DOCUMENT RESUME

ED 274 890 CG 019 394

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TITLE	Ten Suggestions on Teaching Research to Counseling Students.
PUB DATE	Oct 86
NOTE	24p.; Paper presented at the Annual Meeting of the North Central Association for Counselor Education and Supervision (Kansas City, MO, October 1986).
PUB TYPE	Guides - Non-Classroom Use (055) -- Speeches/Conference Papers (150)
EDRS PRICE	MF01/PC01 Plus Postage.
DESCRIPTORS	*College Students; Counseling; *Counselor Training; Higher Education; *Microcomputers; *Research; *Statistics; *Teaching Methods

ABSTRACT

This paper presents 10 specific innovative ideas for teaching a basic research course to counseling students. Each idea is presented briefly and an illustrative example is provided in the appendices. The ideas presented include: (1) encouraging full-time counselor educators to teach the research courses; (2) making direct attempts to reduce student anxiety; (3) involving students in critiquing published research; (4) using the game of "MasterMind (tm)" to introduce hypothesis testing; (5) generating discussion examples that ask students to identify alternative hypothesis testing; (6) presenting basic statistical concepts while analyzing important measurement concepts; (7) creating a student-designed instrument to illustrate important measurement concepts; (8) decreasing social distance between students and statistics by teaching use of inexpensive microcomputer statistical software; (9) designing computer simulations and games to demonstrate research concepts; and (10) developing an electronic classroom facility. The basic equipment for an electronic classroom is described as a microcomputer station with appropriate software, a large screen projector, and student response keypads. Videocassette players/recorders, printers, and modems are listed as optional additional equipment. (NB)

Ten Suggestions on Teaching Research to Counseling Students

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Paper Presented at the
Annual Meeting of the
North Central Association for Counselor Education and Supervision
Kansas City, MO
October, 1986

Ten Suggestions for Teaching Research to Counseling Students

This paper has been prepared to present ten specific innovative ideas for teaching a basic research course to counseling students. Each idea is presented briefly and an illustrative example is provided in an appendix. The ideas presented include:

» encouraging full-time counselor educators to teach the research courses,

» making direct attempts to reduce student anxiety,

» involving students in critiquing published research,

» using "MasterMind [tm]" to introduce hypothesis testing,

» generating discussion examples that ask students to identify "alternative hypotheses,"

» presenting basic statistical concepts while analyzing data collected from the class,

» creating a student-designed instrument to illustrate important measurement concepts,

» decreasing social distance between students and statistics by teaching use of inexpensive microcomputer statistical software,

» designing computer simulations and games to demonstrate research concepts, and

» developing an electronic classroom facility.

Despite the brevity of each description, it is hoped that the "flavor" of each of the ten suggestions is conveyed in the abbreviated explanation presented. If further information or details are desired, the authors would be pleased to respond to requests.

<u>Suggestion #1: Encourage full-time counselor educators to teach the research courses to counseling students.</u>

All too often, counseling programs tend to "subcontract" the teaching of research and statistics classes to departments and programs other than counseling. We feel that there are a number of excellent reasons for counselor educators to teach these courses themselves.

» First of all, allocating valuable faculty time to include the teaching of research classes serves as a clear indicator that the counseling program views research as an important and necessary skill. When we ask students to take such courses in other departments, it appears to some students that research is secondary and tangential in importance.

» Secondly, the counseling faculty members who teach these classes will serve as highly visible models for students. Despite academic counseling training, these counselor educators will be demonstrating, through their research teaching, that counseling skills and the effective use of scientific methodology are <u>not</u> incompatible with one another.

» Counseling students, generally, tend to be very humanistic and gestalt-oriented in their views of other people and of the world in general. Research and statistics, on the other hand, tend to be very linear and very logical. If the teacher of the required research class is so linear as to be inflexible in accepting (understanding) the more "gestalty" notions of the counseling students, a restricted amount of learning may result. A counselor educator, with greater insight into the likely reactions of counseling students, may be better able to teach "linear research" with an emphasis on "big pictures" with lots of specific examples. Certainly, the counselor educator is much more likely to attend to the emotive issues involved in learning research and statistics. (In some cases, it may be more important that the student leaves research with a positive attitude than that the student knows every detail of research methodology and statistics.) The remaining nine teaching ideas represent methods to help present "big pictures with specific ideas" to counseling students.

