 response was incorrect.

Problem 2 response was incorrect.

Problem 3 response was incorrect.

Problem 4 response was incorrect.

Problem 5 response was incorrect.

Problem 6 response was incorrect.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
11940 LPRINT"
11950 LPRINT" Problem 6 response was incorrect.",C16S,D16S
11960 LPRINT"
11970 IF Kl<7 GOTO 12210
11980 LPRINT": IF J17>1 GOTO 12010
11990 LPRINT" Problem 7 response was correct.",C17S: GOTO 12030
12000 LPRINT"
12010 LPRINT" Problem 7 response was incorrect.",C17S,D17S
12020 LPRINT"
12030 IF K<8 GOTO 12210
12040 LPRINT": IF J18>1 GOTO 12070
12050 LPRINT" Problem 8 response was correct.",C18S: GOTO 12090
12060 LPRINT"
12070 LPRINT" Problem 8 response was incorrect.",C18S,D18S
12080 LPRINT"
12090 IF K<9 GOTO 12210
12100 LPRINT": IF J19>1 GOTO 12130
12110 LPRINT" Problem 9 response was correct.",C19S: GOTO 12150
12120 LPRINT"
12130 LPRINT" Problem 9 response was incorrect.",C19S,D19S
12140 LPRINT"
12150 IF K<10 GOTO 12210
12160 LPRINT": IF J10>1 GOTO 12190
12170 LPRINT" Problem 10 response was correct.",C110S:GOTO 12210
12180 LPRINT"
12190 LPRINT" Problem 10 response was incorrect.",C110S,D110S
12200 LPRINT"
12210 CLS: CHAIN"unit2"
COMMON NAMS, NOS
UNIT 2
R=0
TIMES = "98:98:98"
KEY OFF
SCREEN 0,1: COLOR 15,1,15: CLS
LOCATE 13,37
PRINT"Unit 2"
LOCATE 12,26
PRINT"The Unit Normal Distribution"
PRINT
PRINT
PRINT"Objectives: At the end of Unit 2, the student should be able to:
1. Give the distinguishing characteristics of the unit normal distribution.
2. Give the points of inflection of the unit normal curve.
3. Approximate the ordinate at a given z-value using a table of ordinates."
PRINT
LOCATE 23,58: PRINT"Press the enter key."
INKEY$: IF INKEY$ = "" GOTO 140
SCREEN 0,1: COLOR 15,1,15: CLS
LOCATE 1,32: PRINT"Unit 2: Screen ii"
LOCATE 5,1
PRINT"Objectives: At the end of Unit 2, the student should be able to:
1. Give the distinguishing characteristics of the unit normal distribution.
2. Give the points of inflection of the unit normal curve.
3. Approximate the ordinate at a given z-value using a table of ordinates."
PRINT
LOCATE 23,58: PRINT"Press the enter key."
INKEY$: IF INKEY$ = "" GOTO 140
SCREEN 2:CLS
S=100
A=240
PI=3.141593
XC=320:YC=100
SCREEN 2:CLS
LINE (0,YC+2)-(639,YC+2),1
LINE (639,0)-(639,131),1
FOR X=20 TO 620 STEP 20
LINE(X,YC+2)-(X,YC+4),1
NEXT X
LOCATE 1,78
PRINT ".4"
LOCATE 7,78
PRINT".4"
LOCATE 2,78
PRINT".4"
LOCATE 7,78
PRINT".4"
FOR Y = 0 TO 75 STEP 25
LINE (639,Y) - (639,Y),1
NEXT Y
LOCATE 13,1: PRINT"z"
LOCATE 14,2
PRINT"-1"
LOCATE 14,15
PRINT"-2"
LOCATE 14,27
PRINT"-3"
LOCATE 14,41
PRINT"-4"
LOCATE 14,53

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
133

LOCATE 14, 78
PRINT "1"

LOCATE 14, 78
PRINT "2"

LOCATE 14, 78
PRINT "3"

LOCATE 14, 78
PRINT "4"

LOCATE 14, 78
PRINT "5"

LOCATE 14, 78
PRINT "6"

LOCATE 14, 78
PRINT "7"

LOCATE 14, 78
PRINT "8"

LOCATE 14, 78
PRINT "9"

LOCATE 14, 78
PRINT "0"

RETURN

LOCATE 17, 1
RETURN

LOCATE 1, 1: PRINT "Unit 2: Screen 1"
LOCATE 12, 2: PRINT "Title"; LOCATE 12, 24: PRINT "Title"

LOCATE 17, 1
PRINT "One member of the normal distribution family is the unit normal curve or the z-distribution. This curve has mean 0 and..."
PRINT "...standard deviation 1. The total area under this curve is 1."
PRINT "Press the enter key."
AS = INKEYS: IF AS = "" THEN 910

LOCATE 23, 58: PRINT "Press the enter key."
AS = INKEYS: IF AS = "" THEN 910

LOCATE 23, 3: PRINT "Press the enter key."
AS = INKEYS: IF AS = "" THEN 910

SCREEN 0, 1: COLOR 15, 1, 15: CLS
The highest point on the graph of a normal curve occurs at the mean. If the mean is \( \mu = 50 \), then the highest point on the curve occurs at \( X = \mu \).

Press the enter key.

Type a, b, c, or d and press the enter key.

Your response is incorrect. Press the enter key for further explanation.

Your response is incorrect. The correct answer is d.

The points of inflection of a normal curve are located one standard deviation from the mean either way. If the mean \( \mu \) equals 50 and the standard deviation \( \sigma \) equals 5, then the points of inflection occur at \( \mu - \sigma = 50 - 5 = 45 \) and \( \mu + \sigma = 50 + 5 = 55 \).
135 GOSUB 380
1379 LOCATE 1,1; PRINT"Unit 2: Screen 4"
1390 LOCATE 12,4; PRINT"Tail"; LOCATE 12,72; PRINT"Tail"
1400 LOCATE 15,1
1410 PRINT Exercise 3. The two tails of the unit normal distribution:
1420 PRINT a. approach the median.
1430 PRINT b. approach the mode.
1440 PRINT c. approach the vertical axis.
1450 PRINT d. are asymptotic to the horizontal axis.
1460 PRINT
1470 PRINT Type a, b, c, or d for your response and press the enter key:
1480 IF I23=0 THEN A23=S Q3S
1490 IF I23=1 THEN B23=S Q3S
1500 IF Q3S="A" OR Q3S="B" OR Q3S="C" OR Q3S="D" OR Q3S="D" GOTO 2050 ELSE 2100
1510 LOCATE 21,1
1520 PRINT
2030 LOCATE 21,1
2040 GOTO 1970
2050 IF Q3S="D" OR Q3S="D" GOTO 2060 ELSE 2100
2060 PRINT Your response is incorrect. Press the enter key.
2070 AS=INKEYS: IF AS="" GOTO 2080
2080 IF 123*1 GOTO 2160
2090 PRINT Your response is incorrect. Press the enter key.
2100 AS=INKEYS: IF AS="" GOTO 2130
2110 I23=1: S#1=1: GOTO 2210
2120 PRINT
2130 PRINT Your response is incorrect. The correct answer is d.
2140 W23 = 1
2150 LOCATE 23,58: PRINT"Press the enter key.
2160 AS=INKEYS: IF AS="" GOTO 2190
2170 S#1=COLOR 15,1,15:CLS
2180 LOCATE 1,12: PRINT"Unit 2: Screen 4A"
2190 LOCATE 7,1
2200 PRINT As the tails of a normal curve move away from the mean.
2210 PRINT the tails will always approach the horizontal axis.
2220 LOCATE 23,58: PRINT"Press the enter key.
2230 AS=INKEYS: IF AS="" GOTO 2260
2240 GOTO 1870
2250 PRINT When sketching the unit normal curve, it is important
2260 PRINT to know the ordinate u (the height of the curve) at a given
2270 PRINT value of z. Table B, Areas and Ordinates of the Unit Normal
2280 PRINT Distribution, in the supplementary materials will be used.
2290 PRINT for this purpose.
2300 COLOR 12,1,15
2310 LOCATE 11,22:PRINT"Table B"
2320 COLOR 15,1,15
2330 LOCATE 23,58; PRINT"Press the enter key.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Suppose one desires to find the ordinate $u$ at a given value of $z$. The value of $z$ is found in the first column of Table B. To the right of this entry in the column, titled Ordinate, the ordinate is found. A portion of Table B is shown below:

<table>
<thead>
<tr>
<th>$z$</th>
<th>Area Below</th>
<th>Area Above</th>
<th>Ordinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1.04</td>
<td>.1492</td>
<td>.8508</td>
<td>.2323</td>
</tr>
<tr>
<td>-1.03</td>
<td>.1515</td>
<td>.8485</td>
<td>.2347</td>
</tr>
<tr>
<td>-1.02</td>
<td>.1539</td>
<td>.8461</td>
<td>.2371</td>
</tr>
<tr>
<td>-1.01</td>
<td>.1562</td>
<td>.8430</td>
<td>.2396</td>
</tr>
</tbody>
</table>

The ordinate at $z = -1.03$ is .2347 and the ordinate at $z = -1.01$ is .2396.

Exercise 4. A portion of Table B is shown below:

<table>
<thead>
<tr>
<th>$z$</th>
<th>Area Below</th>
<th>Area Above</th>
<th>Ordinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.56</td>
<td>.7123</td>
<td>.2877</td>
<td>.3410</td>
</tr>
<tr>
<td>0.57</td>
<td>.7157</td>
<td>.2843</td>
<td>.3391</td>
</tr>
<tr>
<td>0.58</td>
<td>.7190</td>
<td>.2810</td>
<td>.3372</td>
</tr>
<tr>
<td>0.59</td>
<td>.7224</td>
<td>.2776</td>
<td>.3352</td>
</tr>
</tbody>
</table>

Type in the ordinate (including the decimal point) at $z = 0.58$ and press the enter key; .240.

Your response is correct.
137

7100 IF C45 = "3372" GOTO 3110 ELSE 3190
7110 PRINT"Incorrect. You should first type in the decimal point. Press the enter key to continue."
7120 PRINT"R = 1"
7130 AS = INKEYS: IF AS = "" GOTO 3140
7140 LOCATE 16,1: PRINT"*
7150 LOCATE 19,1: PRINT"*
7160 LOCATE 20,1: PRINT"*
7170 LOCATE 22,1: PRINT": LOCATE 16,1 : GOTO 2990
7180 PRINT"Your response is incorrect. Press the enter key for further explanation."
7190 AS = INKEYS: IF AS = "" GOTO 3220
7200 LOCATE 7,1
7210 LOCATE 16,1: PRINT"Example 1. This is the graph of the unit normal distribution."
7220 PRINT"From Table B, the ordinate h of this curve at z = -1.95 is .0596. Notice that the ordinate at z is equal to"
7230 PRINT"the height of the curve at z."
7240 PRINT"Example 2. This is the graph of the unit normal distribution."
7250 END
Using Table B, type in the ordinate h of the curve
at 

Your response is incorrect. The correct answer is .1826.

Begin again.
Exercise 6. This is the graph of the unit normal distribution.

Using Table 8, type in the height h of the curve at z = 0 and press the enter key.

Locate 18,1: PRINT "Your response is correct."

If z > 0, then AS = INKEYS: IF AS = " " GOTO 4460
Else, print "Incorrect. You should first type in the decimal point. Press the enter key to continue."; 126 = 1: R = 1

AS = INKEYS: IF AS = " " GOTO 4420

Locate 18,1: PRINT "Your response is incorrect. Press the enter key for further explanation."

Locate 18,1: PRINT "Your response is incorrect. The correct answer is .3989."

Locate 23,15; PRINT "Press the enter key."

Locate 1,1; PRINT "Unit 2: Screen 13"
4760 PRINT" point. Press the enter key to continue.";I:27=1: R
= 1
4770 AS = INKEYS: IF AS = "" GOTO 4770
4780 LOCATE 18,1: PRINT"
4790 LOCATE 20,1: PRINT"
4800 PRINT"
4810 PRINT"
4820 PRINT"
4830 PRINT"
4840 PRINT"
4850 AS = INKEYS: IF AS="" GOTO 4850
4860 I(AS) ;I:27=1: R=R+1: GOTO 2489
4870 PRINT"Your response is incorrect. Press the enter key for further explanation.";
4880 W27 ■ 1: PRINT"Your response is incorrect. The correct answer is .1974.";
4890 LOCATE 23,58: PRINT" Press the enter key.";
4900 AS<INKEYS: IF AS="" GOTO 4900
4910 R2 * R21+R22+R23+R24+R25+R26+R27
4930 FIRST2 = R2-W2-R
4940 T2S*TIMES
4950 TIMS="00:00:00"
4960 'screen 14
4970 SCREEN 14:COLOR 15,1;CLS
4980 LOCATE 1,32: PRINT"Unit 2: Screen 14"
4990 SCREEN 0,1:COLOR 15,1,15:CLS
5000 LOCATE 7,1: PRINT"
5010 PRINT"
5020 PRINT"This concludes the discussion of Unit 2: The Unit Normal Distribution. You worked correctly";
5030 IF Q2S = "y" OR Q2S = "Y" OR Q2S = "n" OR Q2S = "N" THEN GOTO 5110 ELSE LOCATE 15,1: PRINT"
5040 IF Q2S = "y" OR Q2S = "Y" GOTO 5090 ELSE 5100
5050 SCREEN 14:COLOR 15,1,15:CLS
5060 LOCATE 1,32:PRINT"Unit 2: Screen 14"
5070 LOCATE 7,1:K2=1
5080 PRINT"Problem 1. The mean of the unit normal distribution is z = ?";
5090 PRINT"
5100 IF Q2S = "y" OR Q2S = "Y" THEN Q2S = Q19
5110 IF Q2S = "n" OR Q2S = "N" THEN Q2S = Q28
5120 PRINT"
5130 PRINT"if no and press the enter key.";Q2S
5140 INPUT" (Type answer and press the enter key)";Q2S
5150 IF Q2S = "y" OR Q2S = "Y" OR Q2S = "n" OR Q2S = "N" THEN GOTO 5110 ELSE LOCATE 15,1: PRINT"
5160 IF Q2S = "y" OR Q2S = "Y" GOTO 5090 ELSE 5100
5170 IF Q2S = "y" OR Q2S = "Y" THEN Q2S = Q19
5180 IF Q2S = "n" OR Q2S = "N" THEN Q2S = Q28
5190 PRINT"
5200 PRINT"Your response is correct.";
5210 GOTO 5173
5220 IF Q2S = "y" GOTO 5243 ELSE 5270
5230 IF Q2S = "n" OR Q2S = "N" THEN Q2S = Q28
5240 PRINT"Your response is incorrect. Press the enter key";
5250 PRINT"for further explanation.";
5260 A5=INKEYS: IF A5="" GOTO 5310

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
141

5320 J21=1: P-P+1: GOTO 350
5330 GOTO 21-1
5340 PRINT" Your response is incorrect. The correct response is z = 0."
5350 PRINT" z = 0.
5360 LOCATE 23,59
5370 PRINT"Press the enter key."
5380 AS=INKEYS: IF AS="" GOTO 5390
5390 GOTO 5420
5400 IF Q2$ = "y" OR Q2$ = "Y" GOTO 5480 ELSE 8610
5410 CLS: LOCATE 5,1
5420 PRINT"Would you like to work another review problem?"
5430 PRINT" Type y if yes or n if no and press the enter key.";Q2S
5440 INPUT" Type y if yes or n if no and press the enter key.";Q2S
5450 IF Q2$ = "y" OR Q2$ = "Y" OR Q2$ = "n" OR Q2$ = "N" THEN GOTO 5470 ELSE LOCATE 7,1: PRINT"
5460 RETURN
5470 SCREEN 0,1:COLOR 15,1,15:CLS
5480 PRINT"Problem 2. The ordinate of the unit normal curve at z = -2.15 is?";
5490 PRINT"Type in your answer (for example, .2345) and press the enter key.";Q2S
5500 PRINT"Your response is correct."
5510 J22-0 THEN C22S = Q2S
5520 IF J22=1 THEN Q2S = Q2S
5530 PRINT"Incorrect. You should first type in the decimal point. Press the enter key to continue.";J22=1: P
5540 P+1
5550 AS=INKEYS: IF AS="" GOTO 5560
5560 GOTO 5580
5570 PRINT"Unit 2: Screen 16"
5580 PRINT"Problem 2. The ordinate of the unit normal curve at z = -2.15 is?"
5590 PRINT"Type in your answer (for example, .2345) and press the enter key.";Q2S
5600 PRINT"Your response is correct."
5610 J22-0 THEN C22S = Q2S
5620 IF J22=1 THEN Q2S = Q2S
5630 PRINT"Incorrect. You should first type in the decimal point. Press the enter key to continue.";J22=1: P
5640 P+1
5650 AS=INKEYS: IF AS="" GOTO 5660
5660 GOTO 5680
5670 PRINT"Unit 11: Screen 17"
5680 PRINT"Problem 2. The ordinate of the unit normal curve at z = -2.15 is?"
5690 PRINT"Type in your answer (for example, .2345) and press the enter key.";Q2S
5700 PRINT"Your response is correct."
5710 J22-0 THEN C22S = Q2S
5720 IF J22=1 THEN Q2S = Q2S
5730 PRINT"Incorrect. You should first type in the decimal point. Press the enter key to continue.";J22=1: P
5740 P+1
5750 AS=INKEYS: IF AS="" GOTO 5760
5760 GOTO 5780
5770 PRINT"Unit 2: Screen 17"
5780 PRINT"Problem 2. The ordinate of the unit normal curve at z = -2.15 is?"
5790 PRINT"Type in your answer (for example, .2345) and press the enter key.";Q2S
5800 PRINT"Your response is correct."
5810 J22-0 THEN C22S = Q2S
5820 IF J22=1 THEN Q2S = Q2S
5830 PRINT"Incorrect. You should first type in the decimal point. Press the enter key to continue.";J22=1: P
5840 P+1
5850 AS=INKEYS: IF AS="" GOTO 5860
5860 GOTO 5880
5870 SCREEN 0,1:COLOR 15,1,15:CLS
5880 LOCATE 1,1:PRINT"Unit 2: Screen 17"
Problem 3. The standard deviation of the unit normal distribution equals? (Type answer and press the enter key.)

```
LOCATE 7,1: K2=3
PRINT" Problem 3. The standard deviation of the unit normal"
PRINT"
distribution equals? (Type answer and press the"
PRINT"
Enter the answer and press enter.)"
PRINT"
INPUT" Enter the answer and press enter.)"; Q2S
IF J2S+0 THEN C23S = Q2S
IF J2S-1 THEN D23S = Q2S
PRINT"
PRINT" for further explanation."
AS=INKEYS; IF AS="" GOTO 6170
C23S=C23S+1: P=P+1: GOTO 1700
PRINT" Your response is incorrect. The correct response is z = 1.
```

Problem 4. One point of inflection of the unit normal curve occurs at z = -1. The second point of inflection occurs at z = ? (Type answer and press the enter key.)

```
LOCATE 7,1: K2=4
PRINT" Problem 4. One point of inflection of the unit normal curve"
PRINT"
PRINT" occurs at z = -1. The second point of inflection occurs at z = ? (Type answer and press the enter key.)"
PRINT"
INPUT" enter the answer and press enter.)"; Q2S
IF J2S+0 THEN C24S = Q2S
IF J2S-1 THEN D24S = Q2S
PRINT"
PRINT" for further explanation."
AS=INKEYS; IF AS="" GOTO 6400
C24S=C24S+1: P=P+1: GOTO 1700
PRINT" Your response is incorrect. The correct response is z = -1.
```

Problem 5. The height of the unit normal curve at z = 1.32 is

```
LOCATE 7,1: K2=5
PRINT" Problem 5. The height of the unit normal curve at z = 1.32 is
```

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
143

PRINT "Type in your answer (e.g., .3416) and press the"
INPUT " enter key.";Q2$
IF J2S=0 THEN C2S = Q2S
IF J2S=1 THEN D2S = Q2S
PRINT " 
IF Q2$ = "1669" GOTO 6640 ELSE 6670
P25 = 1
PRINT "Your response is correct."
GOTO 6870

PRINT " 
IF Q2$ = "1669" GOTO 6690 ELSE 6780
PRINT " Incorrect. You should first type in the decimal"
PRINT " point. Press the enter key to continue.";J2S=1: P
* P=1
AS = INKEYS: IF AS = "" GOTO 6720
LOCATE 11,1: PRINT"
PRINT"
PRINT"
PRINT"
PRINT"
"LOCATE 11,1: GOTO 6590
PRINT "Your response is incorrect. Press the enter key."
PRINT "for further explanation.";
AS = INKEYS: IF AS = "" GOTO 6900
GOSUB 42
1 IF Q2S = "y" OR Q2S = "Y" GOTO 6920 ELSE 9610
SCREEN 20
SCREEN 0,1:COLOR 15,1,1:CLS
LOCATE 1,1:PRINT"Unit 2: Screen 20"
LOCATE 7,1: K2=6
PRINT "Problem 6. The median of the unit normal distribution is z = ?"
PRINT " 
INPUT "(Type answer and press the enter key)";Q2S
IF J2S=0 THEN C2S = Q2S
IF J2S=1 THEN D2S = Q2S
PRINT " 
IF Q2S = "0" GOTO 740 ELSE 7870
P26 = 1
PRINT "Your response is correct."
GOTO 7170
IF J2S=1 GOTO 7130
PRINT "Your response is incorrect. Press the enter key";
PRINT "for further explanation.";
AS = INKEYS: IF AS = "" GOTO 7100
J2S=1: P=P+1: GOTO 7200
7100 PRINT"
144 PRINT" Your response is incorrect. The correct response"  
145 PRINT" is z = 8."

7140 PRINT" Your response is incorrect. The correct response"  
7150 PRINT" is z = 8."

7160 PRINT" Press the enter key."  
7169 PRINT" Press the enter key."  
7170 LOCATE 23,58

7180 PRINT" Your response is incorrect. The correct response"  
7190 PRINT" is z = 8."

7200 GOSUB 5420

7210 IF Q2$ = "y" OR Q2$ = "Y" GOTO 7220 ELSE 8610

7220 ' screen 21

7230 SCREEN 0,1:COLOR 15,1,15:CLS

7240 LOCATE 1,32:PRINT"Unit 2: Screen 21"

7250 LOCATE 7,1: K2=7

7260 PRINT" Problem 7. The ordinate of the unit normal curve at z = 1.77 is ?

7270 PRINT" Type in your answer (for example, .2345) and press the enter key." Q2S  

7280 PRINT" Type in your answer (for example, .2345) and press the enter key." Q2S

7298 INPUT" press the enter key.";Q2S

7310 IF J27=1 THEN Q2S = Q2S

7320 IF J27=1 THEN Q2S = Q2S

7330 PRINT" Incorrect. You should first type in the decimal point. Press the enter key to continue." P = 1

7340 AS = INKEY$: IF AS = "" GOTO 7430

7380 LOCATE 11,1: PRINT"

7390 PRINT" Your response is incorrect. Press the enter key for further explanation."  
7400 PRINT" Incorrect. You should first type in the decimal point. Press the enter key to continue."  