<u>Suggestion #2: Make direct attempts to reduce the inevitable anxiety of the students on the first day of class.</u>

Counseling students often are afraid of the research and statistics classes that they must take during their graduate programs. For many, the research class is associated with mathematics, a topic of study with a very strong association with feelings of inadequacy and anxiety. If an individual student's anxiety is strong enough, very little learning can occur.

We believe that difficult topics, such as anxiety and fear, can be best controlled by addressing them directly. Thus, in the first class, we recommend one or two anxiety exercises. Below are descriptions of three such approaches:

» After normal class introductions (yes, even in a research class, it is appropriate to allow students to get to know one another), break students down into groups of three or four to talk about their expectations from the class. As they get into their groups, make it clear that the group should discuss each person's level of anxiety and how that influences expectations from the class. If each subgroup hands in a brief summary (anonymously), you can discuss some the types of students fear with the class as a whole.

» Make the assumption that nearly everyone in the class on the first day is anxious. Although you know this assumption is not entirely true, it will not be too poor a generalization for most groups of counselors. Let the students know that such anxiety is to be expected, and ask them to participate in a group relaxation exercise <u>before</u> you explain the specific requirements of the class. A simplified deep muscle relaxation exercise would serve to lessen temporarily some of the greatest discomfort.

» Ask all students in the class to write a sentence or two concerning what they feel most anxious about as they enter the class. Collect these papers and shuffle them completely. Return one, randomly-assigned paper to each student. Then, ask class members to volunteer to read the paper they have been given. As the papers are read, the class as a whole would be encouraged to brainstorm ideas on how the class and the instructor might work together to reduce the anxiety of the person who had initially written the note.

<u>Suggestion #3: Involve the students in critiquing published research articles to engage them in discriminating good from poor design.</u>

Many beginning counseling students skip over the "fine print" and attend only to the introduction, review of literature, and discussion sections in published research. The ability to be a systematic critic is necessary for intelligent consumption of published research. In addition, formal critquing is a <u>discrimination</u> task and is, therefore, an important prerequisite skill necessary for <u>production</u> of original research. Training literature emphasizes that performance is enhanced and anxiety is reduced when students are taught to discriminate between positive and negative exemplars of a concept as preparation for actual use of the skill.

Introduction to Critiquing. Class lectures and readings cover: (a) the statement of the problem and hypotheses, (b) evaluation of literature reviews, (c) variables and operational definitions, (d) internal and external validity, (e) appropriateness of conclusions, and (f) judgment of the relevance of counseling research. During the lectures, important concepts are defined and explained; examples from counseling research are presented; and a rationale for the importance of each concept is given. In addition, the students are also given in-class and homework practice activities to help them master the concepts.

Selection of Articles. Articles for student critiques are selected from recent empirically-based research journals counseling and psychology. Although greater generalizability could be obtained by randomly selecting articles, we recommend some screening of potential articles. To be considered for student critiques, an article must report the methodology and results for a single, straightforward, empirical study with counseling-related content. Reports of multiple studies, studies with convoluted methodologies, and studies using excessively complex statistical analysis are not considered. Once a set of appropriate articles has been identified, two are selected for student examination.

Evaluation of Student Performance. Prior to grading student critiques, you should prepare a model critique for the chosen articles. This model critique is then used as the basis for grading. In addition to specific comments about their own critiques, students receive a copy of the instructor's model critique for examination. To reward successive approximations, the second critique is weighted somewhat more heavily than is the first. A sample critique form is presented in Appendix A.

Suggestion #4: Use a classroom game based on the board game, "MasterMind [tm]" to introduce hypothesis testing.

Hypothesis testing is a difficult concept for many students. Although they may learn to say, "a hypothesis is a conjectural statement about the true state of nature which is testable by empirical methods," they frequently have no real feel for what that definition means. What is needed is a simple way of simulating research hypothesis testing in the classroom.

MasterMind [tm] is a simple game which pits the player (whose objective is to guess a secret code) against an opponent who holds the code and provides feedback. In a numerical adaptation of MasterMind [tm], developed by Dan Wheeler at the

University of Cincinnati, the "guesser" tries to identify a preselected four-digit number. After each guess, the "guesser" is given feedback on the number of correct digits in the guess and the number of digits that are also in the correct position. A sample game is presented in Appendix B.