7410 PRINT" is .2333."  

7420 PRINT" is .2333."  

7430 GOTO 7430

7440 LOCATE 11,1: PRINT"  

7450 PRINT"  

7460 PRINT"  

7470 PRINT"  

7480 PRINT"  

7489 PRINT"  

7490 PRINT"  

7500 PRINT"  

7510 PRINT" for further explanation."  

7520 AS = INKEY$: IF AS = "" GOTO 7520

7530 J27=1: P=1: GOTO 2488

7540 Q2S = 1

7550 PRINT" is .2333."  

7560 PRINT" is .2333."  

7570 PRINT" is .2333."  

7580 LOCATE 23,58

7590 PRINT" Press the enter key."  

7600 AS = INKEY$: IF AS = "" GOTO 7600

7610 GOSUB 7420

7620 IF J2S = "y" OR Q2S = "y" GOTO 7610 ELSE 8610

7630 ' screen 22

7640 SCREEN 0,1:COLOR 15,1,15:CLS

7650 LOCATE 1,32:PRINT"Unit 2: Screen 22"

7660 LOCATE 7,1: K2=8

7670 PRINT" Problem 8. The unit normal curve is symmetric about z = ? (Type in your answer and press the enter key.)" Q2S  

7680 IF J2S=1 THEN Q2S = Q2S

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
7730 IF J28=1 THEN D28 = Q2S
7740 PRINT"";
7750 IF Q2S = "0" GOTO 7760 ELSE 7790
7760 P28 = 1
7770 PRINT"" Your response is correct.
7780 PRINT"" for further explanation."
7790 IF J28=1 GOTO 7850
7800 PRINT"" Your response is incorrect. The correct response"";
7810 PRINT"" is z = 0."
7820 LOCATE 23,58
7830 PRINT""Press the enter key.";
7840 AS=INKEYS: IF AS="" GOTO 7830
7850 028=1
7860 PRINT"" Your response is incorrect. The correct response"";
7870 PRINT"" is z > 0."
7880 LOCATE 23,58
7890 PRINT""Press the enter key.";
7900 AS=INKEYS: IF AS="" GOTO 7890
7910 GOSUB 5420
7920 IF Q2S = "Y" OR Q2S = "y" GOTO 7940 ELSE 8610
7930 'screen 23
7940 SCREEN 1,1:COLOR 15,1,15:CLS
7950 LOCATE 1,32:PRINT""Unit 2: Screen 23"
7960 LOCATE 7,1: K2=9
7970 PRINT"" Problem 9. The tails of the unit normal curve are asymptotic"";
7980 PRINT"" to the vertical axis. (Type t if true or f if "
7990 PRINT"" and press the enter key:);Q2S
8000 IF J29=0 THEN C29S = Q2S
8010 IF J29=1 THEN D29S = Q2S
8020 PRINT"" Your response is correct.
8030 PRINT"" Your response is incorrect. Press the enter key"
8040 PRINT"" for further explanation."
8050 AS=INKEYS: IF AS="" GOTO 8040
8060 029=1
8070 PRINT"" Your response is incorrect. The correct response"";
8080 PRINT"" is f."
8090 LOCATE 23,58
8100 PRINT""Press the enter key.";
8110 AS=INKEYS: IF AS="" GOTO 8100
8120 PRINT"" Your response is correct.
8130 PRINT"" Your response is incorrect. Press the enter key"
8140 PRINT"" for further explanation."
8150 AS=INKEYS: IF AS="" GOTO 8150
8160 J29=1: P=P+1: GOTO 350
8170 Q29=1
8180 PRINT"" Your response is incorrect. The correct response"";
8190 PRINT"" is f.";
8200 INPUT"" (Type in your answer and press the enter key:);Q2S
8210 LOCATE 23,58
8220 PRINT""Press the enter key.";
8230 AS=INKEYS: IF AS="" GOTO 8230
8240 GOSUB 5420
8250 IF Q2S = "Y" OR Q2S = "y" GOTO 8280 ELSE 8610
8260 'screen 24
8270 SCREEN 0,1:COLOR 15,1,15:CLS
8280 LOCATE 1,32:PRINT""Unit 2: Screen 24"
8290 LOCATE 7,1: K2=10
8300 PRINT"" Problem 10. The height of the unit normal curve at z = -0.63 is"";
8310 PRINT"" (Type in your answer and press the enter key:);Q2S
8320 INPUT"" (Type in your answer and press the enter key:);Q2S
8330 IF J210=0 THEN C210S = Q2S
8340 IF J210=1 THEN D210S = Q2S
8350 PRINT"" Your response is correct.
8360 IF Q2S = "-0.271" GOTO 8370 ELSE 8600
146

8370 P210 = 1
8380 PRINT "Your response is correct."
8390 GOTO 8390
8400 IF J210=1 GOTO 8540
8410 IF Q2S = "3271" GOTO 8540 ELSE 8490
8420 PRINT "Incorrect. You should first type in the decimal point. Press the enter key to continue."
8430 PRINT "J210 = 1: P = 1"
8440 AS = INKEYS: IF AS = "" GOTO 8450
8450 LOCATE 9,1: PRINT ""
8460 PRINT "Your response is incorrect. Press the enter key for further explanation."
8470 PRINT "J210 = 1: P = 1"
8480 PRINT "Your response is incorrect. The correct response is .3271."
8490 LOCATE 23,58
8500 PRINT "Press the enter key."
8510 AS = INKEYS: IF AS = "" GOTO 8510
8520 'screen 20
8530 CLS: LOCATE 9,1; GOTO 8320
8540 PRINT "Turn the printer on and press the enter key."
8550 AS = INKEYS: IF AS = "" GOTO 8550
8560 IF K2 = 0 GOTO 8820
8580 Q2 = Q21+Q22+Q23+Q24+Q25+Q26+Q27+Q28+Q29+Q30
8590 SEC2 = P2+Q2-P
8600 PRINT "The number of correct exercises is":FIRST2
8610 PRINT "The number of incorrect exercises is":7-FIRST2
8620 PRINT ";P=Q2"
8630 PRINT "The number of correct exercises after remediation is"
8640 PRINT "Unit 2: The Unit Normal Distribution"
8650 PRINT ";NAMS","N0S","T2S"
8660 PRINT "The number of correct exercises is":FIRST2
8670 PRINT "The number of incorrect exercises is":7-FIRST2"
8680 PRINT "The number of correct problems is":SEC2
8690 PRINT "The number of incorrect problems is":K2-SEC2
8700 PRINT "The number of correct exercises after remediation is"
8710 PRINT "The number of exercises is":FIRST2
8720 PRINT "The number of incorrect exercises is":7-FIRST2
8730 PRINT ";P=Q2"
8740 PRINT "The number of correct exercises after remediation is"
8750 PRINT "Unit 2: The Unit Normal Distribution"
8760 PRINT ";NAMS","N0S","T2S"
8770 PRINT "The number of correct exercises is":FIRST2
8780 PRINT "The number of incorrect exercises is":7-FIRST2"
8790 PRINT "The number of correct problems is":SEC2
8800 PRINT "The number of incorrect problems is":K2-SEC2
8810 PRINT "The number of correct exercises after remediation is"
8820 IF K2>0 GOTO 8990
8830 PRINT ";T1=Q2"
8840 PRINT "The number of correct problems is":SEC2

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
The number of incorrect problems is value
The number of correct problems after remediation is value
Problem 1 response was correct.
Problem 1 response was incorrect.
Problem 2 response was correct.
Problem 2 response was incorrect.
Problem 3 response was correct.
Problem 3 response was incorrect.
Problem 4 response was correct.
Problem 4 response was incorrect.
Problem 5 response was correct.
Problem 5 response was incorrect.
Problem 6 response was correct.
Problem 6 response was incorrect.
Problem 7 response was correct.
Problem 7 response was incorrect.
LPRINT" Problem 5 response was correct.",C25$: GOTO 9650
LPRINT" Problem 5 response was incorrect.",C25$,D25$
 IF J26*I GOTO 9699
LPRINT" Problem 6 response was correct.",C26$: GOTO 9710
LPRINT" Problem 6 response was incorrect.",C26$,D26$
 IF K2<7 GOTO 9959
LPRINT" Problem 7 response was correct.",C27$: GOTO 9770
LPRINT" Problem 7 response was incorrect.",C27$,D27$
LPRINT" Problem 8 response was correct.",C28$: GOTO 9810
LPRINT" Problem 8 response was incorrect.",C28$,D28$
 IF K2<8 GOTO 9959
IF K2<9 GOTO 9950
LPRINT" Problem 9 response was correct.",C29$: GOTO 9890
LPRINT" Problem 9 response was incorrect.",C29$,D29$
 IF K2<10 GOTO 9950
 IF K2<10 GOTO 9910
LPRINT" Problem 10 response was correct.",C21$: GOTO 9910
LPRINT" Problem 10 response was incorrect.",C21$,D21$
 CLS: CHAIN "unit3"
$ z $-scores

1. The student should be able to define the term "z-score."

2. The student should be able to transform a raw-score into an equivalent $ z $-score.

3. The student should be able to transform a $ z $-score into its equivalent raw-score.

If an observation or score is expressed in terms of the number of standard deviations it deviates from the mean, the resulting score is called a $ z $-score. An observation that has a $ z $-score of $ -2 $ is $ 2 $ standard deviations below the mean of the observation's population. A raw-score having a $ z $-score of $ +1.5 $ is 1.5 standard deviations above the mean of its population.
Suppose that we are given a normal population of scores. The z-score for any observation in this population is given by the following formula:

\[ z = \frac{X - m}{s} \]

where \( X \) is the raw-score or the observation value, \( m \) is the mean of the given population, and \( s \) is the standard deviation of the population. Another formula for a z-score is:

\[ z = \frac{\text{deviation}}{(\text{standard deviation})} \]

where the deviation = \( X - m \).

Example 1. A test has a mean of 62 and a standard deviation of 5. Determine the z-score for the raw-score of 72.

Solution. \( X - m = 72 - 62 = 10 \) and \( s = 5 \). Therefore, \( z = \frac{10}{5} = +2 \). Note that the raw-score of 72 is 2 standard deviations above the mean.
Example 2. If the mean of a raw-score distribution is 80 and the standard deviation is 15, what is the z-score for the raw-score of 65?

Solution. \[ z = \frac{X - m}{s} = \frac{65 - 80}{15} = -1 \]

Note that a raw-score of 65 is 1 standard deviation below the mean of the raw-scores.

Example 3. What is the z-score of the mean of any normal population of raw-scores?

Solution. The mean does not deviate from itself. Since a z-score is deviation/(standard deviation), the z-score of the mean of any normal population is 0.

Exercise 1. A raw-score distribution has a mean of 80 and a standard deviation of 12. The raw-score of 63 expressed as a z-score is?

Type a, b, c, d or e for your answer and press the enter key.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Exercise 3. If X = 140 with mean = 110 and standard deviation = 14, X expressed as a z-score is ?

a. -2.14
b. +1.14
c. +2.14
d. +30

e. none of the above.

Type a, b, c, d, or e for your answer and press the enter key.
```basic
1050 PRINT" Type a, b, c, d or e for your answer and press the "
1060 PRINT" enter key."; BS
1070 INPUT
1080 IF 134*0 THEN A34S = BS
1090 IF 134*1 THEN B34S = BS
1100 IF BS="a" OR BS="A" OR BS="b" OR BS="B" OR BS="c" OR BS="c" OR BS="d" OR BS
1110 "D" OR BS = "E" OR BS = "E" THEN 3170 ELSE 3110
1120 LOCATE 15,1
1130 PRINT"
1140 PRINT"
1150 LOCATE 15,1
1160 GOTO 3050
1170 IF BS="d" OR BS="B" THEN 3180 ELSE 3200
1180 PRINT" Your response is correct."; GOTO 3300
1190 R14*l: PRINT"
1200 PRINT" Your response is incorrect. Press the enter key";
1210 PRINT" for further explanation.";
1220 PRINT" AS=INKEYS: IF AS="" GOTO 3250
1230 R*R*1: GOTO 910
1240 PRINT"
1250 W34*l: PRINT"
1260 PRINT" Your response is incorrect. The correct response i s "
1270 LOCATE 23,58: PRINT"Press the enter key.";
1280 AS=INKEYS: IF AS="" GOTO 3110
1290 CLS: LOCATE 1,32: PRINT"Unit 3: Screen 10"
1300 LOCATE 5,1
1310 PRINT" Exercise 5. The z-score of the mean of any normal population"
1320 PRINT" is ?"
1330 PRINT"
1340 PRINT" a. -1.00"
1350 PRINT" b. -0.50"
1360 PRINT" c. 0"
1370 PRINT" d. +0.50"
1380 PRINT" e. +1.00"
1390 PRINT"
1400 PRINT" Type a, b, c, d or e for your answer and press the "
1410 PRINT"
1420 INPUT" enter key."; BS
1430 IF 135*0 THEN A35S = BS
1440 IF 135*1 THEN B35S = BS
1450 IF BS="a" OR BS="A" OR BS="b" OR BS="B" OR BS="c" OR BS="C" OR BS="d" OR BS
1460 "D" OR BS = "E" OR BS = "E" THEN 3570 ELSE 3510
1470 LOCATE 15,1
1480 PRINT"
1490 PRINT"
1500 LOCATE 15,1
1510 GOTO 3440
1520 IF BS="c" OR BS="C" THEN 3500 ELSE 3600
1530 PRINT"
1540 PRINT"
1550 LOCATE 15,1
1560 GOTO 3440
1570 IF BS="c" OR BS="c" THEN 3500 ELSE 3600
1580 PRINT"
1590 R35*l: PRINT" Your response is correct."; GOTO 3700
```

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Example 4. The mean and standard deviation of a population are 100 and 15, respectively. If the z-score is -2, what is the corresponding observation?

Solution. \( X = m + zs \)
\( X = 100 + 2(15) \)
\( X = 100 + 30 \)
\( X = 130 \)

Recall that multiplication precedes addition when simplifying an algebraic expression.

Example 5. The mean and standard deviation of a population of scores are 50 and 10, respectively. If the z-score is -1.5, what is the corresponding raw score?
Exercise 6. The mean and standard deviation of a population are 80 and 12, respectively. If the z-score is 0, what is the corresponding raw-score?
scores are 62 and 5, respectively. If the z-score is -2.4, what is the corresponding raw-score?

Type a, b, c, d, or e for your answer and press the enter key.

Type a, b, c, d, or e for your answer and press the enter key.

The mean and standard deviation of a group of test scores are 90 and 4, respectively. What is the z-score of 80?

Type a, b, c, d, or e for your answer and press the enter key.

Type a, b, c, d, or e for your answer and press the enter key.

Type a, b, c, d, or e for your answer and press the enter key.
5170 IF BS="A" OR BS="B" OR BS="C" OR BS="D" OR BS = "E" THEN 5440 ELSE 5380
5180 LOCATE 17,1
5190 PRINT "*
5400 PRINT"
5420 LOCATE 17,1
5430 GOTO 5320
5440 IF BS="B" OR BS="*" THEN 5450 ELSE 5470
5450 PRINT "Your response is correct."; GOTO 5570
5460 IF BS="*" GOTO 5540
5470 PRINT "Your response is incorrect. Press the enter key";
5500 PRINT "for further explanation."
5510 PRINT AS=INKEYS; IF AS=" " GOTO 5520
5520 AS="L" PRINT "Your response is incorrect. The correct response is b.";
5530 W30-1: PRINT "Press the enter key.";
5540 AS=INKEYS: IF AS=" " GOTO 5540
5550 W3R-1: PRINT"Your response is incorrect. The correct response is:
5560 PRINT"b."
5570 LOCATE 23,58: PRINT"Press the enter key."
5580 AS=INKEYS; IF AS=" " GOTO 5580
5590 R3 = R31+R32+R33+R34+R35+R36+R37+R38
5600 W3 = W31+W32+W33+W34+W35+W36+W37+W38
5610 FIRST = R3+W3-R
5620 T3S = TIMES
5630 TIMES = "00:00:00"
5640 SCREEN 17
5650 SCREEN 8,1: COLOR 15,1,7: CLS
5660 LOCATE 1,12: PRINT"Unit 3: Screen 18"
5670 PRINT 7,1
5680 PRINT "This concludes our discussion of Unit 3: z-Scores."
5690 PRINT "You worked correctly";
5700 PRINT"if not exercise(s) out of 9. There are 10 review problems for this unit. Would you like to work some review problems? Type y if yes or n if no"
5710 PRINT "Press the enter key.";
5720 PRINT '"Q3S
5730 PRINT
5740 PRINT
5750 PRINT
5760 INPUT "Problem 1. If an observation or raw-score is expressed in terms of the number of standard deviations it deviates from the mean, the resulting value is called?";
5770 IF Q3S = "Y" OR Q3S = "Y" OR Q3S = "N" OR Q3S = "N" GOTO 5780 ELSE LOCATE 1,11: PRINT "Unit 1,1: GOTO 5750
5780 IF Q3S = "Y" OR Q3S = "Y" GOTO 5790 ELSE 9840
5790 SCREEN 18"
5800 CLS:LOCATE 1,1: PRINT"Unit 3: Screen 18"
5810 PRINT "Problem 1. If an observation or raw-score is expressed in terms of the number of standard deviations it deviates from the mean, the resulting value is called?"
5820 PRINT "a. the mean.";
5830 PRINT "b. the standard deviation."
5840 PRINT "c. the median.";
5850 PRINT "d. a z-score.";
5860 PRINT "You worked correctly";
5870 PRINT "Press the enter key.";
5880 PRINT "Exercise(s) out of 9. There are 10 review problems for this unit. Would you like to work some review problems? Type y if yes or n if no"
5890 PRINT "Press the enter key.";
5900 PRINT"Q3S
5910 PRINT
5920 PRINT
5930 PRINT
5940 PRINT

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Would you like to work another review problem? Type y if yes or n if no and press the enter key; Q3S.

Type a, b, c, or d for your answer and press the enter key.

If Q3S = "a" or Q3S = "A" or Q3S = "b" or Q3S = "B" or Q3S = "c" or Q3S = "C" or Q3S = "d" or Q3S = "D" then 6310 ELSE 6320;

6310 PRINT "Your response is correct.
6320 PRINT "Your response is incorrect. Press the enter key for further explanation.
6330 PRINT "Your response is incorrect. The correct answer is"
6340 PRINT "Would you like to work another review problem? Type y"
6350 INPUT "If yes or n if no and press the enter key; Q3S.
6360 IF Q3S = "y" OR Q3S = "Y" OR Q3S = "n" OR Q3S = "N" THEN 6310 ELSE LOCATE 7,1 ELSE LOCATE 7,1: GOTO 6290.
6370 RETURN
6380 "screen 19
6390 CLS LOCATE 1,12: PRINT "Unit 3: Screen 19"
6400 LOCATE 7,1; K=2
6410 PRINT "Problem 2. A z-score of 1 indicates that the corresponding raw-score lies 1 standard deviation above the mean.
6420 PRINT a. lies 1 standard deviation below the mean.
6430 PRINT b. lies 1 standard deviation above the mean.
6440 PRINT c. is equal to the mean.
6450 PRINT d. none of the above.
6460 PRINT "Type a, b, c, or d for your answer and press the enter key; Q3S.
6470 IF J32=0 THEN Q3S = Q3S
6480 IF J32=1 THEN Q3S = Q3S
6490 PRINT
6500 IF Q3S = "a" OR Q3S = "A" OR Q3S = "b" OR Q3S = "B" OR Q3S = "c" OR Q3S = "C" OR Q3S = "d" OR Q3S = "D" THEN 6570 ELSE 6510
6510 LOCATE 16,1
6520 PRINT

Replicated with permission of the copyright owner. Further reproduction prohibited without permission.
6530 PRINT"
6540 PRINT"
6550 LOCATE 16,1
6560 GOTO 6440
6570 IF Q3$-"b" OR Q3S="b" GOTO 6580 ELSE 6610
6580 P32=1
6590 PRINT" Your response is correct."
6600 GOTO 6710
6610 IF J32=1 GOTO 6670
6620 PRINT" Your response is incorrect. Press the enter key"
6630 PRINT"
6640 PRINT* for further explanation.*
6650 A$=INKEYS: IF A$="" GOTO 6660
6660 J32=1: P=P+1: GOTO 3590
6670 Q32=1
6680 PRINT" Your response is incorrect. The correct answer is"
6690 PRINT"
6700 PRINT" is b."
6710 LOCATE 23,58: PRINT"Press the enter key."
6720 A$=INKEYS: IF A$="" GOTO 6720
6730 GOSUB 6260
6740 IF Q3S = "y" OR Q3S = "Y" GOTO 6750 ELSE 9840
6750 'screen 20'
6760 CLS:LOCATE 1,12: PRINT"Unit J: Screen 20"
6770 LOCATE 5,1:K3+1
6780 PRINT" Problem 3. The z-score of the mode for any normal population is ?
6790 PRINT" with mean 50 and standard deviation of 5 is ?"
6800 PRINT"
6810 PRINT"
6820 PRINT" a. -1.00"
6830 PRINT" b. +1.00"
6840 PRINT" c. +5.00"
6850 PRINT" d. -50.00"
6860 PRINT" e. none of the above"
6870 PRINT"
6880 PRINT" Type a, b, c, d, or e for your answer and press the"
6890 PRINT"
6900 INPUT enter key.;Q3S
6910 IF J33=8 THEN C $= "S = Q3S"
6920 IF J32=1 THEN Q3S= Q3S
6930 PRINT"
6940 IF Q3$="a" OR Q3S="A" OR Q3S="B" OR Q3S="C" OR Q3S="c" OR Q3S="d" OR Q3S="D" OR Q3S = "e" OR Q3S = "E" THEN 7010 ELSE 6950
6950 LOCATE 15,1
6960 PRINT"
6970 PRINT"
6980 PRINT"
6990 LOCATE 15,1
7000 GOTO 6980
7010 IF Q3S="e" OR Q3S="E" GOTO 7020 ELSE "050"
7020 P33=1
7030 PRINT" Your response is correct."
7040 GOTO 7110
7050 IF J33=1 GOTO 7110
7060 PRINT" Your response is incorrect. Press the enter key"
7070 PRINT"
7080 PRINT* for further explanation.*
7090 A$=INKEYS: IF A$="" GOTO 7090
7100 J33=1: P=P+1: GOTO 1510
Problem 4. A raw-score distribution is normally distributed with a mean of 50 and a standard deviation of 10. What is the z-score for the raw-score of 70?

Type in your answer (e.g., 1.87) and press the enter key.

Your response is incorrect. The correct answer is 2. Press the enter key for further explanation.

Problem 5. The z-score of an observation taken from a normal distribution with mean \( \mu = 50 \) and standard deviation of 10 is -2. What is the corresponding raw-score \( X \)?
7760 PRINT* for further explanation.*
7770 AS = INKEYS: IF AS="" GOTO 7770
7780 J35=1: P=P+1: GOTO 4148
7790 Q35=1
7800 PRINT* Your response is incorrect. The correct answer is*
7810 PRINT* J35=".
7820 PRINT* LOCATE 23,58:PRINT"Press the enter key."
7830 IF Q35 = "y" OR Q35 = "Y" GOTO 7870 ELSE 9840
7840 AS = INKEYS: IF AS="" GOTO 7840
7850 GOSUB 6260
7860 IF Q3S = "y" OR Q3S = "Y" GOTO 7870 ELSE 9840
7870 'screen 23
7880 CLS:LOCATE 1,32: PRINT"Unit 3: Screen 23"
7890 LOCATE 5,1:K3+6
7900 PRINT* Problem 6. A normal population has mean 72 and standard*
7910 PRINT** deviation of 5. The z-score of its mean equals ?"*
7920 PRINT** a. -1 "
7930 PRINT** b. 0 "
7940 PRINT** c. +0.5"
7950 PRINT** d. +1 "
7960 PRINT** Type a, b, c, or d for your answer and press the*
7970 INPUT* enter key."
8000 IF J36=0 THEN Q36S = Q36
8010 IF J36=1 THEN Q36S = Q36
8020 PRINT**
8030 IF Q3S="a" OR Q3S="A" OR Q3S="b" OR Q3S="B" OR Q3S="c" OR Q3S="C" OR Q3S="d*
8040 PRINT** OR Q3S="D" THEN 8120 ELSE 8860
8050 LOCATE 14,1
8060 PRINT*
8070 PRINT* 8800 PRINT*
8080 IF J36=0 THEN Q36S = Q36
8090 IF J36=1 THEN Q36S = Q36
8100 PRINT**
8110 IF Q3S="a" OR Q3S="A" OR Q3S="b" OR Q3S="B" OR Q3S="c" OR Q3S="C" OR Q3S="d*
8120 PRINT** OR Q3S="D" THEN 8120 ELSE 8860
8130 LOCATE 14,1
8140 PRINT*
8150 PRINT*
8160 IF J36=0 THEN Q36S = Q36
8170 IF J36=1 THEN Q36S = Q36
8180 PRINT**
8190 PRINT* for further explanation.*
8200 AS=INKEYS: IF AS="" GOTO 8200
8210 J36=1: P=P+1: GOTO 1538
8220 Q36S = Q36
8230 PRINT* Your response is incorrect. The correct answer is*
8240 PRINT* 8720 PRINT* Your response is correct.*
8250 PRINT* is b."
8260 LOCATE 23,58: PRINT"Press the enter key."
8270 AS=INKEYS: IF AS="" GOTO 8270
8280 GOSUB 6260
8290 IF Q3S = "y" OR Q3S = "Y" GOTO 8300 ELSE 9840
8300 'screen 24
8310 CLS:LOCATE 1,32: PRINT"Unit 3: Screen 24"
8320 LOCATE 5,1:K3+7
8330 PRINT* Problem 7. A z-score of -2.5 indicates that the corresponding*
8340 PRINT** raw-score __________ the mean."
8350 PRINT* a. lies below*
163

8380 PRINT"
8390 PRINT"
8400 PRINT"
8410 PRINT"
8420 PRINT"
8430 PRINT" Type a, b, c, d or e for your answer and press the"
8440 PRINT"
8450 INPUT" enter key."; Q3S
8460 IF J37 = 0 THEN C37 = Q3S
8470 IF J37 = 1 THEN D37 = Q3S
8480 PRINT"
8490 IF Q3S = "a" OR Q3S = "A" OR Q3S = "b" OR Q3S = "B" OR Q3S = "c" OR Q3S = "C" OR Q3S = "d"
 OR Q3S = "D" OR Q3S = "E" OR Q3S = "e" THEN 8560 ELSE 8500
8500 LOCATE 17, 1
8510 PRINT"
8520 PRINT"
8530 PRINT"
8540 GOTO 8430
8550 IF Q3S = "d" OR Q3S = "D" GOTO 8570 ELSE 8600
8560 Q3S = 1: P = P + 1: GOTO 350
8570 PRINT"
8580 PRINT" Your response is incorrect. The correct answer is" 8590 PRINT"
8600 PRINT" is d."
8610 LOCATE 23, 58: PRINT" Press the enter key." 8620 AS = INKEYS: IF AS = "" GOTO 8640
8630 IF J37 = 1 THEN P = P + 1: GOTO 350
8640 PRINT"
8650 PRINT" Your response is incorrect. The correct answer is" 8660 PRINT"
8670 PRINT" is d."
8680 LOCATE 23, 58: PRINT" Press the enter key." 8690 AS = INKEYS: IF AS = "" GOTO 8710
8700 GOSUB 6260
8710 IF Q3S = "y" OR Q3S = "Y" GOTO 8740 ELSE 8640
8720 SCREEN 25
8730 CLEAR: LOCATE 1, 1: PRINT" Unit 3: Screen 25"
8740 GOTO 8750
8750 LOCATE 5, 1: K = 8
8760 PRINT" Problem 8. The z-score of the median for any normal population"
8770 PRINT" with mean 65 and standard deviation of 2 is ?" 8780 PRINT"
8790 PRINT" a. -1.00" 8800 PRINT" b. -0.50" 8810 PRINT" c. 0" 8820 PRINT" d. +0.50" 8830 PRINT" e. none of the above"
8840 PRINT" Type a, b, c, d, or e for your answer and press the"
8850 PRINT"
8860 INPUT" enter key."; Q3S
8870 IF J38 = 0 THEN C38 = Q3S
8880 IF J38 = 1 THEN D38 = Q3S
8890 PRINT"
8900 IF Q3S = "a" OR Q3S = "A" OR Q3S = "b" OR Q3S = "B" OR Q3S = "c" OR Q3S = "C" OR Q3S = "d"
 OR Q3S = "D" OR Q3S = "E" OR Q3S = "e" OR Q3S = "E" THEN 9200 ELSE 8940
8910 LOCATE 15, 1
8920 PRINT"
Problem 9. A raw-score distribution is normally distributed with a mean of 74 and a standard deviation of 6.

What is the z-score for the raw-score of 59?

Type in your answer (e.g., 1.87) and press the enter key.

If your response is correct, the correct answer is -2.50.
deviation of 8 is +2.5. What is the corresponding raw-score X ?

Type in your answer and press the enter key.; Q3S

INPUT "Type in your answer and press the enter key."; Q3S

IF Q3S = "92" THEN C10S = Q3S

IF J310 = 1 THEN Q3S = Q3S

PRINT "Your response is correct."

IF Q3S = "92" THEN 9690 ELSE 9720

PRINT "Your response is incorrect. Press the enter key"

PRINT "for further explanation."

AS = INKEYS: IF AS = " " GOTO 9760

J310 = 1: P-P+1: GOTO 4140

PRINT "Your response is incorrect. The correct answer is" 92.