Similarities Between MasterMind [tm] and Research. There are several important similarities in tasks when MasterMind [tm] and hypothesis testing are compared:

MasterMind [tm]	Research
(1) Make a guess	(1) Form a hypothesis
(2) Request feedback	(2) Run experiment
(3) Draw conclusions	(3) Draw conclusions
(4) Frame a new guess	(4) Modify hypothesis
(5) Recycle to (1)	(5) Recycle to (1)

The game of MasterMind [tm] and hypothesis testing in research share the following:

» Both have the same cyclic pattern of steps (one guess or one experiment is rarely enough);

» Both have specific methods for making the reasoning easier (changing one thing at a time is the easiest way to get information);

» Both have common pitfalls for the unwary;

» Both have similar levels of complexity (if one can understand how to play MasterMind [tm] then one can understand hypothesis testing).

We are indebted to Dr. Daniel Wheeler (University of Cincinnati) who developed the use of MasterMind [tm] to teach hypothesis testing for permission to include his work in this presentation.

Suggestion #5: Generate discussion examples that ask students to identify "alternative hypotheses."

One important technique in both critiquing and designing research is the generation of alternative hypotheses and explanations. Students can profit from specific practice in such divergent thinking. An illustrative example of a paper asking the student to generate potential alternative explanations for a possible counseling-like situation is presented in Appendix C. This illustration focuses on standard scores and their meaning. The discussion example included is typical of those we have used in class: it is interesting and somewhat humorous. As small groups of students meet during class to talk about possible explanations of the example, it is clear that students enjoy the discussions. Although some of the small groups are able to recognize the same "alternative hypothesis" as that identified by the instructor, they inevitably have been able to find several other possible explanations. They certainly have been encouraged to think creatively and analytically.

The text Rival Hypotheses: Alternative Interpretations of Data Based Conclusions by Huck and Sandler (Harper and Row, 1979) presents a wide variety of similar examples drawn from a variety of sources, including many published research articles. Huck and Sandler's book presents illustrations from many educational research areas.

Suggestion #6: Present basic statistical concepts while analyzing data collected from the class.

A traditional approach to presenting statistics follows the "rule-example" model. Students are taught the formula for a statistic and then given data upon which to practice. An alternative approach is to generate data first and, then, to introduce statistics as part of an attempt to "make sense" out of the raw data: an "example-rule" approach.

The questionnaire presented in Appendix D can provide an initial set of data for analysis by the class. As can be determined by inspection, the questions in this questionnaire combine to form a general "Attitudes toward the Research and Statistics Class Survey." After students have completed the survey, possible hypotheses relating to the questionnaire are generated by the class. Without any advanced preparation, students are easily able to identify the questions of interest: Are students' attitudes toward the research class related to how well they performed in their algebra class in high school? Are males more anxious about the research class than are females?

During the next class meeting, the results of the survey could be presented a little at a time. For example, the class might begin by putting all summed scores for the entire class on the board. Once all scores are written down, the instructor can ask what they mean. Of course, as unorganized scores on the chalk board, they mean nothing. "Well, how can we make sense out of these scores?" This type of question will lead to the introduction of scatterplots, central tendencies, and variability. As the class moves later to consider correlations, the actual data collected on algebra scores can be correlated with the attitude survey scores. Furthermore, when t-tests are introduced, the male/female comparison may be used to illustrate this concept with the same familiar set of data.

<u>Suggestion #7: Create a student-designed instrument to illustrate important measurement concepts.</u>

Teaching principles of instrument construction can be enlivened by engaging the students in the construction of their own instrument. The student-designed questionnaire presented in Appendix E is a specific illustration of an instrument designed in a recent class. As with nearly all psychological and educational measures, this instrument includes a set of questions that provide indirect indicators of the underlying trait that is being assessed. Unlike most instruments, however, this questionnaire was designed to measure an underlying trait that <u>is</u> easily obtainable: the respondent's age (other good traits would be height and weight).

Generating the "Age Test" in class serves the following purposes:

» Since each student contributes three to five items, everyone feels a sense of investment in the resulting test.

» Class discussions concerning the originally-generated test items (many more items than will eventually be needed) often lead to learning about test construction: e.g., confusing items, difficult wording, items with several possible interpretations.

» After the questionnaire has been examined by class for both clarity and content validity, it is printed and distributed to a wide variety of individuals. Each student is, again, encouraged to collect at least 5 - 10 sets of responses. This gives the student some feel for the process of data collection.

» When the responses are complete, the instructor can run several statistical analyses on the collected data. First of all, the internal consistency of the instrument can be calculated. As is true of most internal consistency programs, it is easily possible to point to those items which seem to have the least in common with the other items in the survey (through item analyses and reliabilities with each item deleted). Those "odd" items can be discussed in class, with discussion of the possible reasons why these items did not fit as well with the others. (The actual internal consistency reliability of the attached instrument was .91.)

» Since the questionnaire also asks directly for the respondent's age (a luxury not available with most psychological instruments), a direct validity coefficient can also be calculated between actual age and the questionnaire's total score. (In the case of the illustrated questionnaire, the validity coefficient was calculated to be .88.)

» By the end of this exercise, students usually have a much better working knowledge of measurement principles and their application to social science research.

Suggestion #8: Decrease the social distance between students and the use of statistics by teaching them to use inexpensive microcomputer statistical software.

The proliferation of microcomputers has provided both a challenge and an opportunity in the instruction of counseling students. Student utilization of mainframe, minicomputer, and microcomputer implementations of the major statistical packages is often limited to their activities in formal statistics courses. Yet, it is often the "number-crunching" that stymies counseling students. Students can be helped to overcome their fears about "number-crunching" by decreasing the social distance between them and statistical analysis aids.

Levels of Technological Support. Technological support for statistical analysis can be arrayed on a continuum: (a) major statistical packages (e.g., mainframe, minicomputer, and microcomputer implementations of SPSS, BIOMED, SAS), (b) minor integrated microcomputer statistical programs (e.g., Stat-1, PsychoStat-3), (c) collections of stand-alone programs to run specific statistics (e.g., Epistat, Statistics-SPPC), and (d) single purpose programs to run a chosen statistic.

Instructional Use. Opportunities for instructional integration of data analysis occur throughout the counseling curriculum. For example:

» In behavioral counseling courses or practica, student-collected or instructor-provided data may be analyzed to test the effect of treatment.

» In courses reviewing research literature, students can conduct meta-analysis studies on selected topics.

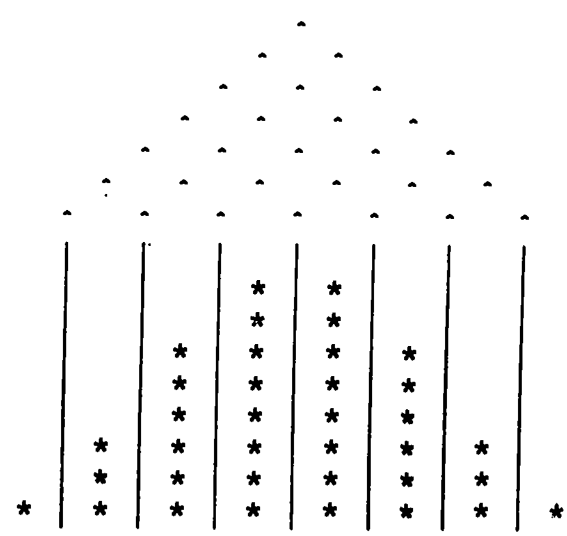
» In research training courses, a class might conduct a joint research project with each student individually conducting the data analysis and writing a report of the findings and their implications.

<u>Accessability: A Key to Success</u>. Major statistical packages can handle reams of data and provide comprehensive analysis options, but their strength can also be a weakness. Often students are frightened by their complexity. Further, once they have "completed the course," they often lose access to the equipment. Since increasing numbers of counseling students own or have access to microcomputing equipment, the minor statistical packages and the collections of stand alone programs may have several important advantages (Appendix F). They are relatively inexpensive (some can be purchased for under $50.00). Several are available in versions for the full spectrum of machines (IBM, Apple, Macintosh, C/PM). And, most important, social distance between the student and data analysis is decreased when students own and have immediate access to their own copies of the software.

<u>Suggestion #9: Design computer simulations and games to demonstrate research concepts.</u>

Presentations of issues in research design can often best be understood when accompanied by numerical examples illustrating the principle under consideration. For example, when discussing the use of randomized blocks, a direct comparison of the results of the one-way test of treatment effects with a two-way analysis of treatment, randomized blocks, and their interaction can be most instructive. Because the computations needed for any but the most simple of numerical examples are difficult to manage spontaneously during a lecture or presentation, such examples are typically presented as static, pre-computed handouts drawn from text-books or instructor data-sets. A dynamic alternative to traditional static numerical illustrations can be provided through the use of microcomputers.