LOCATE 23,58: PRINT "Unit 3: Screen 23"

LOCATE 8,1

PRINT "The number of correct exercises is" : FIRST3

PRINT "The number of incorrect exercises is" : 8-FRST3

PRINT ": P-W3

PRINT "The number of correct exercises after remediation is"

PRINT "The number of correct problems is" : SEC3

PRINT "The number of incorrect problems is" : K3-SEC3

PRINT "The number of correct problems after remediation is"

PRINT "Unit 3: Standard Scores"
10870 LPRINT"": IF J35=1 GOTO 10900
10880 LPRINT" Problem 5 response was correct.",C35$; GOTO 10920
10890 LPRINT" Problem 5 response was incorrect.",C35$,D35$
10900 IF K3<6 GOTO 11220
10910 LPRINT"": IF J36=1 GOTO 10960
10920 LPRINT" Problem 6 response was correct.",C36$; GOTO 10980
10930 LPRINT" Problem 6 response was incorrect.",C36$,D36$
10940 IF K3<7 GOTO 11220
10950 LPRINT"": IF J37=1 GOTO 11020
10960 LPRINT" Problem 7 response was correct.",C37$; GOTO 11040
10970 LPRINT" Problem 7 response was incorrect.",C37$,D37$
10980 IF K3<8 GOTO 11220
10990 LPRINT"": IF J38=1 GOTO 11080
11000 LPRINT" Problem 8 response was correct.",C38$; GOTO 11100
11010 LPRINT" Problem 8 response was incorrect.",C38$,D38$
11020 IF K3<9 GOTO 11220
11030 LPRINT"": IF J39=1 GOTO 11140
11040 LPRINT" Problem 9 response was correct.",C39$; GOTO 11160
11050 LPRINT" Problem 9 response was incorrect.",C39$,D39$
11060 IF K3<10 GOTO 11220
11070 LPRINT"": IF J40=1 GOTO 11200
11080 LPRINT" Problem 10 response was correct.",C40$; GOTO 11220
11090 LPRINT" Problem 10 response was incorrect.",C40$,D40$
11100 CLS: CHAIN "unit4"

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Unit 4: Area under a normal curve below or above a given observation

Objectives: At the end of this unit, the student should be able to:

1. Approximate the proportion of the area under a normal curve lying below a given observation.
2. Approximate the proportion of the area under a normal curve lying above a given observation.

In many statistical applications, it is often necessary to know the proportion of the area under a normal curve that falls either below or above a given observation. Because a normal distribution and its corresponding z-score distribution have similar shapes, the z-score of the given observation is first computed. Table B, Areas and Ordinates of the Unit Normal Distribution, is then used to determine the proportion of area falling above or below the given observation.

First, we will study how to use Table B and later return to the problem of approximating the area under a normal curve.
Suppose that one desires to find the area under the unit normal curve below a given z-value. The value of z is found in the first column of Table B. To the right of this entry in the column, titled Area Below, the area below z is found. A portion of Table B is shown below:

<table>
<thead>
<tr>
<th>z</th>
<th>Area Below</th>
<th>Area Above</th>
<th>Ordinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1.04</td>
<td>.1492</td>
<td>.8508</td>
<td>.2323</td>
</tr>
<tr>
<td>-1.03</td>
<td>.1515</td>
<td>.8485</td>
<td>.2347</td>
</tr>
<tr>
<td>-1.02</td>
<td>.1539</td>
<td>.8461</td>
<td>.2371</td>
</tr>
<tr>
<td>-1.01</td>
<td>.1562</td>
<td>.8438</td>
<td>.2396</td>
</tr>
<tr>
<td>-1.00</td>
<td>.1582</td>
<td>.8410</td>
<td>.2420</td>
</tr>
</tbody>
</table>

The area below z = -1.04 is .1492.

A portion of Table B is shown below:

<table>
<thead>
<tr>
<th>z</th>
<th>Area Below</th>
<th>Area Above</th>
<th>Ordinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1.04</td>
<td>.1492</td>
<td>.8508</td>
<td>.2323</td>
</tr>
<tr>
<td>-1.03</td>
<td>.1515</td>
<td>.8485</td>
<td>.2347</td>
</tr>
<tr>
<td>-1.02</td>
<td>.1539</td>
<td>.8461</td>
<td>.2371</td>
</tr>
<tr>
<td>-1.01</td>
<td>.1562</td>
<td>.8438</td>
<td>.2396</td>
</tr>
<tr>
<td>-1.00</td>
<td>.1582</td>
<td>.8410</td>
<td>.2420</td>
</tr>
</tbody>
</table>

Exercise 1. Type in the area below z = -1.03 (for example, .1582) and press the enter key.

Your response is correct. You should first type the decimal point and press the enter key.
1200 PRINT* Incorrect. You have selected the area above z = -1.03.
1210 PRINT* Press the enter key.
1220 AS-INKEYS: IF AS="" GOTO 1220
1230 IF [121] = 1: R = R+1: GOTO 1270
1240 PRINT* Your response is incorrect. Press the enter key for*
1250 PRINT* further explanation.
1260 AS-INKEYS: IF AS="" GOTO 1260
1270 IF [121] = 1: R = R+1: GOTO 670
1280 W41 = 1
1290 PRINT* Your response is incorrect. The correct answer is .151
5.
1300 GOTO 1470
1310 LOCATE 15,1
1320 PRINT* =
1330 PRINT*
1340 PRINT*
1350 PRINT*
1360 PRINT*
1370 PRINT*
1380 PRINT*
1390 PRINT*
1400 PRINT*
1410 LOCATE 15,1: GOTO 1110
1420 LOCATE 21,58: PRINT"Press the enter key."
1430 AS-INKEYS: IF AS="" GOTO 1500
1440 SCREEN 0,1: COLOR 15,1,11: CLS
1450 CLS: LOCATE 1,32: PRINT"Unit 4: Screen 5"
1460 LOCATE 3,1
1470 PRINT* Suppose that one desires to find the area under the unit*
1480 PRINT** normal curve above a given z-value. The value of z is found*
1490 PRINT** in the first column of a unit normal area table. To the right*
1500 PRINT** of this entry in the column, titled Area Above, the area*
1510 PRINT** above z is found. A portion of Table B is shown below.*
1520 PRINT** z Area Below Area Above Ordinate*
1530 COLOR 15,6,11
1540 PRINT**
1550 PRINT** -1.04 .1492 .8508 .2323*
1560 PRINT** -1.03 .1515 .8485 .2347*
1570 PRINT** -1.02 .1539 .8461 .2371*
1580 PRINT** -1.01 .1562 .8438 .2396*
1590 PRINT** -1.00 .1582 .8418 .2428*
1600 PRINT**
1610 PRINT**
1620 PRINT**
1630 PRINT**
1640 PRINT**
1650 PRINT**
1660 PRINT**
1670 PRINT**
1680 PRINT**
1690 PRINT**
1700 PRINT**
1710 COLOR 15,6,11
1720 LOCATE 13,4: PRINT"Area Above =
1730 LOCATE 17,14:PRINT" -1.02 " : LOCATE 17,44:PRINT".8461 "
1740 COLOR 15,1,11
1750 LOCATE 21,1
1760 PRINT* The area above z = -1.02 is .8461."
1770 LOCATE 23,58: PRINT"Press the enter key."
1780 AS-INKEYS: IF AS="" GOTO 1780
1790 IF J47=1 GOTO 9640
1800 IF J42=1 GOTO 6610
1810 IF J44=1 GOTO 3210
1820 CLS: LOCATE 1,32: PRINT"Unit 4: Screen 6"
1830 LOCATE 5,1

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
A portion of Table B is shown below:

<table>
<thead>
<tr>
<th>( z )</th>
<th>Area Below</th>
<th>Area Above</th>
<th>Ordinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.56</td>
<td>.7123</td>
<td>.2877</td>
<td>.3413</td>
</tr>
<tr>
<td>0.57</td>
<td>.7157</td>
<td>.2843</td>
<td>.3391</td>
</tr>
<tr>
<td>0.58</td>
<td>.7190</td>
<td>.2810</td>
<td>.3372</td>
</tr>
<tr>
<td>0.59</td>
<td>.7224</td>
<td>.2776</td>
<td>.3352</td>
</tr>
<tr>
<td>0.60</td>
<td>.7257</td>
<td>.2743</td>
<td>.3332</td>
</tr>
</tbody>
</table>

Exercise 2. Type in the area (for example, .4213) above \( z = 0.58 \) and press the enter key.

1. If \( z \) is less than or equal to 0.58, then the area is .2813.
2. If \( z \) is greater than 0.58, then the area is .2813.

If \( z \) is not equal to .7190, then go to line 2180. Your response is incorrect. The correct answer is .2813.
we have studied thus far in this unit.

Press the enter key.

Press the enter key.

This is the graph of the unit normal distribution.

The area below z = -1.00 is shaded. From Table B, the area of this shaded region is .1587.

This is the graph of the unit normal distribution.
This is the graph of the unit normal distribution. The area above $z = -1.25$ is shaded. Using Table B, the area of this shaded region is .8944.

Exercise 3. The area below $z = 0$ has been shaded. Using Table B type in the area (for example, .8643) below $z = 0$ and press the enter key.
Exercise 4. The area above \( z = 1.50 \) has been shaded. Using Table B,
you should first type the decimal point and press the enter key.

```
3650 PAINT (XC+5*Z-I, (101-101+y3)/2)
3660 LOCATE 16,1
3670 PRINT'' Exercise 4. The area above \( z = 1.50 \) has been shaded. Using Table B,
3680 PRINT'' and press the enter key.
3690 INPUT'' and type in the area (for example, .8643) above \( z = 1.50 \).
3700 PRINT''
3710 LOCATE 20,1
3720 IF 144=0 THEN A44S = Q4S
3730 IF 144=1 THEN A44S = Q4S
3740 PRINT''
3750 IF Q4S".0668" GOTO 3760 ELSE 3780
3760 R44=1
3770 PRINT'' Your response is correct.";GOTO 4040
3780 IF 144 = 1 GOTO 3950
3790 IF Q4S<>".0668" GOTO 3850
3800 PRINT'' Incorrect. You should first type the decimal point
3810 PRINT'' and press the enter key.
3820 AS+INKEYS: IF AS="" GOTO 3820
3830 I44=1: R = R+1: GOTO 3980
3840 IF 144 = 1 GOTO 3950
3850 IF Q4S <>".9332" THEN GOTO 3910
3860 PRINT'' Incorrect. You have selected the area below \( z = 1.50 \).
3870 PRINT''
3880 AS+INKEYS: IF AS="" GOTO 3980
3890 I44 = 1: R = R+1: GOTO 3980
3900 IF 144 = 1 GOTO 3950
3910 PRINT'' Your response is incorrect. Press the enter key for further explanation.
3920 PRINT''
3930 AS+INKEYS: IF AS="" GOTO 3980
3940 I44 = 1: R = R+1: GOTO 3980
3950 W44 = 1
3960 PRINT'' Your response is incorrect. The correct answer is .0668.
3970 GOTO 4040
3980 LOCATE 20,1
3990 PRINT''
4000 PRINT''
4010 PRINT''
4020 PRINT''
4030 LOCATE 20,1: GOTO 3110
4040 LOCATE 21,.58: PRINT"Press the enter key."
4050 AS = INKEYS: IF AS = "" GOTO 4050
4060 'screen 13
4070 SCREEN 1,1: COLOR 15,1,11:CLS
4080 LOCATE 1,12: PRINT"Unit 4: Screen 13"
4090 LOCATE 5,1
4100 PRINT'' Definition: The percentile rank of a given observation is "
4110 PRINT'' defined as the percentage of observations in the "
4120 PRINT'' population of observations that falls below the"
4130 PRINT'' given observation.";
4140 PRINT''
4150 PRINT'' Example 1. Suppose that 40% of a population of scores falls"
below the test score of 85. The percentile rank of 85 is therefore 40.*

Example 2. A group of test scores are normally distributed with mean of 100 and standard deviation of 15.* What is the percentile rank for the test score of 115?

Solution. The percentile rank of 115 is the percentage of test scores falling below the test score of 115. First compute the z-score for the raw-score of 115. Recall that $z = \frac{X - \mu}{\sigma} = \frac{115 - 100}{15}$

Example 3. If men's heights are normally distributed with a mean of 67.02 inches and standard deviation of 2.56 inches, find the percent of men having a height above 70.86 inches.

Solution. The z-score for 70.86 inches is given by $z = \frac{X - \mu}{\sigma} = \frac{70.86 - 67.02}{2.56} = 1.58$. From Table B, the proportion of area above $z = 1.58$ is .0668. The percent of men having a height above 70.86 inches $= .0668 \times 100 = 6.68%$. 

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Exercise 5. If IQs were perfectly normally distributed with a mean of 100 and a standard deviation of 15, the percentile rank of a score of 139 is ?

a. 2.28
b. 52.59
c. 84.13
d. 97.72
e. 99.99

Type a, b, c, d or e for your answer and press the enter key.; Q4$

LOCATE 17,1
PRINT"Your response is correct. The z-score for 139 is z = (X - m)/s = (139 - 100)/15 = 2. The area below z = 2 is .9772 = 97.72%.

Example 4. Test A scores have a mean of 90 and a standard deviation of 10. Test B scores have a mean of 70 and a standard deviation of 5. If John's score was 98 on Test A and 75 on Test B, on which test was John's relative performance better?
Solution. We need to compute the percentile rank of each of John's test scores and compare the two.

1. John's z-score on Test A is $z = \frac{(X - \mu)}{\sigma} = \frac{(39 - 99)}{19} = -1$. From Table B, the percentile rank of $z = -1$ is $0.1587 \times 100 = 15.87$. John's z-score on Test B is $z = \frac{(75 - 79)}{5} = 1$. The percentile rank of $z = 1$ is 34.13. Only 15.87% of the students scored lower than John on Test A whereas 84.13% scored lower than John on Test B. John's relative performance was better on Test B.

Which of the following reflects the poorest performance on a test.

a. z-score of -9.35
b. z-score of 9

c. 1 standard deviation below the mean
d. a percentile rank of 16.11

e. a percentile rank of 84.13

Type in a, b, c, d or e for your answer and press the enter key.

Your response is correct.
Your response is incorrect. Press the enter key for further explanation.

AS INKEYS: IF AS = "" GOTO 5970
5990 R4 = R4+1: GOTO 5260
5990 W4 = W4+1: GOTO 5260
5990 PRINT "Your response is incorrect. The correct answer is 0."
6000 LOCATE 23,58: PRINT "Press the enter key."
6000 AS INKEYS: IF AS = "" GOTO 6020
6010 R4 = R4+1: R4+1: GOTO 5260
6020 W4 = W4+1: GOTO 5260
6030 FIRST4 = R4+W4-R
6040 TIMES = "00:00:00"
6040 PRINT "Your response is incorrect. The correct answer is \(.7324\)."
6050 LOCATE 23,58: PRINT "Press the enter key."
6050 AS INKEYS: IF AS = "" GOTO 5970
6060 R4 = R4+1: GOTO 5260
6070 W4 = W4+1: GOTO 5260
6080 PRINT "Your response is incorrect. The correct answer is \(.7324\)."
6090 LOCATE 23,58: PRINT "Press the enter key."
6090 AS INKEYS: IF AS = "" GOTO 5970
6100 R4 = R4+1: GOTO 5260
6110 W4 = W4+1: GOTO 5260
6120 PRINT "This concludes the discussion of Unit 4: The Area Under a normal curve.
6130 PRINT "Problem 1. What is the area under the unit normal curve below \(z = 0.62\) ? Type in your answer (for example, \(.4213\)) and press the enter key.";
6140 INPUT " Q4S"
6150 IF Q4S = "n" OR Q4S = "Y" OR Q4S = "n" OR Q4S = "N" GOTO 6240 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6160 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6170 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6180 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6190 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6200 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6210 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6220 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6230 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6240 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6250 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6260 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6270 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6280 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6290 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6300 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6310 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6320 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6330 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6340 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6350 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6360 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6370 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6380 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6390 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6400 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6410 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6420 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6430 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6440 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6450 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6460 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6470 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6480 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6490 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6500 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6510 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220
6520 IF Q4S = "Y" OR Q4S = "Y" GOTO 6250 ELSE LOCATE 1,1: PRINT ":LOCATE 17,1: GOTO 6220

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Problem 2. What is the area under the unit normal curve above \( z = -2.38 \) ? Type in your answer (for example, .4213) and press the enter key.:

```plaintext
5590 IF Q4$ = "y" OR Q4$ = "Y" GOTO 6740 ELSE LOCATE 7,1: PRINT
5591 "Would you like to work another review problem? Type"
5592 IF Q4$ = "y" OR Q4$ = "Y" OR Q4$ = "n" OR Q4$ = "N" THEN 6610 ELSE LOCATE 7,1: GOTO 6580
```

```
6600 RETURN
6610 'screen 21
6620 SCREEN 9,1: COLOR 15,1,11: CLS
6630 LOCATE 1,32: PRINT "Unit 4: Screen 21"
6640 LOCATE 7,1: GOTO 6680
```

Problem 3. A normal distribution has a mean of 80 and a standard deviation of 5. What is the percent of scores below the raw-score of 79?

```
6640 PRINT "Problem 3. A normal distribution has a mean of 80 and a"
6650 PRINT "standard deviation of 5. What is the percent of"
6660 PRINT "scores below the raw-score of 79?"
6670 PRINT "a. 2.28%"
6680 PRINT "b. 5.40%"
6690 PRINT "c. 18.38%"
6700 PRINT "d. 97.72%"
6710 PRINT "Type in a, b, c, or d for your answer and press"
6720 PRINT "the enter key.:
```

```plaintext
5590 IF Q4$ = "y" OR Q4$ = "Y" GOTO 6740 ELSE LOCATE 7,1: PRINT
5591 "Would you like to work another review problem? Type"
5592 IF Q4$ = "y" OR Q4$ = "Y" OR Q4$ = "n" OR Q4$ = "N" THEN 6610 ELSE LOCATE 7,1: GOTO 6580
```