<u>Dynamic Modeling of Distributions</u>. Those who have visited the science museum at Toronto may have seen the immense binary tree illustrating how, as the sample size increases, the binomial probability distribution approximates the normal distribution. Steel balls are rolled down a large board and as they hit each successive pin are forced to go either to the right or the left. As the balls fall out the bottom of the array of pins, they are accumulated in bins. The



resulting "histogram" provides a good approximation to the normal probability distribution. A relatively simple program can be written in BASIC or Pascal to illustrate this phenomenon.

Dynamic Modeling of Covariation. Findings from studies of people's ability to recognize and estimate covariation have been generally unflattering. Nisbett and Ross (1980) report that studies of estimating association from fourfold, presence-absence tables reveal faulty reliance on the "present/present" cell. Although paper and pencil illustrations of fourfold tables could be easily prepared, with rudimentary knowledge of programming in BASIC or Pascal, a program may easily be prepared which (a) presents a fourfold table filled with randomly selected data, (b) pauses to permit class discussion, and (c) calculates and displays the contingency coefficient when requested. With somewhat more programming skill, a similar program could be developed to explore the covariation in ordinal or interval bivariate data. A sample BASIC program to display four-fold tables has been provided in Appendix G.

Alternatives to Programming. For those who are interested in using microcomputers to assist in illustrating research design issues, but who are intimidated by the thought of creating original programming, several aids are available.

Major spreadsheet programs like Lotus 1-2-3 and SuperCalc can be used to illustrate how changes in data can effect the overall result of the statistic. A spreadsheet is like an electronic worksheet which permits entry of alphanumeric labels, numeric data, and formulas. For example, a spreadsheet prepared to calculate a *t*-test with independent samples of size 10 could be used to quickly illustrate the effect of increasing the within or between groups variability. Sophisticated spreadsheet programs include graphics routines which facilitate graphic illustration of the data. User supported spreadsheet software like PC-CALC provides the basic spreadsheet functions without graphics at a nominal cost.

The Kemeny/Kurtz Math Series is a collection of programs to assist in the teaching of mathematics, statistics, and research. Of particular interest are TrueSTAT (an interactive program which creates, edits, and runs statistical programs) and Probability Theory (a program which provides simulations of coin toss, dice toss, random walks, Bayes' Theorem, random variable distributions, and other probability phenomena).

A List of Relevant Software

Professional BASIC, Morgan Computing Co., Inc. (available through Chambers & Assoc., 5499 N. Federal Hwy, Suite A, Boca Raton, FL 33431-4963. List price $149.00; educational discount, $65.00. IBM.) A window-oriented programming environment for writing, editing, testing, and debugging BASIC programs.

Turbo Pascal (Borland International, 4585 Scotts Valley Dr., Scotts Valley, CA 95066. List price $99.95). Programming environment for writing, editing, testing, debugging, and compiling Pascal programs.

PC-CALC (Acorn Software Library, Greater Cincinnati IBM-PC Users Group, P. O. Box 3097, Cincinnati, OH 45201. User supported software. IBM.)

TrueSTAT, part of the Kemeny/Kurtz Math Series (available through Chambers & Assoc., 5499 N. Federal Hwy, Suite A, Boca Raton, FL 33431-4963. List price $79.95; educational discount, $48.00. IBM, Mac.) Interactive program; creates, edits, and runs statistical programs.

Probability Theory, part of the Kemeny/Kurtz Math Series (available through Chambers & Assoc., 5499 N. Federal Hwy, Suite A, Boca Raton, FL 33431-4963. List price $49.95; educational discount, $36.00. IBM, Mac.) Provides simulations of coin toss, dice toss, random walks, Bayes' Theorem, random variable distributions, etc.

Suggestion #10: Develop an electronic classroom to provide facilities for experimentation in teaching research.

Visual aids for classroom instruction have improved markedly since teachers first used purple ditto masters and chalkboards. Photoduplication has replaced dittos for reproducing classroom handouts, and slide-tape presentations, audio-video recordings, and overhead projector transparencies have increasingly been used to augment chalkboard illustrations. Recently, large screen projectors have been harnessed to microcomputers to permit large audiences to view the information normally displayed on the computer's video display terminal. Though each of these technological advances have improved the transmission of information from teacher to student, none work directly to improve the communication flow in the opposite direction.