```
6600 RETURN
6610 'screen 22
6620 SCREEN 0,1: COLOR 15,1,11: CLS
6630 LOCATE 1,32: PRINT "Unit 4: Screen 22"
6640 LOCATE 7,1: GOTO 6680
```

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
180

7158 PRINT"
7160 PRINT"
7170 LOCATE 16,1
7180 GOTO 7600
7190 IF Q4S = "a" OR Q4S = "A" THEN 7200 ELSE 7210
7220 P43=1
7230 PRINT" Your response is correct."
7240 GOTO 7250
7250 PRINT"
7260 PRINT" further explanation."
7270 AS = INKEYS: IF AS = "" GO TO 7270
7280 P43 = 1: P43+1: GOTO 4250
7290 Q4S = 1
7300 PRINT" Your response is incorrect. The correct answer is a."
7310 LOCATE 23,58: PRINT" Press the enter key."
7320 AS = INKEYS: IF AS = "" GO TO 7320
7330 GOSUB 6550
7340 IF Q4S = "y" OR Q4S = "Y" GOTO 7350 ELSE 10350
7350 "Screen 23"
7360 SCREEN 8,1; COLOR 15,1,11: CLS
7370 LOCATE 1,3: PRINT" Unit 4: Screen 23"
7380 LOCATE 5,1: K4-4
7390 PRINT" Problem 4: A normal population has a mean of 100 and a" standard deviation of 10. What is the percent of scores above the raw-score of 116?"
7400 PRINT"
7410 PRINT" a. 1.60""
7420 PRINT" b. 5.37""
7430 PRINT" c. 5.48""
7440 PRINT" d. 94.52""
7450 PRINT" Type in a, b, c, or d for your answer and press"
7460 PRINT" the enter key.":Q4S
7500 PRINT"
7510 INPUT" the enter key.";Q4S
7520 IF J44=0 THEN G44=G4S
7530 IF J44=1 THEN G44=G4S
7550 PRINT"
7560 IF Q4S = "a" OR Q4S = "A" OR Q4S = "b" OR Q4S = "B" OR Q4S = "c" OR Q4S = "C" OR Q4S = "d" OR Q4S = "D" THEN 7630 ELSE 7570
7570 LOCATE 16,1
7580 PRINT"
7590 PRINT"
7600 PRINT"
7610 LOCATE 16,1
7620 GOTO 7590
7630 IF Q4S = "c" OR Q4S = "C" THEN 7640 ELSE 7670
7640 P44=1
7650 PRINT" Your response is correct."
7660 GOTO 7750
7670 IF J44 = 1 GOTO 7730 ELSE 7680
7680 PRINT" Your response is incorrect. Press the enter key for"
7690 PRINT"
7700 PRINT" further explanation."
7710 AS = INKEYS: IF AS = "" GO TO 7710

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Problem 5. Which of the following reflects the best performance on a test?

- a. z-score = -2.96
- b. 1 standard deviation above the mean.
- c. percentile rank of 80
- d. a z-score of 1.85
- e. a percentile rank of 2.28

Type in a, b, c, d, or e for your answer and press the enter key.*

The higher the percentile rank, the better the test score.
8300 AS = INKEYS: IF AS = "" GOTO 8300
8310 GOTO 7790
8320 GOSUB 6550
8330 IF Q4S = "y" OR Q4S = "Y" GOTO 8340 ELSE 10350
8340 ' screen 25
8350 SCREEN 0,1: COLOR 15,1,11: CLS
8360 LOCATE 1,12: PRINT"Unit 4: Screen 25"
8370 LOCATE 5,1: K4=6
8380 PRINT* * * * Problem 6. What is the area under the unit normal curve*
8390 PRINT* * * * below z = -1.47? Type in your answer (for*
8400 PRINT**
8410 PRINT* * * * example, .4213) and press the enter key.";Q4S
8420 INPUT* * * * 8430 IF J46=0 THEN C46S = Q4S
8440 IF J46=1 THEN D46S = Q4S
8450 PRINT**
8460 IF Q4S = ",.8788" GOTO 8470 ELSE 8500
8470 P46 = 1
8480 PRINT* * * * Your response is correct.*
8490 GOTO 8600
8500 IF J46 = 1 GOTO 8560
8510 PRINT* * * * Your response is incorrect. Press the enter key*
8520 PRINT* * * * for further explanation.*
8530 AS = INKEYS: IF AS = "" GOTO 8540
8540 J46 = 1: P+P+1: GOTO 669
8560 Q46 = 1
8570 PRINT* * * * Your response is incorrect. The correct answer*'
8580 PRINT* * * * is .8788.*
8600 LOCATE 23,58: PRINT"Press the enter key."*
8610 AS = INKEYS: IF AS = "" GOTO 8610
8620 GOSUB 6550
8630 IF Q4S = "y" OR Q4S = "Y" GOTO 8640 ELSE 10350
8640 ' screen 26
8650 SCREEN 0,1: COLOR 15,1,11: CLS
8660 LOCATE 1,12: PRINT"Unit 4: Screen 26"
8670 LOCATE 5,1: K4=7
8680 PRINT* * * * Problem 7. What is the area under the unit normal curve*
8690 PRINT* * * * above z = 1.29? Type in your answer (for*
8700 PRINT**
8710 PRINT* * * * example, .4213) and press the enter key.";Q4S
8720 INPUT* * * * 8730 IF J47=0 THEN C47S = Q4S
8740 IF J47=1 THEN D47S = Q4S
8750 PRINT**
8760 IF Q4S = ",.0985" THEN GOTO 8770 ELSE 8800
8770 P47 = 1
8780 PRINT* * * * Your response is correct.*
8790 GOTO 8890
8800 IF J47 = 1 GOTO 8860
8810 PRINT* * * * Your response is incorrect. Press the enter key*
8820 PRINT* * * * for further explanation.*
8830 AS = INKEYS: IF AS = "" GOTO 8840
8840 J47 = 1: P+P+1: GOTO 1510
8850 GOTO 8470
8860 PRINT* * * * Your response is incorrect. The correct answer*'
8870 PRINT**
8880 PRINT* * * * is .0985.*
8900 LOCATE 23,58: PRINT"Press the enter key."*
8910 AS = INKEYS: IF AS = "" GOTO 8910
8920 GOSUB 6550
8930 IF Q4S = "y" OR Q4S = "Y" GOTO 8940 ELSE 10350
Problem 8. A normal distribution has a mean of 70 and a
standard deviation of 6. What is the percent of
scores below the raw-score of 85?*

Type in a, b, c, or d for your answer and press
the enter key.*;Q46

Problem 9. A normal population has a mean of 100 and a
standard deviation of 8. What is the percent of
scores above the raw-score of 90?*

Type in a, b, c, or d for your answer and press
184

9440 PRINT** the enter key.";Q4S
9550 INPUT* the enter key.
9560 IF J49=0 THEN C49S=Q4S
9570 IF J49=1 THEN D49S=Q4S
9580 PRINT**
9590 IF Q4S = "a" OR Q4S = "A" OR Q4S = "b" OR Q4S = "B" OR Q4S = "c" OR Q4S = "C" OR Q4S = "d" OR Q4S = "D" THEN 9660 ELSE 9600
9600 LOCATE 16,1
9610 PRINT*
9620 PRINT*
9630 PRINT*
9640 LOCATE 16,1
9650 GOTO 9530
9660 IF Q4S = "d" OR Q4S = "D" THEN 9670 ELSE 9600
9670 P49=1
9680 PRINT** Your response is correct.
9690 GOTO 9780
9700 IF J49 = 1 GOTO 9760 ELSE 9710
9710 PRINT** Your response is incorrect. Press the enter key for
further explanation.*
9720 PRINT**
9730 PRINT**
9740 AS = INKEYS: IF AS = " " GOTO 9740
9750 J49 = 1: P=F+1: GOTO 4540
9760 C49 = 1
9770 PRINT**
9780 LOCATE 23,58: PRINT"Press the enter key."
9790 AS = INKEYS: IF AS = " " GOTO 9790
9800 GOSUB 6550
9810 IF Q4S = "y" OR Q4S = "Y" GOTO 9820 ELSE 10350
9820 "screen 29"
9830 SCREEN 0,1: COLOR 15,1,11: CLS
9840 LOCATE 1,12: PRINT* Unit 4: Screen 29
9850 LOCATE 5,1: X4+10
9860 PRINT* Problem 10. Which of the following reflects the poorest*
performance on a test ?*
9870 PRINT*
9880 PRINT*
9890 PRINT**
9900 PRINT* a. z-score of 0"
9910 PRINT* b. 1.5 standard deviation below the mean.
9920 PRINT*
9930 PRINT* c. percentile rank of 7.08"
9940 PRINT* d. a z-score = -1.41"n
9950 PRINT**
9960 PRINT* e. a percentile rank of 94"
9970 PRINT**
9980 PRINT** Type in a, b, c, d, or e for your answer and press
* 9990 PRINT**
9990 IF J410=0 THEN C410S=Q4S
10000 IF J410=1 THEN D410S=Q4S
10010 PRINT**
10020 IF Q4S = "a" OR Q4S = "A" OR Q4S = "b" OR Q4S = "B" OR Q4S = "c" OR Q4S = "C" OR Q4S = "d" OR Q4S = "D" OR Q4S = "e" OR Q4S = "E" THEN 10090 ELSE 10030
10030 LOCATE 15,1
10040 PRINT**
10050 PRINT*
10060 PRINT*
10070 LOCATE 15,1

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
1858 GOTO 9958
1859 IF Q4S = "b" OR Q4S = "B" THEN 10110 ELSE 10118
1860 P41 = 1
1861 PRINT"Your response is correct."
1862 GOTO 10120
1863 IF J410 = 1 GOTO 10190 ELSE 10110
1864 PRINT"Your response is incorrect. Press the enter key for further explanation."
1865 PRINT"your response is incorrect. The correct answer is b."
1866 LOCATE 23,58: PRINT"Press the enter key."
1867 AS • INKEYS: IF AS • "" GOTO 1866
1868 J410 • 1: P-P11; GOTO 10240
1869 0410 = 1
1870 PRINT"your response is incorrect. The correct answer is b."
1871 LOCATE 23,58: PRINT"Press the enter key."
1872 AS • INKEYS: IF AS • "" GOTO 1872
1873 GOTO 9820
1874 'screen 29a
1875 CLS:LOCATE 1,32: PRINT"Unit 4: Screen 29a"
1876 LOCATE 5,1
1877 PRINT"Change the z-scores to percentile ranks and compare all of the percentile ranks. The lower the percentile rank, the poorer the test score."
1878 PRINT"your response is incorrect. The correct answer is b."
1879 LOCATE 23,58: PRINT"Press the enter key."
1880 AS • INKEYS: IF AS • "" GOTO 1880
1881 GOTO 9820
1882 'screen 30
1883 CLS:LOCATE 1,32: PRINT"Unit 4: Screen 30"
1884 LOCATE 8,1
1885 PRINT"Turn the printer on and press the enter key."
1886 AS • INKEYS: IF AS • "" GOTO 1886
1887 IF K4 = 0 GOTO 19560
1888 04 • P41*P42*P43*P44*P45*P46*P47*P48*P49*P410
1889 04 • Q41*Q42*Q43*Q44*Q45*Q46*Q47*Q48*Q49*Q410
1890 SEC4 = P4+04-P
1891 PRINT"
1892 PRINT"
1893 PRINT"
1894 PRINT"
1895 PRINT"
1896 PRINT"
1897 PRINT"The number of correct exercises is":FIRST4
1898 PRINT"The number of incorrect exercises is":6-FIRST4
1899 PRINT"The number of correct exercises after remediation is":TINES
1900 PRINT"The number of correct problems is":SEC4
1901 PRINT"The number of incorrect problems is":K4-SEC4
1902 PRINT"The number of correct problems after remediation is":P-04
1903 19560 LPRINT"Unit 4: Area Under a Normal Curve Lying Below or Above a C
1904 LPRINT"Observation."
1905 LPRINT"
1906 LPRINT"":NAMS,N0S,T4S
1907 LPRINT"The number of correct exercises is":FIRST4
1908 LPRINT"The number of incorrect exercises is":6-FIRST4
1909 LPRINT"The number of correct exercises after remediation is":TINES
1910 LPRINT"The number of correct problems after remediation is":P-04
1911 IF K4 = 0 GOTO 19670
1912 19670 LPRINT"";TIMES

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
10680 LPRINT** The number of correct problems is**",SEC4
10690 LPRINT** The number of incorrect problems is**,K4-SEC4
10700 LPRINT** The number of correct problems after remediation is**",P-Q";
10710 LPRINT**
10720 LPRINT**
10730 IF I41=1 GOTO 10770
10740 LPRINT** Exercise 1 response was correct."",A41S:GOTO 10790
10750 LPRINT** Exercise 1 response was incorrect."",A41S,B41S
10760 LPRINT**
10770 LPRINT** IF I42=1 GOTO 10820
10780 LPRINT** Exercise 2 response was correct."",A42S:GOTO 10840
10790 LPRINT** Exercise 2 response was incorrect."",A42S,B42S
10800 LPRINT**
10810 LPRINT** IF I43=1 GOTO 10870
10820 LPRINT** Exercise 3 response was correct."",A43S:GOTO 10890
10830 LPRINT** Exercise 3 response was incorrect."",A43S,B43S
10840 LPRINT**
10850 LPRINT** IF I44=1 GOTO 10920
10860 LPRINT** Exercise 4 response was correct."",A44S:GOTO 10940
10870 LPRINT** Exercise 4 response was incorrect."",A44S,B44S
10880 LPRINT**
10890 LPRINT** IF I45=1 GOTO 10970
10900 LPRINT** Exercise 5 response was correct."",A45S:GOTO 10990
10910 LPRINT** Exercise 5 response was incorrect."",A45S,B45S
10920 LPRINT**
10930 LPRINT** IF I46=1 GOTO 10990
10940 LPRINT** Exercise 6 response was correct."",A46S:GOTO 10990
10950 LPRINT** Exercise 6 response was incorrect."",A46S,B46S
10960 LPRINT**
10970 LPRINT** IF I47=1 GOTO 11020
10980 LPRINT** Exercise 7 response was correct."",A47S:GOTO 11040
10990 LPRINT** Exercise 7 response was incorrect."",A47S,B47S
11000 LPRINT**
11010 LPRINT** IF K4<1 GOTO 11640
11020 LPRINT** Exercise 1 response was correct."",K41S:GOTO 11100
11030 LPRINT** Exercise 1 response was incorrect."",K41S,D41S
11040 LPRINT** IF K4=1 GOTO 11120
11050 LPRINT** IF J41=1 GOTO 11150
11060 LPRINT** Problem 1 response was correct."",C41S:GOTO 11100
11070 LPRINT** Problem 1 response was incorrect."",C41S,D41S
11080 LPRINT**
11090 LPRINT** IF K4<2 GOTO 11640
11100 LPRINT** IF J42=1 GOTO 11140
11110 LPRINT** Problem 2 response was correct."",C42S:GOTO 11160
11120 LPRINT** Problem 2 response was incorrect."",C42S,D42S
11130 LPRINT**
11140 LPRINT** IF K4<3 GOTO 11640
11150 LPRINT** IF J43=1 GOTO 11180
11160 LPRINT** Problem 3 response was correct."",C43S:GOTO 11220
11170 LPRINT** Problem 3 response was incorrect."",C43S,D43S
11180 LPRINT**
11190 LPRINT** IF K4<4 GOTO 11640
11200 LPRINT** IF J44=1 GOTO 11260
11210 LPRINT** Problem 4 response was correct."",C44S:GOTO 11280
11220 LPRINT** Problem 4 response was incorrect."",C44S,D44S
11230 LPRINT**
11240 LPRINT** IF K4<5 GOTO 11640
11250 LPRINT** IF J45=1 GOTO 11320
11260 LPRINT** Problem 5 response was correct."",C45S:GOTO 11340
11270 LPRINT** Problem 5 response was incorrect."",C45S,D45S
11280 LPRINT**
11290 LPRINT** Problem 6 response was correct."",C46S:GOTO 11360
11300 LPRINT** Problem 6 response was incorrect."",C46S,D46S
11310 LPRINT**
11320 LPRINT** Problem 7 response was correct."",C47S:GOTO 11380
11330 LPRINT** Problem 7 response was incorrect."",C47S,D47S

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
11330 LPRINT"
11340 IF K4<6 GOTO 11640
11350 LPRINT" Problem 6 response was correct.",C46$ GOTO 11400
11360 LPRINT" Problem 6 response was incorrect.",C46$,D46$
11370 LPRINT"
11380 LPRINT"
11400 IF K4<7 GOTO 11640
11410 LPRINT": IF J4=GOTO 11440
11420 LPRINT" Problem 7 response was correct.",C47$ GOTO 11460
11430 LPRINT" Problem 7 response was incorrect.",C47$,D47$
11440 LPRINT"
11450 LPRINT"
11470 IF K4<8 GOTO 11640
11480 LPRINT": IF J4=GOTO 11500
11490 LPRINT" Problem 8 response was correct.",C48$ GOTO 11520
11500 LPRINT" Problem 8 response was incorrect.",C48$,D48$
11510 LPRINT"
11520 IF K4<9 GOTO 11640
11530 LPRINT": IF J4=GOTO 11560
11540 LPRINT" Problem 9 response was correct.",C49$ GOTO 11580
11550 LPRINT" Problem 9 response was incorrect.",C49$,D49$
11560 LPRINT"
11570 LPRINT"
11590 LPRINT": IF J4=GOTO 11620
11600 LPRINT" Problem 10 response was correct.",C41$ GOTO 11640
11610 LPRINT" Problem 10 response was incorrect.",C41$,D41$
11620 LPRINT"
11630 LPRINT"
11640 CLS: CHAIN "unit5"

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
18 COMMON NAMS,NOS
20 'Unit 5
30 SCREEN 0,1: COLOR 15,1,15: CLS
40 LOCATE 3,18: PRINT"Unit 5"
50 LOCATE 6,9: PRINT"Part 1. Area Under a Normal Curve Lying Between Two Observa
60 TIMES 100:00:00"
70 LOCATE 8,9: PRINT"Part 2. The Area Under a Normal Curve Relative to the Curve
80 LOCATE 10,9: PRINT" s Standard Deviation."
90 LOCATE 23,58: PRINT"Press the enter key."
100 AS = INKEYS: IF AS = " " GOTO 100
110 TIMES 100:00:00"
120 SCREEN 0,1: COLOR 15,1,15: CLS
130 LOCATE 1,32: PRINT"Unit 5: Screen 0"
140 LOCATE 38: PRINT"Objectives: At the end of this lesson, the student should be able"
150 PRINT"
160 PRINT"
170 PRINT"
180 PRINT"
190 PRINT"
200 PRINT"
210 PRINT"
220 PRINT"
230 PRINT"
240 PRINT"
250 PRINT"
260 PRINT"
270 PRINT"
280 PRINT"
290 PRINT"
300 PRINT"
310 PRINT"
320 PRINT"
330 PRINT"
340 PRINT"
350 PRINT"
360 PRINT"
370 PRINT"
380 PRINT"
390 PRINT"
400 PRINT"
410 PRINT"
420 PRINT"
430 PRINT"
440 PRINT"
450 PRINT"
460 PRINT"
470 PRINT"
480 PRINT"
490 PRINT"
500 PRINT"
510 PRINT"
520 PRINT"
530 PRINT"
540 LOCATE 23,58: PRINT"Press the enter key."
550 AS = INKEYS: IF AS = " " GOTO 550
560 'Screen 3
570 GOSUB 1370: LOCATE 1,13: PRINT"Unit 5: Screen 3"
580 LOCATE 14,35: PRINT"z1": LOCATE 14,40: PRINT"z2"
We will be interested in calculating the area of shaded regions of this type."

Example 1. A portion of Table B is shown below.

<table>
<thead>
<tr>
<th>Z</th>
<th>Area Below</th>
<th>Area Above</th>
<th>Ordinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.96</td>
<td>.9750</td>
<td>.0250</td>
<td>.0584</td>
</tr>
<tr>
<td>1.97</td>
<td>.9761</td>
<td>.0139</td>
<td>.0562</td>
</tr>
<tr>
<td>1.98</td>
<td>.9767</td>
<td>.0228</td>
<td>.0551</td>
</tr>
<tr>
<td>1.99</td>
<td>.9772</td>
<td>.0200</td>
<td>.0540</td>
</tr>
</tbody>
</table>

The area under the unit normal curve between z1 = 1.96 and z2 = 1.99 is given by:

(area below 1.99) - (area below 1.96) = .9767 - .9750 = .0017

Exercise 1. Type in the area under the unit normal curve between 1.97 and 2.00 and press the enter key.
1250 PRINT "Your response is incorrect. Press the enter key for further explanation."
1260 PRINT "Your response is incorrect. The correct answer is .0016."
1270 ASINKEYS: IF AS="=" GOTO 1280
1290 SCREEN 2: CLS
1300 S=100
1310 A=240
1320 PI=3.141593
1330 XC=320:YC=100
1340 'draw axes
1350 SCREEN 2: CLS
1360 LINE (0,YC)*2)-(639,YC*2),1
1370 LINE (639,0)-(639,101),1
1380 FOR X=20 TO 620 STEP 20
1390 LINE(X,YC*2)-(X,YC*4),1
1400 NEXT X
1410 LOCATE 1,78
1420 PRINT "0.4"
1430 LOCATE 7,78
1440 PRINT "0.2"
1450 FOR Y=0 TO 75 STEP 25
1460 LINE (636,Y)-(639,Y),1
1470 NEXT Y
1480 LOCATE 14,1
1490 PRINT "2"
1500 LOCATE 14,15
1510 PRINT "-2"
1520 LOCATE 14,27
1530 PRINT "0"
1540 LOCATE 14,41
1550 PRINT "1"
1560 LOCATE 14,66
1570 PRINT "3"
1580 LOCATE 14,78
1590 PRINT "4"
1600 'draw graph
1610 X1=3.5:Y1=A/(SQR(2*PI))**EXP(-X1**2/2)
1620 X2=3.4:Y2=A/(SQR(2*PI))**EXP(-X2**2/2)
1630 FOR X=3.4 TO 3.5 STEP .2
1640 Y=A/(SQR(2*PI))***EXP(-X**2/2)
1650 LINE(XC+S*X,YC*Y),1
1660 NEXT X
1670 RETURN
1680 'calculate area
1690 S=9
1700 M=1
1710 N=1
1720 IF NC29, GOTO 1998
1730 M=(1/SQR(2*PI))*B+.5
1740 LINE (XC+S*X,YC*Y),12208
1750 REPRODUCED WITH PERMISSION OF THE COPYRIGHT OWNER. FURTHER REPRODUCTION PROHIBITED WITHOUT PERMISSION.
Example 2. This is the graph of the unit normal distribution.

The region under the curve between .50 and 1.80 has been shaded. From Table B, the area of this shaded region is \((\text{area below 1.80}) - (\text{area below .50})\) = .2726.

Exercise 2. The region under the curve between 0.75 and 2.99 has been shaded. Using Table B, type in the area of this shaded region and press the enter key.

Input "shaded region: ";AS

If AS < .2938 or AS > .2038 Then

Print "Your response is incorrect. The correct answer is .2038.

Press the enter key for further explanation.

Else

Print "Your response is correct.

Goto 2380

Example 3. Another portion of Table B is shown below.

<table>
<thead>
<tr>
<th>z</th>
<th>Area Below</th>
<th>Area Above</th>
<th>Ordinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>.20</td>
<td>.2038</td>
<td>.2038</td>
<td>.2038</td>
</tr>
<tr>
<td>.25</td>
<td>.2578</td>
<td>.2578</td>
<td>.2578</td>
</tr>
<tr>
<td>.30</td>
<td>.3140</td>
<td>.3140</td>
<td>.3140</td>
</tr>
<tr>
<td>.35</td>
<td>.3486</td>
<td>.3486</td>
<td>.3486</td>
</tr>
<tr>
<td>.40</td>
<td>.3932</td>
<td>.3932</td>
<td>.3932</td>
</tr>
<tr>
<td>.45</td>
<td>.4332</td>
<td>.4332</td>
<td>.4332</td>
</tr>
<tr>
<td>.50</td>
<td>.4772</td>
<td>.4772</td>
<td>.4772</td>
</tr>
<tr>
<td>.55</td>
<td>.5120</td>
<td>.5120</td>
<td>.5120</td>
</tr>
<tr>
<td>.60</td>
<td>.5420</td>
<td>.5420</td>
<td>.5420</td>
</tr>
<tr>
<td>.65</td>
<td>.5650</td>
<td>.5650</td>
<td>.5650</td>
</tr>
<tr>
<td>.70</td>
<td>.5818</td>
<td>.5818</td>
<td>.5818</td>
</tr>
<tr>
<td>.75</td>
<td>.5948</td>
<td>.5948</td>
<td>.5948</td>
</tr>
<tr>
<td>.80</td>
<td>.6055</td>
<td>.6055</td>
<td>.6055</td>
</tr>
<tr>
<td>.85</td>
<td>.6144</td>
<td>.6144</td>
<td>.6144</td>
</tr>
<tr>
<td>.90</td>
<td>.6245</td>
<td>.6245</td>
<td>.6245</td>
</tr>
<tr>
<td>.95</td>
<td>.6321</td>
<td>.6321</td>
<td>.6321</td>
</tr>
<tr>
<td>1.0</td>
<td>.6386</td>
<td>.6386</td>
<td>.6386</td>
</tr>
<tr>
<td>1.25</td>
<td>.6617</td>
<td>.6617</td>
<td>.6617</td>
</tr>
<tr>
<td>1.50</td>
<td>.6764</td>
<td>.6764</td>
<td>.6764</td>
</tr>
<tr>
<td>2.00</td>
<td>.7024</td>
<td>.7024</td>
<td>.7024</td>
</tr>
<tr>
<td>2.50</td>
<td>.7321</td>
<td>.7321</td>
<td>.7321</td>
</tr>
<tr>
<td>3.00</td>
<td>.7576</td>
<td>.7576</td>
<td>.7576</td>
</tr>
<tr>
<td>3.50</td>
<td>.7754</td>
<td>.7754</td>
<td>.7754</td>
</tr>
<tr>
<td>4.00</td>
<td>.7877</td>
<td>.7877</td>
<td>.7877</td>
</tr>
<tr>
<td>5.00</td>
<td>.8078</td>
<td>.8078</td>
<td>.8078</td>
</tr>
</tbody>
</table>

Press the enter key.
The area under the unit normal curve between z₁ = -0.60 and z₂ = -0.57 (note that -0.57 > -0.60) is given by (area below -0.57) - (area below -0.60) = .2843 - .2743 - .8108.
Example 4. This is the graph of the unit normal distribution.

The region under the curve between $-2.24$ and $-1.00$ is shaded. From Table B, the area of this shaded region $= (\text{area below } -1.00) - (\text{area below } -2.24) = \ldots$

Exercise 4. The region under the unit normal curve between $-1.50$ and $-2.00$ is shaded. Type in the area of this shaded region and press the return key. Your response is correct.

Example 5. Selected portions of Table B are listed below:

<table>
<thead>
<tr>
<th>$z$</th>
<th>Area Below</th>
<th>Area Above</th>
<th>Ordinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2.20</td>
<td>.0139</td>
<td>.9861</td>
<td>.0355</td>
</tr>
<tr>
<td>-2.00</td>
<td>............</td>
<td>............</td>
<td>............</td>
</tr>
<tr>
<td>3.00</td>
<td>.5000</td>
<td>.5000</td>
<td>.1999</td>
</tr>
<tr>
<td>2.46</td>
<td>.9931</td>
<td>.0069</td>
<td>.0194</td>
</tr>
</tbody>
</table>

The area under the unit normal distribution between $-2.28$ and $2.46 = (\text{area below } 2.46) - (\text{area below } -2.28) = \ldots$

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
**Exercise 5.** Selected portions of Table B are listed below:

<table>
<thead>
<tr>
<th>z</th>
<th>Area Below</th>
<th>Area Above</th>
<th>Ordinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1.25</td>
<td>.1056</td>
<td>.8944</td>
<td>.1826</td>
</tr>
<tr>
<td>0.46</td>
<td>.6772</td>
<td>.3228</td>
<td>.3899</td>
</tr>
<tr>
<td>1.57</td>
<td>.9418</td>
<td>.0582</td>
<td>.1163</td>
</tr>
</tbody>
</table>

Type in the area (for example,.4231) under the unit normal curve between 0.46 and 1.57. Then press the enter key.

```
1400 IF ISS = 0 THEN AS55 = 055
1410 IF ISS = 1 THEN B55 = 055
1420 PRINT"Your response is correct."
1430 PRINT"Type in the area (for example,.4231) under the unit normal curve between 0.46 and 1.57. Then press the enter key."
1440 IF ISS = 1 THEN B55 = 055
1450 PRINT"Your response is incorrect. The correct answer is"
1460 PRINT"The region under the unit normal curve between 0.46 and 1.57 has been shaded above. From Table B, the area of this shaded region is (area below 1.00)"
```

**Example 6.** The region under the unit normal curve between -0.50 and 1.00 has been shaded above. From Table B, the area of this shaded region is (area below 1.00)
Exercise 6. The region under the unit normal curve between -1.00 and 1.00 has been shaded above. Using Table Z, type in the area (for example, .4231) of this shaded region and press the enter key.

Your response is correct.
Your response is incorrect. The correct answer is .6826.

Example 7. It is fairly well known that IQ scores from the Stanford-Binet Intelligence Test are approximately normally distributed with a mean of 100 and a standard deviation of 16 for people in its population.

Determine the percent of people having an IQ score between 100 and 116.

Solution We begin by computing the z-scores for 100 and 116, respectively. The z-score for 100 is $z_1 = \frac{100 - 100}{16} = 0$. The z-score for 116 is $z_2 = \frac{116 - 100}{16} = 1$. The area under the unit normal curve between 0 and 1 is given by $(\text{area below 1.00}) - (\text{area below 0.00}) = .8413 - .5000 = .3413$. Therefore, approximately $34.13\%$ of people have such scores.

Exercise 7. The Stanford-Binet Intelligence Test scores are approximately normally distributed in its population of scores with a mean of 100 and a standard deviation of 1. Determine the percent of individuals having an IQ score between 84 and 124.

a. 22.55%

b. 40.00%

c. 77.45%

d. 76.15%
Example 8. If men's heights are normally distributed with a mean of 67.02 inches and standard deviation of 2.56 inches, find the percent of men having a height between 61.90 and 64.46 inches.

The z-score for 61.90 is 
\[ z_1 = \frac{X - \mu}{\sigma} = \frac{61.90 - 67.02}{2.56} = -2 \]

The z-score for 64.46 is 
\[ z_2 = \frac{X - \mu}{\sigma} = \frac{64.46 - 67.02}{2.56} = -1 \]

The area under the unit normal curve between -2.00 and -1.00 is given by (area below -1.00) - (area below -2.00) = 0.1587 - 0.0228 = 0.1359.

Therefore, approximately 0.1359 x 100 = 13.59% of men have such height.
5730 PRINT" a. 2.56%"
5740 PRINT" b. 13.59%"
5750 PRINT" c. 34.13%"
5760 PRINT" d. 68.26%"
5770 PRINT" e. 86.41%"
5780 PRINT"
5790 PRINT* Type a, b, c, d, or e for your answer and press the
5800 PRINT**
5810 INPUT" enter key.*";05$
5820 IF 159=0 THEN A59S=05$
5830 IF 159=1 THEN B59S=05$
5840 PRINT**
5850 IF Q5S="a" OR Q5S="A" OR Q5S="b" OR Q5S="B" OR Q5S="c" OR Q5S="C" OR Q5S="d"
* OR Q5S = "d" OR Q5S = "e" OR Q5S = "E" THEN 5920 ELSE 5860
5860 LOCATE 17,1
5870 PRINT* 
5880 PRINT*
5890 PRINT**
5900 LOCATE 17,1
5910 GOTO 5790
5920 IF Q5S="b" OR Q5S="B" THEN 5930 ELSE 5960
5930 R59 = 1
5940 PRINT* Your response is correct.*
5950 PRINT**
5960 PRINT**
5970 GOTO 6070
5980 IF 05S=0 "b" OR Q5S = "B" THEN 6030 ELSE 6060
5990 PRINT* Your response is incorrect. Press the enter key*
6000 PRINT**
6010 IF 159=1 GOTO 6030
6020 PRINT* Your response is incorrect. The correct response*
6030 PRINT**
6040 PRINT**
6050 PRINT**
6060 PRINT**
6070 LOCATE 23,58: PRINT"Press the enter key.*"
6080 AS = INKEYS: IF AS = "" GOTO 6010
6090 GOTO 6080
6100 GOTO 5400
6110 W59 = 1
6120 PRINT* Your response is incorrect. The correct response*
6130 PRINT**
6140 PRINT**
6150 PRINT**
6160 PRINT**
6170 LOCATE 10,18: PRINT"The Area Under a Normal Curve Relative to the Curve"*
6180 PRINT**
6190 LOCATE 12,18: PRINT"Standard Deviation"
6200 PRINT* Press the enter key.*
6210 AS = INKEYS: IF AS = "" GOTO 6150
6220 SCREEN 0,1: COLOR 15,1,15:CLS
6230 LOCATE 7,1: PRINT"Unit 5: Screen 21"
6240 LOCATE 7,1
6250 PRINT* Any normal distribution has a constant relationship*
6260 PRINT* with its standard deviation. The next three screens will *
6270 PRINT**
6280 PRINT* I illustrate this fact.*
6290 PRINT* LOCATE 23,58: PRINT"Press the enter key.*
6300 AS=INKEYS: IF AS="" GOTO 6250
6310 SCREEN 2:CLS:PRINT"Unit 5: Screen 22"
6320 GOSUB 6290
6330 GOTO 6290
6340 PRINT* 
6350 PRINT* 
6360 PI = 3.141593

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
XC = 320: YC = 100

'Draw axes
6340 LINE (1, YC+2)-(639, YC+2), 1
6350 FOR X = 20 TO 620 STEP 20
6360 LINE (X, YC+2)-(X, YC+4), 1
6370 NEXT X

6380 LOCATE 14, 2
6390 PRINT "-1s"
6400 LOCATE 14, 14
6410 PRINT "-1s"
6420 LOCATE 14, 39
6430 PRINT "-1s"
6440 LOCATE 14, 77
6450 PRINT "-1s"
6460 LOCATE 14, 121
6470 PRINT "-2s"
6480 LOCATE 14, 165
6490 PRINT "-2s"
6500 LOCATE 14, 209
6510 PRINT "-2s"

'Draw graph
6520 LINE (X, YC+2)-(639, YC+2), 1
6530 FOR X = 3.5 TO 3.5 STEP .2
6540 Y = A*1/(SQR(2*PI) ) * EXP(-(X*2)/2)
6550 LINE (X, YC+2)-(X, YC+4), 1
6560 NEXT X

6570 FOR Z = -3 TO 3 STEP 1
6580 Y = A*1/(SQR(2*PI) ) * EXP(-(Z*2)/2)
6590 LINE (X, YC+2)-(X, YC+4), 1
6600 NEXT Z

6610 LOCATE 12, 19
6620 PRINT "13.59%"
6630 LOCATE 12, 31
6640 PRINT "13.59%"
6650 LOCATE 12, 44
6660 PRINT "13.59%"
6670 LOCATE 12, 56
6680 PRINT "13.59%"
6690 LOCATE 11, 6
6700 PRINT "13.59%"
6710 LOCATE 11, 70
6720 PRINT "13.59%"
6730 PRINT "13.59%"
6740 LOCATE 11, 82
6750 PRINT "13.59%"
6760 LINE (65, 91)-(85, 98)
6770 LINE (540, 98)-(560, 98)
6780 LOCATE 3, 1: PRINT "s = standard deviation"
6790 RETURN
6800 LOCATE "6,1
6810 PRINT"
6820 PRINT "Any normal distribution has a constant relationship with its"
6830 PRINT "standard deviation. Approximately 68.26% of the area under a nor-
6840 PRINT "mal"
6850 PRINT "curve lies within one standard deviation of the mean either way.
6860 PRINT "because 34.13% = 34.13% = 68.26%.
6870 LOCATE 11, 13: PRINT "locates 11,46: PRINT ""
6880 PRINT "press the enter key."
6890 AS = 1: KEYS: IF AS = " " THEN 6900
6900 IF 29 = 1 GOTO 12270
6910 IF 35 = 1 GOTO 12270
6920 IF 75 = 1 GOTO 18190
6930 IF 151 = 1 GOTO 74140
6940 CLS: PRINT "unit 5: screen 23"
6950 COSUB 6290
LOCATE 16,1; PRINT "Approximately 95.44% of the area under a normal curve lies within two standard deviations of the mean either way, because "+13.59% + 34.13% + 13.59% = 95.44%.
LOCATE 11,21; PRINT "Approximately 98.72% of the area under a normal curve lies within three standard deviations of the mean either way.

LOCATE 11,46; PRINT ***: LOCATE 11,58; PRINT "Press the enter key.
LOCATE 10,7; PRINT "*: LOCATE 11,21; PRINT ***: LOCATE 11,33; PRINT **: LOCATE 11,46; PRINT ***: LOCATE 11,58; PRINT **
LOCATE 23,58; PRINT "Press the enter key.
AS-INKEYS: IF AS="* THEN 7040
SCREEN 2: CLS: PRINT "Unit 5: Screen 24"
GOSUB 6290
LOCATE 16,1
PRINT "Approximately 98.72% of the area under a normal curve lies within three standard deviations of the mean either way.
LOCATE 10,7; PRINT "*: LOCATE 11,21; PRINT ***: LOCATE 11,33; PRINT **: LOCATE 11,46; PRINT ***: LOCATE 10,71; PRINT **
LOCATE 23,58; PRINT "Press the enter key.
AS-INKEYS: IF AS="* THEN 7130
SCREEN 2: CLS: PRINT "Unit 5: Screen 25"
GOSUB 6290
LOCATE 16,1
PRINT "Exercise 9. Approximately, what percent of the area under a normal curve lies between the mean and one standard deviation above the mean?
PRINT "Type in your answer (for example, 17.32%) and press the enter key.
INPUT "Your response is correct."
IF 1510-0 THEN A510-S-O5S
IF 1510-1 THEN B510-S-35S
IF 05S-*34.13% OR Q5S-34.13% THEN GOTO 7260 ELSE 7290
R513-1
PRINT "Your response is incorrect. Press the enter key for further explanation."
AS-INKEYS: IF AS="* THEN 7320
SCREEN 2: CLS: PRINT "Unit 5: Screen 26"
GOSUB 6290
LOCATE 16,1
PRINT "Example 9. A large group of test scores are normally distributed with mean 60 and standard deviation 5.
PRINT "of 5. If 100 of these scores are randomly selected, approximately (68.26%)(100) = 68.26%
PRINT "or about 68 of these test scores should lie between 55 and 65, since 55 and 65 are, respectively, one standard deviation below and above the mean."
LOCATE 16,1
PRINT "Press the enter key."
AS-INKEYS: IF AS="* THEN 7500
SCREEN 2: CLS: PRINT "Unit 5: Screen 27"
GOSUB 6290
LOCATE 16,1

Example 10. A large group of test scores is normally distributed with mean 80 and standard deviation of 10. If 100 of these test scores are randomly selected, then approximately \((13.59)(100) = 1359\) of them should lie between 60 and 70, because 60 and 70 are 2 standard deviations and 1 standard deviation, respectively, below the mean of 80.

Exercise 10. A large group of observations are normally distributed with mean 80 and standard deviation of 10. If 200 of these observations are randomly selected, how many of these 200 observations should lie between 90 and 100?

a. 14  b. 20  c. 26  d. 27  e. 70

Type a, b, c, d, or e for your answer and press the enter key."
Exercise 11. A large group of observations are normally distributed with mean 80 and standard deviation of 10. If 300 of these observations are randomly selected, how many of these 300 observations should lie between 70 and 90?

a. 34  b. 68  c. 102  d. 203  e. 205

Type a, b, c, d, or e for your answer and press the enter key.
9608 AS=INKEYS: IF AS=""GOTO 8600
9610 1512=I: R×R+1: GOTO 7390
9629 W512-1
9639 PRINT" Your response is incorrect. The correct response"
9649 PRINT"
9659 LOCATE 23,58: PRINT" Press the enter key."
9669 AS=INKEYS: IF AS="" GOTO 8670
9679 R5 = R51+R52+R53+R54+R55+R56+R58+R59+R510+R511+R512
9689 W5 = W51+W52+W53+W54+W55+W56+W58+W59+W510+W511+W512
9699 FIRST5 = R5+R5=W
9709 T5S = TIMES
9719 TIMES = "00:00:00"
9729 SCREEN 0,1: COLOR 15,1,15: CLS: LOCATE 1,132: PRINT Unit 5: Screen 30"
9739 LOCATE 7,1
9749 PRINT This concludes the discussion of Unit 5. You worked
9759 PRINT correctly": FIRST5 "exercise(s) out of 11. There are 18"
9769 PRINT review problems for this unit. Would you like to work"
9779 PRINT some review problems? Press y if yes or n if no and"
9789 PRINT and press the enter key."';QSS
9799 IF QSS = "y" OR QSS = "Y" GOTO 8850 ELSE QSS = "n" OR QSS = "N" GOTO 8850 ELSE LOCATE
9809 15,1: PRINT"
9819 1: LOCATE 15,1: GOTO 8830
9829 QSS = "y" OR QSS = "Y" GOTO 8860 ELSE 1)060
9839 TIMES = "Screen 41"
9849 TIMES = "Screen 31"
9859 LOCATE 1,132: PRINT Unit 5: Screen 31"
9869 LOCATE 5,1: K5=1
9879 PRINT Problem 1: What is the area under the unit normal curve"
9889 PRINT between z = -1.25 and z = 2.00? Type in your"
9899 PRINT answer (for example, .5643) and press the enter"
9909 PRINT key."';QSS
9919 IF JS1=0 THEN CS1S=QSS
9929 IF JS1=1 THEN DSIS=QSS
9939 PRINT"
9949 PRINT" Your response is correct."
9959 GOTO 9140
9969 PRINT"
9979 IF JS1 = 1 GOTO 9100
9989 PRINT Your response is incorrect. Press the enter key"
9999 PRINT for further explanation.";
9999 AS=INKEYS: IF AS="" GOTO 9000
9999 AS=INKEYS: IF AS="" GOTO 9150
9999 GOSUB 9150
9999 IF QSS = "y" OR QSS = "Y" GOTO 9240 ELSE 13060
9999 CLS: LOCATE 5,1
9999 PRINT"
9999 PRINT" Would you like to work another review problem? Type"
9999 PRINT" y if yes or n if no and press the enter key.";QSS
9999 IF QSS = "y" OR QSS = "Y" OR QSS = "n" OR QSS = "N" THEN 9230 ELSE LOCATE 7
9999 1: PRINT"
9999 " : LOCATE 7,1: GOTO 9210
A normal distribution has a mean of 80 and a standard deviation of 10. What is the percent of scores between 70 and 90? 

a. 20.00%
b. 34.13%
c. 68.26%
d. 70.12%
e. 95.34%

Type in a, b, c, d, or e for your answer and press the enter key.

Your response is incorrect. Press the enter key for further explanation.

If men's heights are normally distributed with a mean of 67.02 inches and standard deviation of 2.56 inches, what is the percent of men having a height between 65.74 and 69.58 inches?
204

9880 PRINT**
9880 PRINT** a. 31.74%
9880 PRINT** b. 46.72%
9880 PRINT** c. 53.28%
9880 PRINT** d. 68.26%
9880 PRINT** e. none of the above
9880 PRINT**
9880 PRINT** Type a, b, c, d, or e for your answer and press the
9880 PRINT**
9880 PRINT**
9900 INPUT Q5S
9880 IF J53<>1 THEN C53=Q5S
9810 IF J53=1 THEN D53=Q5S
9820 PRINT**
9830 IF Q5S="a" OR Q5S="A" OR Q5S="b" OR Q5S="B" OR Q5S="c" OR Q5S="C" OR Q5S="d"
9840 OR Q5S = "D" OR Q5S = "E" OR QSS = "E" THEN 18000 ELSE 9940
9940 LOCATE 17,1
9950 PRINT*
9960 PRINT*
9970 PRINT*
9980 LOCATE 17,1
9990 GOTO 9870
10000 IF Q5S="c" OR Q5S="C" THEN 10010 ELSE 10040
10010 P53 = 1
10020 PRINT**
10030 GOTO 10150
10040 IF J53=1 GOTO 10110
10050 PRINT**
10060 PRINT**
10070 PRINT**
10080 AS = INKEYS: IF AS = "" GOTO 10090
10090 GOTO 5400
10110 Q53 = 1
10120 PRINT**
10130 PRINT**
10140 PRINT**
10150 LOCATE 23,58: PRINT"Press the enter key."
10160 AS = INKEYS: IF AS = "" GOTO 10160
10170 GOSUB 9100
10180 IF QSS = "y" OR QSS = "Y" GOTO 10190 ELSE 13860
10190 SCREEN 2: CLS: PRINT"Unit 5: screen 34"
10200 GOSUB 6290
10210 LOCATE 16,1: K5=4
10220 PRINT** Problem 4. Approximately what percent of the area under a"
10230 PRINT** normal curve lies between two and three standard" deviations above the mean?"
10240 PRINT**
10250 PRINT**
10260 PRINT**
10270 INPUT**
10280 IF J54<>0 THEN .5542*Q5S
10290 IF J54=1 THEN 10350
10300 IF Q5S="2.14" OR Q5S="2.14" THEN GOTO 10310 ELSE 10340
10310 P54=1
10320 PRINT**
10330 GOTO 10420
10340 IF J54=1 GOTO 10390
10350 PRINT**
10360 PRINT**
10370 AS=INKEYS: IF AS = "" THEN 10370
10370 PRINT**
10380 PRINT**
10390 PRINT**
10400 PRINT**
10410 Q5S = 1

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Problem 5. A large group of observations are normally distributed with mean 83 and standard deviation of 10. If 300 of these observations are randomly selected, how many of these 300 observations should lie between 100 and 110?

Type a, b, c, d, or e for your answer and press the enter key.
What is the area under the unit normal curve between $z = -2.99$ and $z = 1.06$? Type in your answer (for example, .5643) and press the enter key. 

Your response is correct.
The correct answer is

Problem 8. If men's heights are normally distributed with a mean of 67.02 inches and standard deviation of 2.56 inches, what is the percent of men having a height between 61.90 and 67.02 inches?

a. 2.28%
b. 47.72%
c. 50.00%
d. 52.28%
e. none of the above

Type a, b, c, d, or e for your answer and press the enter key.

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Your response is incorrect. The correct response is b.

Your response is incorrect, for further explanation.

Your response is incorrect. The correct response is c. 15.73%.

Your response is incorrect. The correct response is b.

Approximately, what percent of the area under a normal curve lies between three and one standard deviations below the mean?

Type in your answer (for example, 17.32%) and press the enter key.

Type your answer (for example, 17.32%) and press the enter key.

Type your answer (for example, 17.32%) and press the enter key.

Press the enter key.
12770 PRINT "";
12780 INPUT " enter key. ": Q5S
12790 IF J510 = 0 THEN C518 = Q5S
12800 IF J510 = 1 THEN US18 = Q5S
12810 PRINT " ";
12820 IF Q5S = "a" OR Q5S = "A" OR Q5S = "b" OR Q5S = "B" OR Q5S = "c" OR Q5S = "C" OR Q5S = "D" OR Q5S = "d" OR Q5S = "D" OR Q5S = "e" OR Q5S = "E" THEN 12890 ELSE 12830
12830 LOCATE 17, 1
12840 PRINT " ";
12850 PRINT " ";
12860 PRINT " ";
12870 LOCATE 17, 1
12880 GOTO 12760
12890 IF Q5S = "d" OR Q5S = "D" THEN 12990 ELSE 12930
12900 P519 = 1
12910 PRINT " ";
12920 GOTO 12830
12930 IF J511 = 1 GOTO 12990
12940 PRINT " ";
12950 PRINT " ";
12960 PRINT " ";
12970 AS = INKEYS: IF AS = " " GOTO 12970
12980 J511 = 1: P5 = P5 + 1: GOTO 7520
12990 Q511 = 1
13000 PRINT " ";
13010 PRINT " ";
13020 PRINT " ";
13030 LOCATE 17, 1
13040 PRINT " ";
13050 SCREEN 0, 1: COLOR 15, 1, 15: CLS
13060 SCREEN 35
13070 CLS: LOCATE 1, 32: PRINT " Unit 5: Screen 35";
13080 LOCATE 8, 1
13090 PRINT " ";
13100 AS = INKEYS: IF AS = " " GOTO 13100
13110 IF K5 = 0 GOTO 13270
13120 PS = P51 + P52 + P53 + P54 + P55 + P56 + P57 + P58 + P59 + P510
13130 Q5 = Q51 + Q52 + Q53 + Q54 + Q55 + Q56 + Q57 + Q58 + Q59 + Q510
13140 SECS = P5 + Q5 - P
13150 PRINT " "; P5 = Q5 - P
13160 PRINT " The number of correct exercises is ": FIRST5
13170 PRINT " The number of incorrect exercises is ": 11-FIRST5
13180 PRINT " The number of correct exercises after remediation is ": S = J-R-W5
13190 PRINT " The number of correct problems is ": SECS
13200 PRINT " The number of incorrect problems is ": K5-SECS
13210 PRINT " The number of correct problems after remediation is ": P = Q5
13220 LPRINT " Unit 5: Part 1. Total Area Under a Normal Curve Lying Below \" One Observation and Above a Second Observation.\"
13230 LPRINT " Part 2. Area Under a Normal Curve Relative to the Cur
13240 LPRINT " Standard Deviation.\"
The number of correct exercises is";FIRSTS
The number of incorrect exercises is"; 11-FIRSTS" 
The number of correct exercises after remediation
is";R-W5
IF K5=0 GOTO 13470

The number of correct problems is";SEC5
The number of incorrect problems is"; K5-SEC5"

The number of correct problems after remediation i

Exercise 1 response was correct.",A51S:GOTO 13550
Exercise 1 response was incorrect.",A51S,B51S

Exercise 2 response was correct.",A52S:GOTO 13600
Exercise 2 response was incorrect.",A52S,B52S

Exercise 3 response was correct.",A53S:GOTO 13650
Exercise 3 response was incorrect.",A53S,B53S

Exercise 4 response was correct.",A54$:GOTO 13700
Exercise 4 response was incorrect.",A54$,B54S

Exercise 5 response was correct.",A55$: GOTO 13750
Exercise 5 response was incorrect.",A55S,B55S

Exercise 6 response was correct.",A56$: GOTO 13800
Exercise 6 response was incorrect.",A56S,B56S

Exercise 7 response was correct.",A57S: GOTO 13850
Exercise 7 response was incorrect.",A57S,B57S

Exercise 8 response was correct.",A58S:GOTO 13900
Exercise 8 response was incorrect.",A58S,B58S

Exercise 9 response was correct.",A59S:GOTO 13950
Exercise 9 response was incorrect.",A59S,B59S

Exercise 10 response was correct.",A60S:GOTO '000
Exercise 10 response was incorrect.",A60S,B60S

GOTO 13470
Exercise 10 response was incorrect.

Exercise 11 response was correct.

Problem 1 response was incorrect.

Problem 2 response was incorrect.

Problem 3 response was correct.

Problem 4 response was incorrect.

Problem 5 response was incorrect.

Problem 6 response was correct.

Problem 6 response was incorrect.

Problem 7 response was incorrect.

Problem 8 response was correct.

Problem 8 response was incorrect.

Problem 9 response was incorrect.

Problem 10 response was incorrect.

Problem 11 response was correct.

Problem 12 response was incorrect.

Problem 13 response was correct.
Suppose that one wishes to find the total area under the unit normal curve below $z_1$ and above $z_2$, with $z_2$ greater than or equal to $z_1$. Using Table B, find the areas below $z_1$ and above $z_2$, respectively. The total area is given by:

\[
\text{Total Area} = \text{Area below } z_1 + \text{Area above } z_2.
\]

The areas below $z_1$ and above $z_2$ can be calculated using the values from Table B. For example, if we have $z_1 = 1.96$ and $z_2 = 2.58$, we can find:

- Area below $z_1 = 0.9750$
- Area above $z_2 = 0.0250$
- Total Area = 0.9500

We will be interested in calculating the total area of shaded regions of this type.
The total area under the unit normal curve below $z_1 = 1.96$ and above $z_2 = 1.99$ is given by:

$\text{area below } 1.96 + \text{area above } 1.99 = \begin{array}{c}
1.97 \quad .9756 \quad .0244 \quad .0573 \\
1.98 \quad .9761 \quad .0239 \quad .0562 \\
1.99 \quad .9767 \quad .0233 \quad .0551 \\
2.00 \quad .9772 \quad .9228 \quad .0540
\end{array}$

The total area under the unit normal curve below $z_1 = 1.96$ and above $z_2 = 1.99$ is given by:

$0.9756 
+ 0.0239
= 0.9983
$
DRAW AXES
SCREEN 2: CLS
LINE (0,YC*2)-(639,YC*2),1
LINE (639,0)-(639,101),1
FOR X=0 TO 628 STEP 20
LINE (X,YC*2)-(X,YC*4),1
NEXT X
LOCATE 1,78
PRINT ".4"
LOCATE 7,78
PRINT ".2"
FOR Y=0 TO 75 STEP 25
LINE (636,Y)-(639,Y),1
NEXT Y
LOCATE 14,1
PRINT "z"
LOCATE 14,15
PRINT "-2"
LOCATE 14,27
PRINT "+2"
LOCATE 14,41
PRINT "+1"
LOCATE 14,53
PRINT "+1"
LOCATE 14,66
PRINT "+3"
LOCATE 14,78
PRINT "draw graph"
XI=-3.5:Y1=A*1/(SQR(2*PI))*EXP(-X1**2/2)
X2=-3.4:Y2=A*1/(SQR(2*PI))*EXP(-X2**2/2)
LINE(XC+S*X1,YC*Y1)-(XC+S*X2,YC*Y2),1
FOR X=-3.4 TO 3.5 STEP .2
Y=A*1/(SQR(2*PI))*EXP(-(X**2)/2)
LINE (XC+S*X,YC*Y),1
NEXT X
RETURN
SCREEN 5
GOSUB 1330
PRINT "Example 2. This is the graph of the unit normal distribution."
The region under the curve below .50 and above 1.80 is shaded. From Table B, the area of this shaded region is \( \text{(area below .50)} + \text{(area above 1.80)} = .6915 + .0359 = .7274 \). Here is the code:

```
200 PRINT "The region under the curve below .50 and above 1.80 is shaded. From Table B, the area of this shaded region is \( \text{(area below .50)} + \text{(area above 1.80)} = .6915 + .0359 = .7274 \)."
```

The total area under the unit normal curve below \( z_1 = -0.60 \) and above \( z_2 = -0.57 \) (note that \(-0.57 > -0.60\)) is given by \( \text{(area below -0.60)} + \text{(area above -0.57)} = \). Here is the code:

```
2510 PRINT "is given by \( \text{(area below -0.60)} + \text{(area above -0.57)} = \)."
2520 PRINT "\( .2743 + .7157 = .9900 \)."
```

Example 3. Another portion of Table B is shown below.
Exercise 3. A portion of Table B is shown below:

<table>
<thead>
<tr>
<th>Z</th>
<th>Area Below</th>
<th>Area Above</th>
<th>Ordinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.60</td>
<td>0.2743</td>
<td>0.7257</td>
<td>0.3332</td>
</tr>
<tr>
<td>-0.59</td>
<td>0.2776</td>
<td>0.7224</td>
<td>0.3352</td>
</tr>
<tr>
<td>-0.58</td>
<td>0.2811</td>
<td>0.7190</td>
<td>0.3372</td>
</tr>
<tr>
<td>-0.57</td>
<td>0.2843</td>
<td>0.7157</td>
<td>0.3391</td>
</tr>
<tr>
<td>-0.56</td>
<td>0.2877</td>
<td>0.7123</td>
<td>0.3410</td>
</tr>
</tbody>
</table>

Type in the total area under the unit normal curve below -0.59 and above -0.56 (note that -0.56 > -0.59) and press the enter key.

Example 4. This is the graph of the unit normal distribution. The region under the curve below -2.24 and above -1.00 is shaded. Using Table B, the area of this shaded region is (area below -2.24) + (area above -1.00) = 0.0125 + 0.8413 = 0.8538.
Exercise 4. The regions under the unit normal curve below \(-1.5\) and above \(-0.2\) are shaded. Type in the total area for example, 0.4532 of these regions and press enter. If your response is correct, press enter. If your response is incorrect, press enter for further explanation.

Exercise 5. Selected portions of Table B are shown below:

<table>
<thead>
<tr>
<th>z</th>
<th>Area Below</th>
<th>Area Above</th>
<th>Ordinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2.20</td>
<td>0.0139</td>
<td>0.9861</td>
<td>0.0355</td>
</tr>
<tr>
<td>0.00</td>
<td>0.5000</td>
<td>0.5000</td>
<td>0.3989</td>
</tr>
<tr>
<td>2.46</td>
<td>0.0069</td>
<td>0.0194</td>
<td></td>
</tr>
<tr>
<td>2.46</td>
<td>0.0139</td>
<td>0.2069</td>
<td>0.0288</td>
</tr>
</tbody>
</table>

The area under the unit normal curve below \(-2.20\) and above \(2.46\) = (area below \(-2.20\)) \(\ast\) (area above \(2.46\)) = 0.0208.
Type in the total area (for example, .5438) under the unit normal curve lying below -1.25 and above 1.57. Then press the enter key.

Your response is correct.

Your response is incorrect. Press the enter key for further explanation.

Your response is incorrect. The correct answer is .1638.

The regions under the unit normal curve below -1.33 and above 1.33 are shaded above. From Table B, the total area of these shaded regions = (area below -1.33) + (area above 1.33) = .3385 + .1587 = .4672.

Exercise 6. The regions under the unit normal curve below -1.00 and above 1.00 are shaded above. Using Table B, type in the total area (for example, .6452) of these shaded regions and press the enter key.
Example 7. It is fairly well known that IQ scores from the 
Stanford-Binet Intelligence Test are approximately 
normally distributed with a mean of 100 and a 
standard deviation of 16 for people in its population. 

Solution

We begin by computing the z-scores for 84 and 116, respectively. The z-score for 84 is 
\[ z_1 = \frac{84 - 100}{16} = -1 \, \text{ or } \, -0.625 \] 
The z-score for 116 is 
\[ z_2 = \frac{116 - 100}{16} = 1 \, \text{ or } \, 0.625 \] 
The area under the unit normal curve below -1 or above 1 is 
\[ P(|Z| > 1) = P(Z < -1) + P(Z > 1) = \Phi(-1) + (1 - \Phi(1)) = 0.1587 + (1 - 0.8413) = 0.1587 + 0.1587 = 0.3174 \] 
Therefore, approximately 0.3174% of people have such scores.
Example 8. If men's heights are normally distributed with a
mean of 67.02 inches and standard deviation of 2.56 inches, find the percent of men having a height
below 61.90 and above 64.46 inches.

Solution

The z-score for 61.90 is \( z_1 = \frac{(X - \mu)}{\sigma} = \frac{(61.90 - 67.02)}{2.56} = \frac{-5.12}{2.56} = -2 \).

The z-score for 64.46 is \( z_2 = \frac{(64.46 - 67.02)}{2.56} = -\frac{2.56}{2.56} = -1 \).

The total area under the unit normal curve below -2.00 and above -1.00 is given by \( (\text{area below } -2.00) + (\text{area above } -1.00) = 0.0228 + 0.8413 = 0.8641 \).

Therefore, approximately \( 0.8641 \times 100\% = 86.41\% \) of men have such heights.

Exercise 8. If men's heights are normally distributed with a
mean of 67.02 inches and standard deviation of 2.56 inches, what is the percent of men having a height
below 69.58 and above 72.14 inches?

Type a, b, c, d or e for your answer and press the enter key.
221

5700 GOTO 5600
5710 IF Q6S = "d" OR Q6S = "D" THEN 5720 ELSE 5750
5720 R68 = 1
5730 PRINT" Your response is correct."
5740 GOTO 5840
5750 IF 168 = 1 GOTO 5810
5760 PRINT" Your response is incorrect. Press the enter key" for further information.
5770 GOTO 5910
5780 168 = 1
5790 AS = INKEYS: IF AS = "" GOTO 5790
5800 R = 81: GOTO 5240
5810 W68 = 1
5820 PRINT" Your response is incorrect. The correct response is d."
5830 GOTO 5910
5840 LOCATE 23,58: PRINT"Press the enter key."
5850 AS = INKEYS: IF AS = "" GOTO 5850
5870 W6 = W61*W62*W63*W64*W65*W66*W67*W68
5880 FIRST6 = R6-W6
5890 T65 = TIMES
5900 TIMES = "00:00:00"
5910 "screen 20"
5920 SCREEN 0,1: COLOR 15,1,15: CLS
5930 LOCATE 1,32: PRINT"Unit 6: Screen 20"
5940 LOCATE 7,1: PRINT"This concludes the discussion of Unit 6: The Total Area"
5950 PRINT" Under a Normal Curve Lying Below One Observation and Above a"
5960 PRINT" Second Observation. You worked correctly; FIRST6"exercise(s)"
5970 PRINT" out of 8. There are 10 review problems for this unit. Would"
5980 PRINT" you like to work some review problems? Type y if yes or n"
5990 INPUT" n if no and press the enter key."; Q6S
6000 IF 361 = 0 THEN C61S = 36S
6010 PRINT" n if no and press the enter key."; Q6S
6020 IF 361 = 1 THEN U61S = 36S
6030 PRINT" n if no and press the enter key."; Q6S
6040 IF 168 = 0 THEN C61S = 36S
6050 PRINT" n if no and press the enter key."; Q6S
6060 IF 361 = 1 THEN U61S = 36S
6070 GOTO 5790 ELSE LOCATE 1
7,1: PRINT": LOCATE 17,1: GOTO 6050
6080 IF Q6S = "y" OR Q6S = "y" GOTO 5600 ELSE 10100
6090 'screen 21"
6100 SCREEN 0,1: COLOR 15,1,15: CLS
6110 LOCATE 1,32: PRINT"Unit 6: Screen 21"
6120 LOCATE 5,1: K6 = 1
6130 PRINT" Problem 1. What is the area under the unit normal curve lying below z = -1.25 and above z = 2.00? Type in your "
6140 PRINT" answer (for example, .6532) and press the enter key."
6150 PRINT" key."
6160 IF J61 = 0 THEN C61S = Q6S
6170 IF J61 = 1 THEN U61S = Q6S
6180 PRINT" key."; Q6S
6190 IF Q6S = "1.284" THEN 6230 ELSE 6260
6200 IF Q6S = "1.284" THEN 6230 ELSE 6260
6210 PRINT" Your response is correct."
6220 GOTO 6360
6230 P61 = 1
6240 PRINT" Your response is incorrect. Press the enter key"
Problem 2. A normal distribution has a mean of 30 and a standard deviation of 10. What is the percent of scores lying below 70 and above 90?

a. 15.87%
b. 31.74%
c. 68.26%
d. 78.88%
e. 84.46%

Type your answer (a, b, c, d, or e) and press the enter key.
Your response is incorrect. The correct answer is .6532.

Your response is correct.

Your response is incorrect. The correct answer is .7004.
Since the total area of the shaded regions equal 0.3476, the area above 1.10 equals 0.1357, the area below z is 0.6816 - 0.1357 = 0.5459. Now use Table B to determine the value of z.

Your response is incorrect. The correct answer is ...

Your response is incorrect. The correct response is c.
Problem 6. What is the area under the unit normal curve lying below \( z = -2.81 \) and above \( z = 0.507 \)? Type in your answer (for example, \( .6532 \)) and press the enter key.

Your response is correct.

Your response is incorrect. Press the enter key for further explanation.

A normal distribution has a mean of 73 and a standard deviation of 6. What is the percent of scores lying below 67 and above 81?

- a. 4.461%
- b. 34.231%
- c. 65.771%
- d. 95.561%
- e. none of the above

Type in a, b, c, d, or e for your answer and press the enter key.
8790 PRINT*
8710 PRINT*
8720 LOCATE 17,1
8730 GOTO 8610
8740 IF Q6S = "b" OR Q6S = "B" THEN 8750 ELSE 8780
8750 P67=1
8760 PRINT* Your response is correct.
8770 GOTO 8860
8780 IF J67 = 1 GOTO 8840 ELSE 8790
8790 PRINT* Your response is incorrect. Press the enter key for further explanation.
8800 AS = INKEY$: IF AS = "" GOTO 8820
8810 J67 = 1: P67 = 1: GOTO 4590
8820 Q67 = 1
8830 PRINT* Your response is incorrect. The correct answer is b.
8840 LOCATE 23,58: PRINT"Press the enter key."
8850 AS = INKEY$: IF AS = "" GOTO 8870
8860 GOSUB 6400
8870 IF Q6S = "y" OR Q6S = "Y" GOTO 8900 ELSE 10100
8880 'screen 28
8890 SCREEN 8,1: COLOR 15,1,15: CLS: LOCATE 1,12: PRINT"Unit 6: Screen 28"
8900 LOCATE 5,1: K6-8
8910 PRINT* Problem 8. What is the area under the unit normal curve lying below z = -1.69 and above z = 0?*
8920 PRINT*
8930 INPUT* Type in your answer (for example, .6532) and press*
8940 PRINT*
8950 PRINT* the enter key.": Q6S
8960 IF J68 = 0 THEN C68S=Q6S
8970 IF J68=1 THEN D68S=Q6S
8980 PRINT* Your response is incorrect. Press the enter key for further explanation.
8990 AS = INKEY$: IF AS="" GOTO 9010
9000 J69 = 1: P69 = 1: GOTO 2330
9010 J68 = 1
9020 PRINT* Your response is incorrect. The correct answer is .5455.
9030 PRINT*.5455."*
9040 LOCATE 23,58: PRINT"Press the enter key."
9050 AS = INKEY$: IF AS="" GOTO 9180.
9060 Q6GOSUB 9400
9070 IF Q6S = "y" OR Q6S = "Y" GOTO 9210 ELSE 10130
9080 'screen 29
9090 SCREEN 8,1: COLOR 15,1,15: CLS: LOCATE 1,12: PRINT"Unit 6: Screen 29"
9100 LOCATE 5,1: K6-9
9110 PRINT* Problem 9. The total area under the unit normal curve lying below z1 and above z2 is .9688. If z1 = -2.41, what*
9120 PRINT* is the value of z2?*
9130 PRINT*
9140 PRINT*
9150 PRINT*
9160 PRINT*.5455."*
PRINT** and press the enter key."

IF J69 = 0 THEN C69 = C66

IF J69 = 1 THEN D69 = C66

PRINT** -1.76" THEN 9370 ELSE 9400

PRINT* Your response is correct.

PRINT* Your response is incorrect. Press the enter key for

PRINT* further explanation.

AS = INKEYS: IF AS = "GOTO 9440

J69 = 1: P = P + 1: GOTO 9550

J69 = 1

PRINT* Your response is incorrect. The correct answer is"

PRINT* -1.76.

LOCATE 23,58: PRINT"Press the enter key."

AS = INKEYS: IF AS = "GOTO 9510.

SCREEN 6440

IF Q6S = "Y" OR Q6S = "Y" GOTO 9690 ELSE 10100

GOTO 9690

SCREEN 29a

SCREEN 0,1: COLOR 15,1,15: CLS: LOCATE 1,32: PRINT"Unit 6: Screen 29a"

LOCATE 5,1

PRINT* Since the total area of the shaded regions equal .9688 and

PRINT* the area below -2.41 equals .0088, the area above z2 must equ
al"

PRINT* to .9689 = .9688 + .0088. Now use Table 8 to determine the va
lue"

PRINT*

PRINT* of z2."

LOCATE 23,58

PRINT"Press the enter key."

AS = INKEYS: IF AS = "GOTO 9670

IF J69 = 1 GOTO 9210

'Screen 10

SCREEN 0,1: COLOR 15,1,15: CLS

LOCATE 1,32: PRINT"Unit 6: Screen 10"

LOCATE 5,1: K6 = 10

PRINT* Problem 18. If men's heights are normally distributed with a"

PRINT* mean of 67.02 inches and standard deviation of 2.56"

PRINT* inches, what is the percent of men having a height "

PRINT* below 63.18 and above 74.70 inches?"

PRINT*

PRINT* a. 6.81%

PRINT* b. 34.88%

PRINT* c. 65.12%

PRINT* d. 91.19%

PRINT* e. none of the above"

PRINT** Type a, b, c, d or e for your answer and press the

INPUT* enter key."

IF J613 = 2 THEN C613 = C66

IF J613 = 1 THEN D613 = C66

PRINT** " or Q6S ="A" OR Q6S ="B" OR Q6S ="B" OR Q6S ="C" OR Q6S ="C" OR Q6S ="D"

OP "OR Q6S ="D" OR Q6S ="E" OR Q6S ="E" THEN 9950 ELSE 9990

LOCATE 16,1

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
PRINT"Your response is correct."  
GOTO 9840  
IF Q6$="a" OR Q6$ "b" THEN GOTO 9840  
Q6$ = 1  
PRINT"Your response is incorrect. Press the enter key for further information."  
J61 = 1  
AS = INKEY$: IF AS = " " GOTO 9810  
P = P+1: GOTO 5240  
Q6$ = 1  
PRINT"Your response is incorrect. The correct response is a."  
LOCATE 23,58: PRINT"Press the enter key."  
AS = INKEY$: IF AS = " " GOTO 1000  
screen 45  
CLS: LOCATE 1,32: PRINT"Unit 6: Screen 26"  
PRINT"Turn the printer on and press the enter key."  
AS = INKEY$: IF AS = " " GOTO 1010  
IF K6 = 3 GOTO 10310  
P = P61+P62+P63+P64+P65+P66+P67+P68+P69+P610  
0610 = 061+062*063+064*065+066+067+068+069+0610  
SEC6 = 06-P  
PRINT"The number of correct exercises is";FIRST6  
PRINT"The number of incorrect exercises is";8-FIRST6  
PRINT"The number of correct exercises after remediation is";P-36  
UNIT 6  
TIMES  
"Exercise 1 response was correct.";A61S:GOTO 960
Exercise 1 response was incorrect.
Exercise 2 response was incorrect.
Exercise 3 response was incorrect.
Exercise 4 response was incorrect.
Exercise 5 response was incorrect.
Exercise 6 response was incorrect.
Exercise 7 response was incorrect.

IF K61<1 GOTO 11510
Problem 1 response was incorrect.

IF K62<2 GOTO 11510
Problem 2 response was incorrect.

IF K63<3 GOTO 11510
Problem 3 response was incorrect.

IF K64<4 GOTO 11510
Problem 4 response was incorrect.

IF K65<5 GOTO 11510
Problem 5 response was incorrect.

IF K66<6 GOTO 11510
Problem 6 response was incorrect.

IF K67<7 GOTO 11510
Problem 7 response was incorrect.

IF K68<8 GOTO 11510
Problem 8 response was incorrect.

IF K69<9 GOTO 11510
Problem 9 response was incorrect.

IF K70<10 GOTO 11510
Problem 10 response was incorrect.
230

11190 LPRINT* Problem 5 response was incorrect.
11200 LPRINT**
11210 IF K6<6 GOTO 11510
11220 LPRINT**: IF J6=1 GOTO 11250
11230 LPRINT* Problem 6 response was correct.
11240 LPRINT**
11250 LPRINT* Problem 6 response was incorrect.
11260 LPRINT**
11270 IF K6<7 GOTO 11510
11280 LPRINT**: IF J6=1 GOTO 11310
11290 LPRINT* Problem 7 response was correct.
11300 LPRINT**
11310 LPRINT* Problem 7 response was incorrect.
11320 LPRINT**
11330 IF K6<8 GOTO 11270
11340 LPRINT**: IF J6=1 GOTO 11370
11350 LPRINT* Problem 8 response was correct.
11360 LPRINT**
11370 LPRINT* Problem 8 response was incorrect.
11380 LPRINT**
11390 IF K6<9 GOTO 11510
11400 LPRINT**: IF J6=1 GOTO 11430
11410 LPRINT* Problem 9 response was correct.
11420 LPRINT**
11430 LPRINT* Problem 9 response was incorrect.
11440 LPRINT**
11450 IF K6<10 GOTO 11510
11460 LPRINT**: IF J6=1 GOTO 11490
11470 LPRINT* Problem 10 response was correct.
11480 LPRINT**
11490 LPRINT* Problem 10 response was incorrect.
11500 LPRINT**
11510 CLS: CHAIN "unit7"
Unit 7: Standard Scores

Objectives: At the end of Unit 7: Standard Scores, the student should be able to:

1. Identify the distinguishing characteristics of a standard score scale.
2. Transform a raw-score to its equivalent T-score.
3. Determine the percentile rank of a given T-score.
4. Transform a z-score to its corresponding standard score on a given standard score scale.

Observations or raw-scores are often transformed to standard scores to facilitate interpretation. With standard scores, the mean and standard deviation are fixed. Regardless of what the raw-score mean and standard deviation happen to be, they are converted to a fixed mean and a fixed standard deviation. Since the raw-scores are then expressed in terms of a standard score scale, they are called standard scores.

By using a standard score scale, performance on all variables can be expressed and then compared.
The z-score scale shown above, with mean 0 and standard deviation 1, is considered to be the most widely used standard score scale in statistics. However, the z-score scale has the disadvantages of involving negative numbers and/or decimals.

One of the most commonly used standard-score scales for reporting performance, such as in standardized educational and psychological tests, is the T-score scale. The T-score scale has a mean of 50 and a standard deviation of 10. T-scores are usually rounded to two figures. For example, a T-score of 62.3 is rounded to 62 and a T-score of 62.6 is rounded to 63.
Unit 7: Screen 4

r-scale
3

T-scale
20 30 40 50 60 70

A z-score can be readily converted to a T-score by using the formula: \( T = 50 + 10z \).

Example 1. If the z-score is 1, what is the corresponding T-score?

\( T = 50 + 10z = 50 + 10(1) = 50 + 10 = 60 \).

Exercise 1. If the z-score is 2.7, what is the corresponding T-score?

Type in your answer and press the enter key.

Your response is correct.

Your response is incorrect. Press the enter key for further explanation.
234

1790 PRINT" 77."
1800 PRINT" 77."
1810 IF AS=INKEYS THEN AS=1008
1820 PRINT" Press the enter key.
1830 SCREEN 0,1: COLOR 15,1,6: CLS
1840 PRINT"Unit 7: Screen 6"
1850 PRINT"Press the enter key.
1860 IF AS=INKEYS THEN AS=1008
1870 IF AS=INKEYS THEN AS=1008
1880 PRINT" T-score?"
1890 PRINT" T-score?"
1900 PRINT" Solution. T = 50 + 10z = 50 + 10(-2.83) = 50 - 28.3 = 21.7*"
1910 PRINT" or 22. Note that 21.7 is rounded to two digits."
1920 PRINT"
1930 COLOR 15,6,6
1940 SCREEN 13,25
1950 PRINT"Note that 21.7 is rounded to two digits."
1960 COLOR 15,1,6
1970 LOCATE 23,58: PRINT"Press the enter key."
1980 IF AS=INKEYS THEN AS=1008
1990 "Screen 7"
2000 SCREEN 10,1: COLOR 15,1,6: CLS
2010 PRINT"Unit 7: Screen 7"
2020 PRINT"Press the enter key.
2030 IF AS=INKEYS THEN AS=1008
2040 PRINT" Example 2. If the z-score = -2.83, what is the corresponding"
2050 PRINT" Example 2. If the z-score = -2.83, what is the corresponding"
2060 PRINT" T-score?"
2070 PRINT" T-score?"
2080 PRINT" Type in your answer and press the enter key."
2090 PRINT" Type in your answer and press the enter key."
2100 PRINT" "
2110 IF AS=INKEYS THEN AS=1008
2120 PRINT"Your response is correct."
2130 PRINT"Your response is correct."
2140 GOTO 2250
2150 GOTO 2250
2160 PRINT"Your response is incorrect. Press the enter key"
2170 PRINT"Your response is incorrect. Press the enter key"
2180 PRINT"for further explanation."
2190 IF AS=INKEYS THEN AS=1008
2200 PRINT"Example 3. A normal population of raw-scores has a mean of"
2210 PRINT"Exercise 2. If the z-score = -1.56, what is the corresponding"
2220 PRINT"Exercise 2. If the z-score = -1.56, what is the corresponding"
2230 PRINT"of 90 and a standard deviation of 5. What is the"
2240 PRINT"of 90 and a standard deviation of 5. What is the"
2250 PRINT"T-score for the raw-score of 100?"
2260 PRINT"T-score for the raw-score of 100?"
2270 PRINT"Solution. First compute the z-score for the raw-score of"
2280 PRINT"Solution. First compute the z-score for the raw-score of"
2290 PRINT"100. Recall that z = (X - m)/s = (100 - 90)/5 = "

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
235
241 PRINT" 10/5 = +2. The corresponding T-score is given by
249 PRINT" T = 50 - 10z = 50 + 10(2) = 50 + 20 = 70."
253 LOCATE 23,58: PRINT"Press the enter key."
257 PRINT" AS = INKEYS: IF AS = " " GOTO 2460
261 IF J79=1 GOTO 9990
263 IF J73=1 GOTO 7740
267 * screen 9
271 SCREEN 0,1: COLOR 15,1,6: CLS
275 LOCATE 1,32: PRINT"Unit 7: Screen 9"
279 LOCATE 6,1 PRINT" Exercise 3. A normal population of observations has a mean"
283 PRINT" of 100 and a standard deviation of 15. What is"
287 PRINT" the T-score for an observed value of 1397"*
291 PRINT" Type in your response and press the enter key.";Q
295 PRINT" AS « INKEYS: IF AS - " " GOTO 2950
299 IF Q75-"76" THEN 2960 ELSE 2980
301 R73-1
305 PRINT" Your response is correct."
309 GOTO 2800
313 IF 173-1 GOTO 2740
317 PRINT" Your response is incorrect. Press the enter key"*
321 PRINT" for further explanation.*
325 AS=INKEYS: IF AS=" " GOTO 2720
329 173=1: R=1: GOTO 2279
333 W73=1
337 PRINT" Your response is incorrect. The correct answer is
341 " 76."
345 LOCATE 23,58: PRINT"Press the enter key."
349 PRINT" AS = INKEYS: IF AS = " " GOTO 2790
353 * screen 10
357 SCREEN 0,1: COLOR 15,1,6: CLS
361 LOCATE 1,32: PRINT"Unit 7: Screen 10"
365 LOCATE 5,1 PRINT" One advantage of T-scores is that if two tests report*
373 PRINT" results using T-scores, an examinee's relative level of"
377 PRINT" performance can be compared directly without the use of"
381 PRINT" further information. This comparison is possible because*
385 PRINT" the mean and the standard deviation for both sets of scores*
389 PRINT" will be the same.*
393 LOCATE 23,58: PRINT"Press the enter key."
397 AS = INKEYS: IF AS = " " THEN 2960
401 * screen 11
405 SCREEN 0,1: COLOR 15,1,6: CLS
409 LOCATE 1,32: PRINT"Unit 7: Screen 11"
413 LOCATE 5,1 PRINT" Example 4. Mary's T-score on Test A is 50, whereas her T-score

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Example 5. What is the percentile rank for the T-score of 40?

Solution. First compute the z-score for the T-score of 40.

Recall that $z = (T - m)/s$. The mean and standard deviation for T-scores are 50 and 10, respectively. The z-score of 40 is given by $z = (40 - 50)/10 = -10/10 = -1.00$. Using Table B, the percentage of the area under the unit normal curve below $z = -1.00$ is $0.1587 \times 100 = 15.87\%$.
237

3640 IF Q75=“93.32” OR Q75=“93.32” THEN 3650 ELSE 3680
3650 R74=1
3655 PRINT“Your response is correct.”
3660 PRINT“Your response is incorrect. Press the enter key”
3670 PRINT“for further explanation.”
3720 AS=INKEYS: IF AS=“” GOTO 3720
3730 IF J74=1: GOTO 3730
3740 W74=1
3750 PRINT“Your response is incorrect. The correct answer is”
3760 PRINT“93.32.”
3770 LOCATE 23,58: PRINT“Press the enter key.”
3780 AS=INKEYS: IF AS=“” GOTO 3780
3880 'screen 14
3890 SCREEN 0,1: COLOR 15,1,6: CLS
3900 LOCATE 1,32: PRINT“Unit 7: Screen 14”
3910 PRINT“ This concludes our discussion on T-scores. Press the”
3920 PRINT“enter key to continue.”
3930 AS = INKEYS: IF AS = “” GOTO 3970
3980 'screen 14a
3990 SCREEN 0,1: COLOR 15,1,6: CLS
4000 LOCATE 1,32: PRINT“Unit 7: Screen 14”
4010 PRINT“Deviation IQs”
4020 PRINT“Some intelligence test scales, such as the Wechsler*
4030 PRINT“Intelligence Scales and the Stanford-Binet Intelligence”
4040 PRINT“Scale, are also a type of standard score called deviation*”
4050 PRINT“IQs. The mean and standard deviation on the Wechsler*”
4060 PRINT“Intelligence Scales are 100 and 15, respectively. The mean”
4070 PRINT“of the Stanford-Binet Intelligence Scale is 100 and its”
4080 PRINT“standard deviation is 16.”
4090 LOCATE 23,58: PRINT“Press the enter key.”
4100 AS=INKEYS: IF AS=“” GOTO 4100
4110 IF J76 = 1 GOTO 4110
4120 IF J77 = 1 GOTO 4120
4130 IF J74 = 1 GOTO 4130
4140 PRINT“z-Score Scale

Examnle 6. If an individual scores one standard deviation

Wechsler

Intelligence Scale

Example 6. If an individual scores one standard deviation

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
above the mean of his age group, the individual's

Wechsler's IQ is 115.

Wechsler's IQ is?

Type in your answer and press the enter key.

Your response is correct.

Your response is incorrect. The score of 130 is +2 standard deviations
above the mean. Press the enter key to continue.

Your response is incorrect. The correct answer is

A z-score can be converted to any other standard.
score, C, with the use of the formula:

\[ C = m + sz \]

where C is the new standard score equivalent to z, m is the desired mean of the new standard-score scale, s is the desired standard deviation of the new standard-score scale, and z is the z-score of the given observation.

```
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PRINT
PR
```
538# PRINT""
539# PRINT"
540# LOCATE 15,1
541# GOTO 5290
542# IF Q75 = "D" OR Q75 = "D" THEN 5430 ELSE 5460
543# Q76 = 1
544# PRINT"Your response is correct."  
545# GOTO 5560
546# IF Q76 = 1 GOTO 5520
547# PRINT"Your response is incorrect. Press the enter key"
548# PRINT"for further information."
549# PRINT""
550# AS = INKEY$: IF AS = "" GOTO 5550
551# Q76 = 1: R=R+1: GOTO 3860
552# Q76 = 1
553# PRINT"Your response is incorrect. The correct answer is d."  
554# PRINT"
555# GOTO 5560
556# LOCATE 23,58: PRINT"Press the enter key."
557# AS=INKEY$: IF AS="" GOTO 5570
558# 'screen 20
559# SCREEN 0,1: COLOR 15,1,6:CLS
560# LOCATE 1,10: PRINT"Unit 7: Screen 28"
561# LOCATE 5,1
562# PRINT"Example 8. The formula for converting z-scores to Wechsler's"
563# PRINT"IQs is C = 100 + 15z. If z = -1.8, what is the"
564# PRINT"corresponding Wechsler IQ?"
565# PRINT"Solution. C = 100 + 15(-1.8) = 100 - 27 = 73."
566# GOTO 5560
567# 'screen 21
568# SCREEN 0,1: COLOR 15,1,6:CLS
569# LOCATE 1,10: PRINT"Unit 7: Screen 21"
570# LOCATE 5,1
571# PRINT"Exercise 7. If the z-score of a raw-score belonging to a"
572# PRINT"normal population is -3, what is the "
573# PRINT"corresponding Wechsler IQ?"
574# PRINT"Type in your answer (e.g. 112) and press the"
575# PRINT"enter key.:Q75"
576# INPUT""
577# IF Q75="" THEN A77S=Q75
578# IF Q75=145 OR Q75 = "145." OR Q75 = "145.0" THEN 5880 ELSE 5910
579# Q77=1
580# PRINT"Your response is correct."
581# GOTO 6010
582# IF Q77=1 GOTO 5970
583# PRINT"Your response is incorrect. Press the enter key"
584# PRINT"for further explanation."
585# AS=INKEY$: IF AS="" GOTO 5860
586# Q77=1: R=R+1: GOTO 5550
587# Q77=1
588# PRINT"Your response is incorrect. The correct answer is"
589# PRINT"145."
590# GOTO 6010
591# LOCATE 23,58: PRINT"Press the enter key."
592# AS=INKEY$: IF AS="" GOTO 6020
```

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
This concludes the discussion on deviation IQs. The next screen will give a comparative listing of the typical standard scores for a normal population. The mean for each scale is printed in light red. The standard deviation for each scale can be obtained by subtracting the mean from that number printed to the right of the mean.

The following acronyms will be used:

- **ORE** - Graduate Records Examination
- **SAT** - Scholastic Aptitude Test of the College Entrance Examination Board
- **ACT** - American College Testing Assessment

% of Cases 2.1 13.5 34.1 34.1 13.5 2.1

---|---|---|---|---|---|---|---

**z-Score Scale**

---|---|---|---|---|---|---|---

**T-Score Scale**

---|---|---|---|---|---|---|---

**GRE, SAT Scale**

---|---|---|---|---|---|---|---

**ACT Scale**

---|---|---|---|---|---|---|---

**Wechsler Scale**

---|---|---|---|---|---|---|---

**Stanford-Binet Scale**

---|---|---|---|---|---|---|---

Wechsler

---|---|---|---|---|---|---|---

**Stanford-Binet Scale**

---|---|---|---|---|---|---|---
242

242 NT-109" COLOR 15,1,6
6520 LOCATE 23,58: PRINT"Press the enter key."
6530 AS = INKEYS: IF AS = "" GOTO 6530
6540 R7 = R71+R72+R73+R74+R75+R76+R77
6550 W7 = W71+W72+W73+W74+W75+W76+W77
6560 FIRST7 = R7+R7-R
6570 TIMES = "00:00:00"
6580 "Screen 24
6600 CLS: COLOR 15,1,6: LOCATE 1,32: PRINT"Unit 7: Screen 24"
6610 PRINT"
6620 LOCATE 7,1
6630 PRINT** This concludes our discussion of Unit 7: Standard"
6640 PRINT** Scores. You worked correctly*:FIRST7"exercise(s) out of 7."
6650 PRINT**
6660 PRINT** There are ten review problems for this unit. Would you "
6670 PRINT** like to work some review problems? Type y if yes or n if"
6680 PRINT**
6690 INPUT** no and press the enter key:";Q7S
6700 IF Q7S = "y" OR Q7S = "Y" OR Q7S = "n" OR Q7S = "N" GOTO 6730 ELSE LOCATE 1
5,1: PRINT"
6710 : LOCATE 15,1: GOTO 6710
6720 IF Q7S = "y" OR Q7S = "Y" GOTO 6740 ELSE 11280
6740 "Screen 25
6750 SCREEN 0,1: COLOR 15,1,6: CLS
6760 LOCATE 1,32: PRINT"Unit 7: Screen 25"
6770 LOCATE 5,1: K7=1
6780 PRINT** Problem 1. A standard-score scale has:
6790 PRINT** a. a fixed z-score and a fixed t-score.
6800 PRINT** b. a fixed raw-score and a fixed z-score.
6810 PRINT** c. a fixed mean and a fixed standard deviation.
6820 PRINT** d. a fixed mean only.
6830 PRINT** e. none of the above.
6840 PRINT** Type a, b, c, d, or e for your answer and press"
6850 PRINT** enter key.";Q7S
6860 IF J71 = 0 THEN C71S ■ Q7S
6870 IF J71 = 1 THEN D71S = Q7S
6880 IF Q7S = "a" OR Q7S = "A" OR Q7S = "b" OR Q7S = "B" OR Q7S = "c" OR Q7S = "C"
6890 IF Q7S = "d" OR Q7S = "D" OR Q7S = "e" OR Q7S = "E" THEN 7030 ELSE 6970
6900 LOCATE 17,1
6910 PRINT**
6920 INPUT**
6930 PRINT**
6940 IF J71 = 0 THEN C71S = Q7S
6950 IF J71 = 1 THEN D71S = Q7S
6960 IF Q7S = "a" OR Q7S = "A" OR Q7S = "b" OR Q7S = "B" OR Q7S = "c" OR Q7S = "C"
6970 IF Q7S = "d" OR Q7S = "D" OR Q7S = "e" OR Q7S = "E" THEN 7030 ELSE 6970
6980 LOCATE 17,1
6990 PRINT**
7000 PRINT**
7010 LOCATE 17,1
7020 GOTO 6980
7030 IF Q7S = "c" OR Q7S = "C" THEN 7040 ELSE 7070
7040 P71 = 1
7050 PRINT** Your response is correct."
7060 GOTO 1170
7070 IF J71 = 1 GOTO 7130
7080 PRINT**

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
Problem 2. The mean and standard deviation of the T-score system are:

a. 3 and 1, respectively.

b. 13 and 50, respectively.

c. 50 and 10, respectively.

d. 100 and 15, respectively.

Type a, b, c, or d for your answer and press the enter key.
7680 PRINT"
7690 PRINT"**
7700 PRINT" Problem 3. The mean and standard deviation of a normal "
7700 PRINT"
7710 PRINT" population are 85 and 6, respectively. What"
7710 PRINT"
7720 PRINT" is the T-score for the raw-score of 76?"
7720 PRINT"
7730 PRINT" Typr your answer (e.g. 83) and press the"
7730 PRINT"
7740 PRINT" enter key.";Q7S
7750 PRINT**
7760 PRINT"
7770 IF J74=0 THEN C74S=Q7S
7770 PRINT"
7780 IF J74=1 THEN D74S=Q7S
7780 PRINT"
7790 IF Q7S="35" OR Q7S="35." OR Q7S= "35.0" THEN 7910 ELSE 7940
7790 PRINT"
7800 PRINT" Your response is correct."
7800 PRINT"
7810 PRINT"
7820 PRINT" Your response is incorrect. Press the enter key"
7820 PRINT"
7830 PRINT"
7840 PRINT"
7850 PRINT" for further explanation."
7850 PRINT"
7860 PRINT"
7870 PRINT"
7880 IF J73=0 THEN C73S=Q7S
7880 PRINT"
7890 IF J73=1 THEN D73S=Q7S
7890 PRINT"
7900 IF Q7S="35" OR Q7S="35." OR Q7S= "35.0" THEN 7910 ELSE 7940
7900 PRINT"
7910 PRINT" Your response is incorrect. The correct answer is"
7910 PRINT"
7920 PRINT" 35.";
7920 PRINT"
7930 LOCATE 23,58: PRINT"Press the enter key.";
7930 PRINT"
7940 LOCATE 23,58: PRINT"Press the enter key.";
7940 PRINT"
7950 AS=INKEY$: IF AS="" GOTO 7980
7950 PRINT"
7960 SCREEN 9,1: COLOR 15,1,6: CLS
7960 SCREEN 9,1: COLOR 15,1,6: CLS
7970 LOCATE 1,32: PRINT"Unit 7: Screen 28"
7970 LOCATE 1,32: PRINT"Unit 7: Screen 28"
7980 PRINT"
7990 PRINT" Problem 4. What percent of scores falls below the T-score"
7990 PRINT" of 63?"
8000 PRINT" Type in your answer (e.g. 32.23%) and press the"
8000 PRINT" enter key.";Q7S
8010 PRINT**
8020 PRINT" of 63?
8030 PRINT"
8040 PRINT" Type in your answer (e.g. 32.23%) and press the"
8040 PRINT" enter key.";Q7S
8050 PRINT**
8060 PRINT" of 63?”
8070 PRINT" Type in your answer (e.g. 32.23%) and press the"
8070 PRINT" enter key.”;Q7S
8080 PRINT**
8090 PRINT" of 63?”
8100 PRINT" Type in your answer (e.g. 32.23%) and press the"
8100 PRINT" enter key.”;Q7S
8110 PRINT**
8120 IF J74=0 THEN C74S=Q7S
8120 IF J74=1 THEN D74S=Q7S
8120 IF Q7S="90.324" OR Q7S="90.32" THEN 8210 ELSE 8260
8120 PRINT**
8130 PRINT" Your response is incorrect. The correct answer is"
8130 PRINT" Your response is incorrect. Press the enter key”
8140 PRINT**
8150 PRINT" Your response is incorrect. Press the enter key”
8150 PRINT" for further explanation.”
8160 PRINT**
8170 PRINT" Your response is incorrect. Press the enter key”
8170 PRINT" for further explanation.”
8180 PRINT**
8190 PRINT" Your response is incorrect. The correct answer is"
Problem 5. Which of the following reflect the poorest performance on a group of tests?

a. Test A: z-score = -1.50
b. Test B: a percentile rank of 10%
c. Test C: T-score = 10

Problem 5. Which of the following reflect the poorest performance on a group of tests?

a. Test A: z-score = -1.50
b. Test B: a percentile rank of 10%
c. Test C: T-score = 10

Problem 5. Which of the following reflect the poorest performance on a group of tests?

a. Test A: z-score = -1.50
b. Test B: a percentile rank of 10%
c. Test C: T-score = 10

d. Test D: Wechsler IQ score = 80

e. Test E: 1 standard deviation below the mean

Type a, b, c, d, or e for your answer and press the enter key.
Problem 6. Any score scale having a fixed mean and a fixed standard deviation is called?

a. a percentile rank scale
b. a t-score scale
c. a raw-score scale
d. a standard-score scale
e. none of the above

Type a, b, c, d, or e for your answer and press enter key.

Your response is correct.

Your response is incorrect. The correct answer is d.

Problem 7. The mean and standard deviation of the Wechsler scales are:

IQ scales are:
Type a, b, c, or d for your answer and press the enter key.

Your response is correct.

Your response is incorrect. The correct answer is d.
248

PRINT"Your response is incorrect. Press the enter key*
PRINT
AS-INKEYS: IF AS="" GOTO 10220
J=J+1: P=P+1: GOTO 2270
Q7S=1
PRINT"Your response is incorrect. The correct answer is"

10220 PRINT" 75."  
10230 PRINT"Press the enter key."  
10240 AS-INKEYS: IF AS="" GOTO 10290  
10250 PRINT"Your response is incorrect. Press the enter key"  
10260 AS-INKEYS: IF AS="" GOTO 10540  
10270 PRINT"Your response is incorrect. The correct answer is"

10290 GOTO 10290  
10300 GOSUB 7210
10310 IF Q7S = "y" OR Q7S = "Y" GOTO 10320 ELSE 11280
10320 'screen 33
10330 SCREEN 0,1: COLOR 15,1,6: CLS
10340 LOCATE 1,32: PRINT"Unit 7: Screen 33"
10350 LOCATE 5,1: K7=9
10360 PRINT"Problem 9. What percent of scores falls below the T-score"
10370 PRINT"of 42?"
10380 PRINT"Type in your answer (e.g. 32.23%) and press the"  
10390 PRINT"enter key.;Q7S
10400 INPUT";07S
10410 PRINT"Your response is correct."  
10420 GOTO 10680
10430 IF J79=0 THEN C79S=Q7S
10440 IF J79=1 THEN P79S=Q7S
10450 IF Q7S="21.19%" OR Q7S="21.19" THEN 10470 ELSE 10590
10460 P79=1
10470 PRINT"Your response is incorrect. Press the enter key"
10480 PRINT"Your response is incorrect. Press the enter key"
10490 PRINT"Your response is incorrect. Press the enter key"
10500 PRINT"Your response is incorrect. Press the enter key"
10510 PRINT"Your response is incorrect. Press the enter key"
10520 PRINT"Your response is incorrect. Press the enter key"
10530 PRINT"Your response is incorrect. Press the enter key"
10540 PRINT"Your response is incorrect. Press the enter key"
10550 PRINT"Your response is incorrect. Press the enter key"
10560 PRINT"Your response is incorrect. Press the enter key"
10570 PRINT"Your response is incorrect. Press the enter key"
10580 PRINT"21.19%.
10590 PRINT"21.19%.
10600 PRINT"21.19%.
10610 PRINT"21.19%.
10620 PRINT"21.19%.
10630 PRINT"21.19%.
10640 PRINT"21.19%.
10650 PRINT"21.19%.
10660 PRINT"21.19%.
10670 PRINT"21.19%.
10680 PRINT"Problem 10. Which of the following reflects the best"  
10690 PRINT"performance on a group of tests?
10700 PRINT"
10710 PRINT"a. Test A: z-score = +1.50"
10720 PRINT"
10730 PRINT"b. Test B: a percentile rank of 90"
10740 PRINT"
10750 PRINT"c. Test C: T-score = 64"
10760 PRINT"
10770 PRINT"d. Test D: Wechsler IQ score = 116"
10780 PRINT"
10790 PRINT"e. Test E: 1 standard deviation above th"
10800 PRINT"
10810 PRINT"
10820 PRINT"Type a, b, c, d, or e for your answer and press"
PRINT"the enter key.";Q7S
PRINT"PRINT"
IF J71€ 0 THEN C716S = Q7S
IF J71€ 1 THEN C716S = Q7S
IF Q7S = "a" OR Q7S = "A" OR Q7S = "b" OR Q7S = "B" OR Q7S = "C" OR Q7S = "D" OR Q7S = "D" OR Q7S = "E" OR Q7S = "E" THEN 10950 ELSE 10890
LOCATE 17,1
PRINT"PRINT" PRINT 10910 PRINT"PRINT" PRINT 10920 PRINT
LOCATE 17,1 GOTO 10820
IF Q7S = "a" OR Q7S = "A" THEN 10960 ELSE 10990
LOCATE 17,1 PRINT"PRINT" PRINT 1100 PRINT"PRINT" PRINT 11020 PRINT
GO TO 11090 IF J71€ 1: P€P1: GOTO 11120
LOCATE 17,1 PRINT"PRINT" PRINT 11090 PRINT"PRINT" PRINT 11090 PRINT
LOCATE 23,58: PRINT"Press the enter key." AS - INKEYS: IF AS - " " GOTO 11030
GOTO 11100 AS - INKEYS: IF AS - " " GOTO 11190
LOCATE 23,58: PRINT"Press the enter key." GOTO 11140
GOTO 11280 'screen 34a
CLS
LOCATE 1,32: PRINT"Unit 7: Screen 34a"
LOCATE 5,1 PRINT"One way to solve this problem is to convert each score to its percentile rank equivalent. For example,"
LOCATE 9,1 PRINT"the percentile rank of the T-score of 60 is 84.13."
LOCATE 13,1 PRINT"Then compare the percentile ranks to see which score"
LOCATE 17,1 PRINT"yield the largest percentile rank."
LOCATE 23,58: PRINT"Press the enter key." AS - INKEYS: IF AS - " " GOTO 11160
LOCATE 23,58: PRINT"Press the enter key." GOTO 11340
LOCATE 9,1 PRINT"The number of correct exercises is"; FIRST7
LOCATE 9,1 PRINT"The number of incorrect exercises is"; 7-FIRST7
LOCATE 9,1 PRINT"The number of correct exercises after remediation i
11430 PRINT"
11440 PRINT"
11450 PRINT"
11460 PRINT"
11470 PRINT"
11480 PRINT"
11490 PRINT"
11500 LPRINT"
11510 LPRINT"
11520 LPRINT"
11530 LPRINT"
11540 LPRINT"
11550 LPRINT"
11560 LPRINT"
11570 LPRINT"
11580 LPRINT"

The number of correct problems is"; SEC7
The number of incorrect problems is"; K7-SEC7
The number of correct problems after remediation is

Unit 7: Standard Scores
"NAMS,NOS,T7S
The number of correct exercises is";FIRST7
The number of incorrect exercises is"; 7-FIRST7"
The number of correct exercises after remediation is";R-W7
IF K7=0 GOTO 11660
11660 LPRINT"
11670 IF 171=1 GOTO 11700
11680 LPRINT: Exercise 1 response was correct.";A71S:GOTO 11700
11690 LPRINT: Exercise 1 response was incorrect.";A71S,B71S
11700 LPRINT**
11710 LPRINT**
11720 LPRINT** IF I72=1 GOTO 11750
11730 LPRINT: Exercise 2 response was correct.";A72S:GOTO 11750
11740 LPRINT"
11750 LPRINT: Exercise 2 response was incorrect.";A72S,B72S
11760 LPRINT**
11770 LPRINT** IF I73=1 GOTO 11800
11780 LPRINT: Exercise 3 response was correct.";A73S:GOTO 11800
11790 LPRINT"
11800 LPRINT: Exercise 3 response was incorrect.";A73S,B73S
11810 LPRINT**
11820 LPRINT** IF I74=1 GOTO 11850
11830 LPRINT: Exercise 4 response was correct.";A74S:GOTO 11850
11840 LPRINT"
11850 LPRINT: Exercise 4 response was incorrect.";A74S,B74S
11860 LPRINT**
11870 LPRINT** IF I75=1 GOTO 11900
11880 LPRINT: Exercise 5 response was correct.";A75S:GOTO 11900
11890 LPRINT"
11900 LPRINT: Exercise 5 response was incorrect.";A75S,B75S
11910 LPRINT**
11920 LPRINT** IF I76=1 GOTO 11950
11930 LPRINT: Exercise 6 response was correct.";A76S:GOTO 11950
11940 LPRINT"
11950 LPRINT: Exercise 6 response was incorrect.";A76S,B76S
11960 LPRINT**
11970 LPRINT** IF I77=1 GOTO 12000
11980 LPRINT: Exercise 7 response was correct.";A77S:GOTO 12000
11990 LPRINT"
12000 LPRINT: Exercise 7 response was incorrect.";A77S,B77S
12010 LPRINT**
12020 IF K7=1 GOTO 12620
12030 LPRINT** IF J71=1 GOTO 12960
12040 LPRINT: Problem 1 response was correct.";C71S:GOTO 12960
12050 LPRINT**
12060 LPRINT" Problem 1 response was incorrect." ,C71S,D71S
12070 LPRINT"
12080 IF K7<2 GOTO 12620
12090 LPRINT" Problem 2 response was correct." ,C72S; GOTO 12140
12100 LPRINT" Problem 2 response was incorrect." ,C72S,D72S
12110 LPRINT"
12120 LPRINT" Problem 3 response was correct." ,C73S; GOTO 12140
12130 LPRINT" Problem 3 response was incorrect." ,C73S,D73S
12140 LPRINT"
12150 LPRINT" Problem 4 response was correct." ,C74S; GOTO 12200
12160 LPRINT" Problem 4 response was incorrect." ,C74S,D74S
12170 LPRINT"
12180 LPRINT" Problem 5 response was correct." ,C75S; GOTO 12260
12190 LPRINT" Problem 5 response was incorrect." ,C75S,D75S
12200 LPRINT"
12210 LPRINT" Problem 6 response was correct." ,C76S; GOTO 12320
12220 LPRINT" Problem 6 response was incorrect." ,C76S,D76S
12230 LPRINT"
12240 LPRINT" Problem 7 response was correct." ,C77S; GOTO 12380
12250 LPRINT" Problem 7 response was incorrect." ,C77S,D77S
12260 LPRINT"
12270 LPRINT" Problem 8 response was correct." ,C78S; GOTO 12440
12280 LPRINT" Problem 8 response was incorrect." ,C78S,D78S
12290 LPRINT"
12300 LPRINT" Problem 9 response was correct." ,C79S; GOTO 12500
12310 LPRINT" Problem 9 response was incorrect." ,C79S,D79S
12320 LPRINT"
12330 LPRINT" Problem 10 response was correct." ,C710S; GOTO 12560
12340 LPRINT" Problem 10 response was incorrect." ,C710S,D710S
12350 LPRINT"
12360 LPRINT"
12370 LPRINT"
12380 LPRINT"
12390 LPRINT"
12400 LPRINT"
12410 LPRINT"
12420 LPRINT"
12430 LPRINT"
12440 LPRINT"
12450 LPRINT"
12460 LPRINT"
12470 LPRINT"
12480 LPRINT"
12490 LPRINT"
12500 LPRINT"
12510 LPRINT"
12520 LPRINT"
12530 LPRINT"
12540 LPRINT"
12550 LPRINT"
12560 LPRINT"
12570 LPRINT"
12580 LPRINT"
12590 LPRINT"
12600 LPRINT"
12610 CLS
12620 LOCATE 4,1
12630 PRINT" This is the end of this lesson. Thank you for your participation and have a nice day."
### Areas and Ordinates of the Unit Normal Distribution

**Table B: Areas and Ordinates of the Unit Normal Distribution**

<table>
<thead>
<tr>
<th>z</th>
<th>Area Below</th>
<th>Area Above</th>
<th>Ordinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2.00</td>
<td>.0015</td>
<td>.9985</td>
<td>.0044</td>
</tr>
<tr>
<td>-1.99</td>
<td>.0014</td>
<td>.9986</td>
<td>.0046</td>
</tr>
<tr>
<td>-1.98</td>
<td>.0014</td>
<td>.9986</td>
<td>.0047</td>
</tr>
<tr>
<td>-1.97</td>
<td>.0013</td>
<td>.9987</td>
<td>.0048</td>
</tr>
<tr>
<td>-1.96</td>
<td>.0013</td>
<td>.9987</td>
<td>.0050</td>
</tr>
<tr>
<td>-1.95</td>
<td>.0013</td>
<td>.9988</td>
<td>.0051</td>
</tr>
<tr>
<td>-1.94</td>
<td>.0013</td>
<td>.9989</td>
<td>.0052</td>
</tr>
<tr>
<td>-1.93</td>
<td>.0013</td>
<td>.9991</td>
<td>.0052</td>
</tr>
<tr>
<td>-1.92</td>
<td>.0013</td>
<td>.9992</td>
<td>.0053</td>
</tr>
<tr>
<td>-1.91</td>
<td>.0013</td>
<td>.9993</td>
<td>.0053</td>
</tr>
<tr>
<td>-1.90</td>
<td>.0013</td>
<td>.9994</td>
<td>.0054</td>
</tr>
<tr>
<td>-1.89</td>
<td>.0013</td>
<td>.9995</td>
<td>.0055</td>
</tr>
<tr>
<td>-1.88</td>
<td>.0013</td>
<td>.9996</td>
<td>.0056</td>
</tr>
<tr>
<td>-1.87</td>
<td>.0013</td>
<td>.9997</td>
<td>.0057</td>
</tr>
<tr>
<td>-1.86</td>
<td>.0013</td>
<td>.9998</td>
<td>.0057</td>
</tr>
<tr>
<td>-1.85</td>
<td>.0013</td>
<td>.9999</td>
<td>.0058</td>
</tr>
<tr>
<td>-1.84</td>
<td>.0013</td>
<td>.9999</td>
<td>.0058</td>
</tr>
<tr>
<td>-1.83</td>
<td>.0013</td>
<td>.9999</td>
<td>.0059</td>
</tr>
<tr>
<td>-1.82</td>
<td>.0013</td>
<td>.9999</td>
<td>.0059</td>
</tr>
<tr>
<td>-1.81</td>
<td>.0013</td>
<td>.9999</td>
<td>.0060</td>
</tr>
<tr>
<td>-1.80</td>
<td>.0013</td>
<td>.9999</td>
<td>.0060</td>
</tr>
<tr>
<td>-1.79</td>
<td>.0013</td>
<td>.9999</td>
<td>.0061</td>
</tr>
<tr>
<td>-1.78</td>
<td>.0013</td>
<td>.9999</td>
<td>.0062</td>
</tr>
<tr>
<td>-1.77</td>
<td>.0013</td>
<td>.9999</td>
<td>.0063</td>
</tr>
<tr>
<td>-1.76</td>
<td>.0013</td>
<td>.9999</td>
<td>.0064</td>
</tr>
<tr>
<td>-1.75</td>
<td>.0014</td>
<td>.9999</td>
<td>.0065</td>
</tr>
<tr>
<td>-1.74</td>
<td>.0015</td>
<td>.9999</td>
<td>.0066</td>
</tr>
<tr>
<td>-1.73</td>
<td>.0016</td>
<td>.9999</td>
<td>.0067</td>
</tr>
<tr>
<td>-1.72</td>
<td>.0017</td>
<td>.9999</td>
<td>.0068</td>
</tr>
<tr>
<td>-1.71</td>
<td>.0018</td>
<td>.9999</td>
<td>.0069</td>
</tr>
<tr>
<td>-1.70</td>
<td>.0019</td>
<td>.9999</td>
<td>.0070</td>
</tr>
<tr>
<td>-1.69</td>
<td>.0020</td>
<td>.9999</td>
<td>.0071</td>
</tr>
<tr>
<td>-1.68</td>
<td>.0021</td>
<td>.9999</td>
<td>.0072</td>
</tr>
<tr>
<td>-1.67</td>
<td>.0022</td>
<td>.9999</td>
<td>.0073</td>
</tr>
<tr>
<td>-1.66</td>
<td>.0023</td>
<td>.9999</td>
<td>.0074</td>
</tr>
<tr>
<td>-1.65</td>
<td>.0024</td>
<td>.9999</td>
<td>.0075</td>
</tr>
<tr>
<td>-1.64</td>
<td>.0025</td>
<td>.9999</td>
<td>.0076</td>
</tr>
<tr>
<td>-1.63</td>
<td>.0026</td>
<td>.9999</td>
<td>.0077</td>
</tr>
<tr>
<td>-1.62</td>
<td>.0027</td>
<td>.9999</td>
<td>.0078</td>
</tr>
<tr>
<td>-1.61</td>
<td>.0028</td>
<td>.9999</td>
<td>.0079</td>
</tr>
<tr>
<td>-1.60</td>
<td>.0029</td>
<td>.9999</td>
<td>.0080</td>
</tr>
<tr>
<td>-1.59</td>
<td>.0030</td>
<td>.9999</td>
<td>.0081</td>
</tr>
<tr>
<td>-1.58</td>
<td>.0031</td>
<td>.9999</td>
<td>.0082</td>
</tr>
<tr>
<td>-1.57</td>
<td>.0032</td>
<td>.9999</td>
<td>.0083</td>
</tr>
<tr>
<td>-1.56</td>
<td>.0033</td>
<td>.9999</td>
<td>.0084</td>
</tr>
<tr>
<td>-1.55</td>
<td>.0034</td>
<td>.9999</td>
<td>.0085</td>
</tr>
<tr>
<td>-1.54</td>
<td>.0035</td>
<td>.9999</td>
<td>.0086</td>
</tr>
<tr>
<td>-1.53</td>
<td>.0036</td>
<td>.9999</td>
<td>.0087</td>
</tr>
<tr>
<td>-1.52</td>
<td>.0037</td>
<td>.9999</td>
<td>.0088</td>
</tr>
<tr>
<td>-1.51</td>
<td>.0038</td>
<td>.9999</td>
<td>.0089</td>
</tr>
<tr>
<td>-1.50</td>
<td>.0039</td>
<td>.9999</td>
<td>.0090</td>
</tr>
</tbody>
</table>

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
<table>
<thead>
<tr>
<th>z</th>
<th>Area Below</th>
<th>Area Above</th>
<th>Ordinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1.99</td>
<td>0.1611</td>
<td>0.5189</td>
<td>0.8444</td>
</tr>
<tr>
<td>-1.98</td>
<td>0.1623</td>
<td>0.5195</td>
<td>0.8449</td>
</tr>
<tr>
<td>-1.97</td>
<td>0.1635</td>
<td>0.5201</td>
<td>0.8454</td>
</tr>
<tr>
<td>-1.96</td>
<td>0.1646</td>
<td>0.5207</td>
<td>0.8459</td>
</tr>
<tr>
<td>-1.95</td>
<td>0.1657</td>
<td>0.5213</td>
<td>0.8464</td>
</tr>
<tr>
<td>-1.94</td>
<td>0.1668</td>
<td>0.5219</td>
<td>0.8469</td>
</tr>
<tr>
<td>-1.93</td>
<td>0.1679</td>
<td>0.5225</td>
<td>0.8474</td>
</tr>
<tr>
<td>-1.92</td>
<td>0.1690</td>
<td>0.5231</td>
<td>0.8479</td>
</tr>
<tr>
<td>-1.91</td>
<td>0.1701</td>
<td>0.5237</td>
<td>0.8484</td>
</tr>
<tr>
<td>-1.90</td>
<td>0.1712</td>
<td>0.5243</td>
<td>0.8489</td>
</tr>
<tr>
<td>-1.89</td>
<td>0.1723</td>
<td>0.5249</td>
<td>0.8494</td>
</tr>
<tr>
<td>-1.88</td>
<td>0.1734</td>
<td>0.5255</td>
<td>0.8499</td>
</tr>
<tr>
<td>-1.87</td>
<td>0.1745</td>
<td>0.5261</td>
<td>0.8504</td>
</tr>
<tr>
<td>-1.86</td>
<td>0.1756</td>
<td>0.5267</td>
<td>0.8509</td>
</tr>
<tr>
<td>-1.85</td>
<td>0.1767</td>
<td>0.5273</td>
<td>0.8514</td>
</tr>
<tr>
<td>-1.84</td>
<td>0.1778</td>
<td>0.5279</td>
<td>0.8519</td>
</tr>
<tr>
<td>-1.83</td>
<td>0.1789</td>
<td>0.5285</td>
<td>0.8524</td>
</tr>
<tr>
<td>-1.82</td>
<td>0.1799</td>
<td>0.5291</td>
<td>0.8529</td>
</tr>
<tr>
<td>-1.81</td>
<td>0.1811</td>
<td>0.5297</td>
<td>0.8534</td>
</tr>
<tr>
<td>-1.80</td>
<td>0.1822</td>
<td>0.5303</td>
<td>0.8539</td>
</tr>
<tr>
<td>-1.79</td>
<td>0.1833</td>
<td>0.5309</td>
<td>0.8544</td>
</tr>
<tr>
<td>-1.78</td>
<td>0.1844</td>
<td>0.5315</td>
<td>0.8549</td>
</tr>
<tr>
<td>-1.77</td>
<td>0.1855</td>
<td>0.5321</td>
<td>0.8554</td>
</tr>
<tr>
<td>-1.76</td>
<td>0.1867</td>
<td>0.5327</td>
<td>0.8559</td>
</tr>
<tr>
<td>-1.75</td>
<td>0.1878</td>
<td>0.5333</td>
<td>0.8564</td>
</tr>
<tr>
<td>-1.74</td>
<td>0.1890</td>
<td>0.5339</td>
<td>0.8569</td>
</tr>
<tr>
<td>-1.73</td>
<td>0.1902</td>
<td>0.5345</td>
<td>0.8574</td>
</tr>
<tr>
<td>-1.72</td>
<td>0.1914</td>
<td>0.5351</td>
<td>0.8579</td>
</tr>
<tr>
<td>-1.71</td>
<td>0.1926</td>
<td>0.5357</td>
<td>0.8584</td>
</tr>
<tr>
<td>-1.70</td>
<td>0.1938</td>
<td>0.5363</td>
<td>0.8588</td>
</tr>
<tr>
<td>-1.69</td>
<td>0.1951</td>
<td>0.5369</td>
<td>0.8593</td>
</tr>
<tr>
<td>-1.68</td>
<td>0.1963</td>
<td>0.5375</td>
<td>0.8598</td>
</tr>
<tr>
<td>-1.67</td>
<td>0.1976</td>
<td>0.5381</td>
<td>0.8603</td>
</tr>
<tr>
<td>-1.66</td>
<td>0.1989</td>
<td>0.5387</td>
<td>0.8608</td>
</tr>
<tr>
<td>-1.65</td>
<td>0.2002</td>
<td>0.5393</td>
<td>0.8613</td>
</tr>
<tr>
<td>-1.64</td>
<td>0.2015</td>
<td>0.5399</td>
<td>0.8618</td>
</tr>
<tr>
<td>-1.63</td>
<td>0.2028</td>
<td>0.5405</td>
<td>0.8623</td>
</tr>
<tr>
<td>-1.62</td>
<td>0.2041</td>
<td>0.5411</td>
<td>0.8628</td>
</tr>
<tr>
<td>-1.61</td>
<td>0.2054</td>
<td>0.5417</td>
<td>0.8633</td>
</tr>
<tr>
<td>-1.60</td>
<td>0.2067</td>
<td>0.5423</td>
<td>0.8638</td>
</tr>
<tr>
<td>-1.59</td>
<td>0.2081</td>
<td>0.5429</td>
<td>0.8643</td>
</tr>
<tr>
<td>-1.58</td>
<td>0.2094</td>
<td>0.5435</td>
<td>0.8648</td>
</tr>
<tr>
<td>-1.57</td>
<td>0.2108</td>
<td>0.5441</td>
<td>0.8653</td>
</tr>
<tr>
<td>-1.56</td>
<td>0.2122</td>
<td>0.5447</td>
<td>0.8658</td>
</tr>
<tr>
<td>-1.55</td>
<td>0.2136</td>
<td>0.5453</td>
<td>0.8663</td>
</tr>
<tr>
<td>-1.54</td>
<td>0.2150</td>
<td>0.5459</td>
<td>0.8668</td>
</tr>
<tr>
<td>-1.53</td>
<td>0.2164</td>
<td>0.5465</td>
<td>0.8673</td>
</tr>
<tr>
<td>-1.52</td>
<td>0.2178</td>
<td>0.5471</td>
<td>0.8678</td>
</tr>
<tr>
<td>-1.51</td>
<td>0.2192</td>
<td>0.5477</td>
<td>0.8683</td>
</tr>
<tr>
<td>-1.50</td>
<td>0.2207</td>
<td>0.5483</td>
<td>0.8688</td>
</tr>
</tbody>
</table>

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
<table>
<thead>
<tr>
<th></th>
<th>Area Below</th>
<th>Area Above</th>
<th>Ordinate</th>
<th></th>
<th>Area Below</th>
<th>Area Above</th>
<th>Ordinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>0.0108</td>
<td>0.0162</td>
<td>0.0262</td>
<td>0.05</td>
<td>0.3892</td>
<td>0.3885</td>
<td>0.3221</td>
</tr>
<tr>
<td>0.01</td>
<td>0.0432</td>
<td>0.0465</td>
<td>0.0557</td>
<td>0.05</td>
<td>0.3452</td>
<td>0.3450</td>
<td>0.3183</td>
</tr>
<tr>
<td>0.02</td>
<td>0.0850</td>
<td>0.0883</td>
<td>0.0972</td>
<td>0.05</td>
<td>0.3135</td>
<td>0.3133</td>
<td>0.3058</td>
</tr>
<tr>
<td>0.03</td>
<td>0.1270</td>
<td>0.1303</td>
<td>0.1372</td>
<td>0.05</td>
<td>0.2829</td>
<td>0.2827</td>
<td>0.2786</td>
</tr>
<tr>
<td>0.04</td>
<td>0.1690</td>
<td>0.1723</td>
<td>0.1742</td>
<td>0.05</td>
<td>0.2545</td>
<td>0.2543</td>
<td>0.2478</td>
</tr>
<tr>
<td>0.05</td>
<td>0.2110</td>
<td>0.2143</td>
<td>0.2222</td>
<td>0.05</td>
<td>0.2279</td>
<td>0.2277</td>
<td>0.2245</td>
</tr>
<tr>
<td>0.06</td>
<td>0.2530</td>
<td>0.2563</td>
<td>0.2622</td>
<td>0.05</td>
<td>0.2024</td>
<td>0.2022</td>
<td>0.1975</td>
</tr>
<tr>
<td>0.07</td>
<td>0.2950</td>
<td>0.2983</td>
<td>0.3032</td>
<td>0.05</td>
<td>0.1779</td>
<td>0.1777</td>
<td>0.1724</td>
</tr>
<tr>
<td>0.08</td>
<td>0.3370</td>
<td>0.3403</td>
<td>0.3442</td>
<td>0.05</td>
<td>0.1543</td>
<td>0.1541</td>
<td>0.1483</td>
</tr>
<tr>
<td>0.09</td>
<td>0.3790</td>
<td>0.3823</td>
<td>0.3853</td>
<td>0.05</td>
<td>0.1328</td>
<td>0.1326</td>
<td>0.1261</td>
</tr>
<tr>
<td>0.10</td>
<td>0.4210</td>
<td>0.4243</td>
<td>0.4272</td>
<td>0.05</td>
<td>0.1123</td>
<td>0.1121</td>
<td>0.1059</td>
</tr>
<tr>
<td>0.11</td>
<td>0.4630</td>
<td>0.4663</td>
<td>0.4682</td>
<td>0.05</td>
<td>0.0938</td>
<td>0.0936</td>
<td>0.0874</td>
</tr>
<tr>
<td>0.12</td>
<td>0.5050</td>
<td>0.5083</td>
<td>0.5102</td>
<td>0.05</td>
<td>0.0772</td>
<td>0.0770</td>
<td>0.0708</td>
</tr>
<tr>
<td>0.13</td>
<td>0.5470</td>
<td>0.5503</td>
<td>0.5522</td>
<td>0.05</td>
<td>0.0626</td>
<td>0.0624</td>
<td>0.0562</td>
</tr>
<tr>
<td>0.14</td>
<td>0.5890</td>
<td>0.5923</td>
<td>0.5942</td>
<td>0.05</td>
<td>0.0499</td>
<td>0.0497</td>
<td>0.0437</td>
</tr>
<tr>
<td>0.15</td>
<td>0.6310</td>
<td>0.6343</td>
<td>0.6362</td>
<td>0.05</td>
<td>0.0389</td>
<td>0.0387</td>
<td>0.0327</td>
</tr>
<tr>
<td>0.16</td>
<td>0.6730</td>
<td>0.6763</td>
<td>0.6782</td>
<td>0.05</td>
<td>0.0294</td>
<td>0.0292</td>
<td>0.0233</td>
</tr>
<tr>
<td>0.17</td>
<td>0.7150</td>
<td>0.7183</td>
<td>0.7202</td>
<td>0.05</td>
<td>0.0214</td>
<td>0.0212</td>
<td>0.0153</td>
</tr>
<tr>
<td>0.18</td>
<td>0.7570</td>
<td>0.7603</td>
<td>0.7622</td>
<td>0.05</td>
<td>0.0144</td>
<td>0.0142</td>
<td>0.0084</td>
</tr>
<tr>
<td>0.19</td>
<td>0.8010</td>
<td>0.8043</td>
<td>0.8062</td>
<td>0.05</td>
<td>0.0084</td>
<td>0.0082</td>
<td>0.0024</td>
</tr>
<tr>
<td>0.20</td>
<td>0.8450</td>
<td>0.8483</td>
<td>0.8502</td>
<td>0.05</td>
<td>0.0034</td>
<td>0.0032</td>
<td>0.0004</td>
</tr>
<tr>
<td>0.21</td>
<td>0.8890</td>
<td>0.8923</td>
<td>0.8942</td>
<td>0.05</td>
<td>0.0004</td>
<td>0.0002</td>
<td>0.0000</td>
</tr>
<tr>
<td>0.22</td>
<td>0.9330</td>
<td>0.9363</td>
<td>0.9382</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.23</td>
<td>0.9770</td>
<td>0.9803</td>
<td>0.9822</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.24</td>
<td>1.0210</td>
<td>1.0243</td>
<td>1.0262</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.25</td>
<td>1.0650</td>
<td>1.0683</td>
<td>1.0702</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.26</td>
<td>1.1090</td>
<td>1.1123</td>
<td>1.1142</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.27</td>
<td>1.1530</td>
<td>1.1563</td>
<td>1.1582</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.28</td>
<td>1.1970</td>
<td>1.2003</td>
<td>1.2022</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.29</td>
<td>1.2410</td>
<td>1.2443</td>
<td>1.2462</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.30</td>
<td>1.2850</td>
<td>1.2883</td>
<td>1.2902</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.31</td>
<td>1.3290</td>
<td>1.3323</td>
<td>1.3342</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.32</td>
<td>1.3730</td>
<td>1.3763</td>
<td>1.3782</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.33</td>
<td>1.4170</td>
<td>1.4203</td>
<td>1.4222</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.34</td>
<td>1.4610</td>
<td>1.4643</td>
<td>1.4662</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.35</td>
<td>1.5050</td>
<td>1.5083</td>
<td>1.5102</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.36</td>
<td>1.5490</td>
<td>1.5523</td>
<td>1.5542</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.37</td>
<td>1.5930</td>
<td>1.5963</td>
<td>1.5982</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.38</td>
<td>1.6370</td>
<td>1.6403</td>
<td>1.6422</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.39</td>
<td>1.6810</td>
<td>1.6843</td>
<td>1.6862</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.40</td>
<td>1.7250</td>
<td>1.7283</td>
<td>1.7302</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.41</td>
<td>1.7690</td>
<td>1.7723</td>
<td>1.7742</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.42</td>
<td>1.8130</td>
<td>1.8163</td>
<td>1.8182</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.43</td>
<td>1.8570</td>
<td>1.8603</td>
<td>1.8622</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.44</td>
<td>1.9010</td>
<td>1.9043</td>
<td>1.9062</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.45</td>
<td>1.9450</td>
<td>1.9483</td>
<td>1.9502</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.46</td>
<td>1.9890</td>
<td>1.9923</td>
<td>1.9942</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.47</td>
<td>2.0330</td>
<td>2.0363</td>
<td>2.0382</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.48</td>
<td>2.0770</td>
<td>2.0803</td>
<td>2.0822</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.49</td>
<td>2.1210</td>
<td>2.1243</td>
<td>2.1262</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$x$</td>
<td>Area Below</td>
<td>Area Above</td>
<td>Ordinate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-----</td>
<td>------------</td>
<td>------------</td>
<td>----------</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.00</td>
<td>0.2513</td>
<td>0.7487</td>
<td>0.2420</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.10</td>
<td>0.2720</td>
<td>0.7280</td>
<td>0.2272</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.20</td>
<td>0.2939</td>
<td>0.7061</td>
<td>0.2127</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.30</td>
<td>0.3162</td>
<td>0.6838</td>
<td>0.1982</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.40</td>
<td>0.3388</td>
<td>0.6602</td>
<td>0.1837</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.50</td>
<td>0.3618</td>
<td>0.6358</td>
<td>0.1692</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.60</td>
<td>0.3849</td>
<td>0.6101</td>
<td>0.1547</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.70</td>
<td>0.4083</td>
<td>0.5837</td>
<td>0.1403</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.80</td>
<td>0.4319</td>
<td>0.5565</td>
<td>0.1259</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.90</td>
<td>0.4557</td>
<td>0.5283</td>
<td>0.1114</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.00</td>
<td>0.4807</td>
<td>0.4993</td>
<td>0.0970</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.10</td>
<td>0.5060</td>
<td>0.4693</td>
<td>0.0826</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.20</td>
<td>0.5316</td>
<td>0.4384</td>
<td>0.0682</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.30</td>
<td>0.5574</td>
<td>0.4066</td>
<td>0.0538</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.40</td>
<td>0.5834</td>
<td>0.3740</td>
<td>0.0394</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.50</td>
<td>0.6096</td>
<td>0.3406</td>
<td>0.0250</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.60</td>
<td>0.6359</td>
<td>0.3063</td>
<td>0.0106</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.70</td>
<td>0.6624</td>
<td>0.2712</td>
<td>0.0062</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.80</td>
<td>0.6892</td>
<td>0.2352</td>
<td>0.0018</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.90</td>
<td>0.7163</td>
<td>0.1984</td>
<td>0.0004</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.00</td>
<td>0.7437</td>
<td>0.1610</td>
<td>0.0000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
<table>
<thead>
<tr>
<th>z</th>
<th>Area Below</th>
<th>Area Above</th>
<th>Ordinate</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.777</td>
<td>0.0540</td>
<td></td>
</tr>
<tr>
<td>0.01</td>
<td>0.779</td>
<td>0.0539</td>
<td>0.0092</td>
</tr>
<tr>
<td>0.02</td>
<td>0.782</td>
<td>0.0539</td>
<td>0.0167</td>
</tr>
<tr>
<td>0.03</td>
<td>0.786</td>
<td>0.0538</td>
<td>0.0156</td>
</tr>
<tr>
<td>0.04</td>
<td>0.790</td>
<td>0.0538</td>
<td>0.0153</td>
</tr>
<tr>
<td>0.05</td>
<td>0.795</td>
<td>0.0540</td>
<td>0.0171</td>
</tr>
<tr>
<td>0.06</td>
<td>0.801</td>
<td>0.0541</td>
<td>0.0182</td>
</tr>
<tr>
<td>0.07</td>
<td>0.807</td>
<td>0.0543</td>
<td>0.0187</td>
</tr>
<tr>
<td>0.08</td>
<td>0.814</td>
<td>0.0546</td>
<td>0.0195</td>
</tr>
<tr>
<td>0.09</td>
<td>0.821</td>
<td>0.0549</td>
<td>0.0205</td>
</tr>
<tr>
<td>0.1</td>
<td>0.829</td>
<td>0.0549</td>
<td>0.0214</td>
</tr>
<tr>
<td>0.11</td>
<td>0.837</td>
<td>0.0550</td>
<td>0.0224</td>
</tr>
<tr>
<td>0.12</td>
<td>0.846</td>
<td>0.0552</td>
<td>0.0234</td>
</tr>
<tr>
<td>0.13</td>
<td>0.855</td>
<td>0.0555</td>
<td>0.0244</td>
</tr>
<tr>
<td>0.14</td>
<td>0.865</td>
<td>0.0558</td>
<td>0.0254</td>
</tr>
<tr>
<td>0.15</td>
<td>0.876</td>
<td>0.0561</td>
<td>0.0264</td>
</tr>
<tr>
<td>0.16</td>
<td>0.887</td>
<td>0.0564</td>
<td>0.0274</td>
</tr>
<tr>
<td>0.17</td>
<td>0.900</td>
<td>0.0567</td>
<td>0.0284</td>
</tr>
<tr>
<td>0.18</td>
<td>0.914</td>
<td>0.0571</td>
<td>0.0294</td>
</tr>
<tr>
<td>0.19</td>
<td>0.929</td>
<td>0.0575</td>
<td>0.0304</td>
</tr>
<tr>
<td>0.2</td>
<td>0.945</td>
<td>0.0580</td>
<td>0.0314</td>
</tr>
<tr>
<td>0.21</td>
<td>0.962</td>
<td>0.0586</td>
<td>0.0324</td>
</tr>
<tr>
<td>0.22</td>
<td>0.980</td>
<td>0.0593</td>
<td>0.0334</td>
</tr>
<tr>
<td>0.23</td>
<td>0.999</td>
<td>0.0601</td>
<td>0.0344</td>
</tr>
<tr>
<td>0.24</td>
<td>1.019</td>
<td>0.0611</td>
<td>0.0354</td>
</tr>
<tr>
<td>0.25</td>
<td>1.040</td>
<td>0.0621</td>
<td>0.0364</td>
</tr>
<tr>
<td>0.26</td>
<td>1.064</td>
<td>0.0633</td>
<td>0.0374</td>
</tr>
<tr>
<td>0.27</td>
<td>1.090</td>
<td>0.0646</td>
<td>0.0384</td>
</tr>
<tr>
<td>0.28</td>
<td>1.118</td>
<td>0.0659</td>
<td>0.0394</td>
</tr>
<tr>
<td>0.29</td>
<td>1.149</td>
<td>0.0673</td>
<td>0.0404</td>
</tr>
<tr>
<td>0.3</td>
<td>1.182</td>
<td>0.0689</td>
<td>0.0414</td>
</tr>
<tr>
<td>0.31</td>
<td>1.216</td>
<td>0.0707</td>
<td>0.0424</td>
</tr>
<tr>
<td>0.32</td>
<td>1.252</td>
<td>0.0726</td>
<td>0.0434</td>
</tr>
<tr>
<td>0.33</td>
<td>1.289</td>
<td>0.0747</td>
<td>0.0444</td>
</tr>
<tr>
<td>0.34</td>
<td>1.328</td>
<td>0.0769</td>
<td>0.0454</td>
</tr>
<tr>
<td>0.35</td>
<td>1.368</td>
<td>0.0792</td>
<td>0.0464</td>
</tr>
<tr>
<td>0.36</td>
<td>1.410</td>
<td>0.0816</td>
<td>0.0474</td>
</tr>
<tr>
<td>0.37</td>
<td>1.453</td>
<td>0.0841</td>
<td>0.0484</td>
</tr>
<tr>
<td>0.38</td>
<td>1.498</td>
<td>0.0867</td>
<td>0.0494</td>
</tr>
<tr>
<td>0.39</td>
<td>1.545</td>
<td>0.0894</td>
<td>0.0504</td>
</tr>
<tr>
<td>0.4</td>
<td>1.594</td>
<td>0.0922</td>
<td>0.0514</td>
</tr>
<tr>
<td>0.41</td>
<td>1.646</td>
<td>0.0951</td>
<td>0.0524</td>
</tr>
<tr>
<td>0.42</td>
<td>1.699</td>
<td>0.0981</td>
<td>0.0534</td>
</tr>
<tr>
<td>0.43</td>
<td>1.754</td>
<td>0.1012</td>
<td>0.0544</td>
</tr>
<tr>
<td>0.44</td>
<td>1.811</td>
<td>0.1044</td>
<td>0.0554</td>
</tr>
<tr>
<td>0.45</td>
<td>1.870</td>
<td>0.1077</td>
<td>0.0564</td>
</tr>
<tr>
<td>0.46</td>
<td>1.932</td>
<td>0.1111</td>
<td>0.0574</td>
</tr>
<tr>
<td>0.47</td>
<td>1.997</td>
<td>0.1147</td>
<td>0.0584</td>
</tr>
<tr>
<td>0.48</td>
<td>2.065</td>
<td>0.1185</td>
<td>0.0594</td>
</tr>
<tr>
<td>0.49</td>
<td>2.136</td>
<td>0.1224</td>
<td>0.0604</td>
</tr>
</tbody>
</table>

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
APPENDIX C

STUDENT EVALUATION FORM

Please use the following scale to respond to each item.

SA - Strongly Agree
A - Agree
N - Neither Agree nor Disagree
D - Disagree
SD - Strongly Disagree

Please circle the appropriate response for each question.

Objectives and Pretest
1. I understood the objectives of this lesson.
   a. SA   b. A   c. N   d. D   e. SD
2. The objectives helped me understand what I had to learn.
   a. SA   b. A   c. N   d. D   e. SD
3. The pretest helped me identify the parts of the lesson I already knew.
   a. SA   b. A   c. N   d. D   e. SD

Content
4. The content of this lesson was given in a logical order.
   a. SA   b. A   c. N   d. D   e. SD
5. The lesson was given at the right level of depth.
   a. SA   b. A   c. N   d. D   e. SD
6. There was enough information given in this lesson.
   a. SA   b. A   c. N   d. D   e. SD
7. The language used in this lesson was difficult to understand.
   a. SA   b. A   c. N   d. D   e. SD
8. The examples were helpful to understand the concepts.
   a. SA   b. A   c. N   d. D   e. SD
9. There were enough examples given.
   a. SA   b. A   c. N   d. D   e. SD
10. Directions for question response were clear.
    a. SA   b. A   c. N   d. D   e. SD
11. Information given in this lesson will probably be useful in the future.
    a. SA   b. A   c. N   d. D   e. SD

Questions during the lessons
12. The questions helped gauge whether I knew the concepts.
    a. SA   b. A   c. N   d. D   e. SD
13. There were enough questions.
    a. SA   b. A   c. N   d. D   e. SD
14. Explanations given after my responses helped me understand concepts.
    a. SA   b. A   c. N   d. D   e. SD
Posttest
15. The posttest questions asked different things than had been taught.
   a. SA  b. A  c. N  d. D  e. SD
16. Posttest questions were clearly worded.
   a. SA  b. A  c. N  d. D  e. SD
17. Posttest questions covered all the important points in the lesson.
   a. SA  b. A  c. N  d. D  e. SD
18. Posttest questions were generally fair.
   a. SA  b. A  c. N  d. D  e. SD

Technical
19. The screens were easy to read.
   a. SA  b. A  c. N  d. D  e. SD
20. There were too many words on the screens.
   a. SA  b. A  c. N  d. D  e. SD
21. The graphics reinforced the concepts.
   a. SA  b. A  c. N  d. D  e. SD
22. The colors were distracting.
   a. SA  b. A  c. N  d. D  e. SD

General
23. I generally liked studying this lesson.
   a. SA  b. A  c. N  d. D  e. SD
24. I generally found the terminal easy to use.
   a. SA   b. A   c. N   d. D   e. SD

25. The prerequisites were appropriate for this lesson.
   a. SA   b. A   c. N   d. D   e. SD

26. What did you like most about the lesson?

27. What did you dislike most about the lesson?

28. What parts were confusing?

29. What parts were boring?

30. Did you have any specific problems operating the terminal?

31. Write any additional comments about this lesson.
APPENDIX D

THE NORMAL DISTRIBUTION FAMILY AND STANDARD SCORES

POSTTEST

P. Dinkins

Name ______________________

Place the letter of the option that best answers each of the following in the blank space provided on the answer sheet.

1. Which of these is not a characteristic of a normal distribution?
   a. a bell-shaped graph
   b. one mode
   c. its median is never smaller than its mode
   d. graph is asymptotic to the horizontal axis
   e. its mean is sometimes smaller than its mode

2. One normal distribution A has a mean of 80 and a standard deviation of 14. A second normal distribution B has a mean of 80 and a standard deviation of 15. If the graphs of the two distributions are approximated by the same formula, then:
   a. curve A is flatter than curve B
   b. curve B is flatter than curve A
   c. curve A and curve B coincide
   d. the comparative shapes of the two curves cannot be determined from the information given

3. A normal distribution has a mean of 69 and a standard deviation of 8. The points of inflection of its graph occur at x = ?
   a. 8 and 69
   b. 8 and 77
   c. 61 and 69
   d. 61 and 77
   e. 69 and 77

4. The mean and standard deviation of the unit normal distribution are:
   a. 0 and -1, respectively
   b. 0 and 1, respectively
   c. 1 and 0, respectively
   d. 1 and -1, respectively
5. The height of the unit normal curve at \( z = -1.07 \) is?
   a. .1423
   b. .2251
   c. .8577
   d. 1.0000
   e. none of the above

6. If the ordinate on the unit normal curve equals .1919, then:
   a. \( z = -1.21 \)
   b. \( z = +1.21 \)
   c. \( z = +1.91 \)
   d. \( z = +1.92 \)
   e. a and b

7. A normal distribution of raw scores has a standard deviation of 8. If the raw-score of 63 in the normal distribution has a \( z \)-score of -1.50, what is the mean of the raw-scores?
   a. 51
   b. 55
   c. 71
   d. 75
   e. none of the above

8. A normal distribution has a mean of 94 and a standard deviation of 6. What is the corresponding raw-score if the \( z \)-score = -2.50?
   a. 78
   b. 85
   c. 94
   d. 109
   e. none of the above

9. The \( z \)-score provides information regarding how far a given raw-score is:
   a. from the mean in units of standard deviation
   b. from the mean in percentage units
   c. from the lowest score in percentile units
   d. from the highest score in standard deviation units
   e. from the standard deviation in units of mean
__10. Assume that IQ scores are normally distributed with mean = 100 and standard deviation = 15. Approximately, what percent of a tested population is expected to have an IQ score below 79?

a. 7.92%  
b. 8.08%  
c. 15.00%  
d. 21.00%  
e. 91.92%

__11. Assume that men's heights are normally distributed with mean = 68.5 in. and standard deviation of 2.6 in. Approximately, how many men in 1000 are expected to have a height of 71.1 in. or taller.

a. 159  
b. 161  
c. 711  
d. 841  
e. none of the above

__12. Which of these reflects the poorest performance on a test?

a. z-score = -1.01  
b. raw-score is 1 standard deviation below the mean  
c. a percentile rank of 11.51  
d. z-score = 0  
e. raw-score is 0.2 standard deviation above the mean

__13. What is the proportion of the area under the unit normal curve lying between z = -1.48 and z = -0.20?

a. 0.3429  
b. 0.3513  
c. 0.6487  
d. 1.2800  
e. none of the above

__14. Determine the percent of area under the unit normal curve lying below z = -0.11 and above z = 1.21.

a. 11.37%  
b. 43.07%  
c. 45.62%  
d. 56.93%  
e. 61.29%
15. The area under the unit normal curve lying between $z_1$ and $z_2$ is 0.1113. If $z_2$ is greater than $z_1$ and the area below $z_2$ equals 0.5517, then $z_1$ = ?

a. -0.15
b. -0.13
c. +0.13
d. +0.15
e. +0.44

16. A group of test scores are normally distributed with mean = 85 and standard deviation = 4. Approximately, what percent of the scores should lie between 81 and 91?

a. 10.00%
b. 15.87%
c. 22.55%
d. 77.45%
e. 93.32%

17. A group of observations are normally distributed with mean = 100 and standard deviation = 16. Approximately, what is the proportion of observations falling below 84 and above 108?

a. 0.1587
b. 0.3085
c. 0.4672
d. 0.5328
e. none of the above

18. Which of the following is not true?

a. The mean and standard deviation of the z-score system are 0 and 1, respectively
b. The mean and standard deviation of the T-score system are 50 and 10, respectively
c. The mean and standard deviation of the Wechsler Intelligence Scales are 100 and 20, respectively
d. The percentile rank of the Wechsler IQ score of 100 is 50

e. none of the above

19. Which of the following reflects the best performance on a test?

a. Test A: z-score = +0.50
b. Test B: T-score = 60
c. Test C: a percentile rank of 60
d. Test D: Wechsler IQ score = 110
20. A given raw-score has a z-score value of +1.40. What is the corresponding T-score of this raw-score?

a. 36
b. 46
c. 64
d. 74
e. none of the above
VITA

Preston Dinkins, son of Horace and Myrtis L. Dinkins, was born in Grand Cane, Louisiana on November 18, 1944. After graduating from DeSoto High School in 1962, he entered Southern University in Baton Rouge, Louisiana.

In 1966, he received a Bachelor of Science degree in the Department of Mathematics at Southern University, Baton Rouge campus. In 1968, he received a Master of Arts degree in the Department of Mathematics at the University of Oklahoma in Norman, Oklahoma. In 1968, he accepted a position as instructor of Mathematics at Southern University in Baton Rouge, Louisiana.

From 1969-71, he served as a commissioned officer in the U.S. Army Air Defense Artillery Corp, eventually obtaining the rank of captain. In 1971, he returned to Southern University in Baton Rouge, Louisiana as an Instructor of Mathematics.

In 1984, he received a Master of Science degree in the Department of Mathematics at Louisiana State University in Baton Rouge, Louisiana. Presently, he holds the position of Assistant Professor of Mathematics at Southern University in Baton Rouge, Louisiana.
Candidate: Preston Dinkins

Major Field: Educational Research

Title of Dissertation: Development of a Computer-Assisted Instruction Courseware Package in Statistics and a Comparative Analysis of Three Management Strategies for this Courseware

Approved:

[Signature]
Major Professor and Chairman

[Signature]
Dean of the Graduate School

EXAMINING COMMITTEE:

[Signature]
Kim Maciasga

[Signature]
V. K. Seidman

[Signature]
H. S. Butler

[Signature]
Edgar Barry Moore

[Signature]
Sam Adams

Date of Examination: 11/27/85