Some educators are experimenting with electronic classrooms in which keypads at each student's work station are used to transmit student input to a central microcomputer which collects, evaluates, and compiles the students' responses. An illustration is provided in Appendix H. A research trainer could use the two-way communication capabilities of such an electronic classroom for a number of purposes:

» collecting responses to items on an attitude scale and storing the responses in a database for use in analyzing the measurement properties of the attitude instrument;

» collecting, grading, and storing student responses to quiz items, and then displaying the distribution of student answers to stimulate class discussion;

» collecting and displaying the distribution of student responses to a classroom atmosphere questionnaire to gain formative feedback and prompt class discussion about how to improve the class; or

» collecting "on-line" student feedback during a lecture to insure that none of the class is "left in the dust."

The basic equipment in an electronic classroom includes (a) a microcomputer station with appropriate software to display questionnaire, test, or scale items and receive and process keypad input, (b) a large screen projector to permit audience viewing of the information appearing on the microcomputer's video display, and (c) student response keypads. Optional additional equipment might include (d) a videocasette player/recorder to permit videotaping the computer output or playing prerecorded tapes, (e) a printer to permit production of hardcopies of the computer output, and (f) a modem with appropriate communications software to permit connection with microcomputer or mainframe equipment.

APPENDICES

Appendix A -- Research Critique Form

Appendix B -- *Mastermind* Hypothesis Testing

Appendix C -- Illustration of an Alternative Hypothesis Exercise

Appendix D -- Sample Survey to Generate Data Illustrating Basic Statistics

Appendix E -- Illustration of a Class-Designed Instrument

Appendix F -- Statistical Software for Microcomputers

Appendix G -- Demonstration Program in BASIC for Teaching Covariance Concepts

Appendix H -- The Design of an Electronic Classroom

Appendix A

Research Critique Form

____ I. Reference [Student writes article reference in APA style.]

____ II. Statement of Problem [Student writes a statement of the problem for the article and evaluates the author's presentation of the statement of the problem. NOTE: If the author presents an appropriate statement of the problem, the student may quote author; if the author has neglected or provided an inappropriate statement of the problem, then the student must create one appropriate to what the author actually studied.]

____ III. Hypotheses (Research Questions) [Student writes the hypotheses tested (research questions investigated) in this research and evaluates the author's presentation of hypotheses (research questions). NOTE: If the author presents hypotheses (research questions), the student may quote the author; if the author has neglected or provided inappropriate hypotheses (research questions), then the student must create one(s) appropriate to what the author actually studied.]

____ IV. Review of Literature [Student evaluates the adequacy and appropriateness of author's review of literature given what the author apparently actually studied in the research.]

____ V. Operational Definition of Variables [Student enumerates the independent, moderator, control, and dependent variables utilized in this research and evaluates the author's operational definition of each variable.]

____ VI. Internal Validity [Student evaluates the internal validity of the study: (a) selection, (b) regression, (c) testing, (d) instrumentation, (e) history, (f) maturation, (g) mortality, (h) stability, (i) experimenter/subject effects.]

____ VII. External Validity [Student evaluates the external validity of the study: (a) subject x treatment interaction (generalizability of findings to other subjects, (b) reactivity of experimental arrangements (generalizability of findings to other environments), (c) reactivity of testing (pretest sensitization to the treatment), (d) multiple treatment/test interference.]

____ VIII. Conclusions [Student evaluates whether the author's conclusions are appropriate given the author's statistical analysis and the degree to which the study has internal and external validity.]

____ IX. Relevance to Counseling [Student evaluates the relevance of this study using the Krumboltz test of relevance.]

	GRADING SCALE	Response:
____ RAW SCORE		not attempted = 0
		mostly incorrect = 1
____ STANDARD SCORE		partially correct = 2
		mostly correct = 3
		completely correct = 4
		exemplary = 5

Illustration of Mastermind Hypothesis Testing

Rules. There are only two rules:

1. A hypothesis consists of a four digit number (0000 to 9999).

2. After a hypothesis is stated, feedback will consist of (a) the number of discrete digits which are correct and (b) the number of digits which are in the correct position.

Example. Suppose one were trying to guess the randomly chosen, four-digit number, 3618. A hypothesis testing sequence might go as follows.

Hypothesis	Feedback
H1: 1 2 3 4	Digits Correct = 2 Digits in Right Position = 0
H2: 5 6 7 8	Digits Correct = 2 Digits in Right Position = 2
H3: 5 1 7 3	Digits Correct = 2 Digits in Right Position = 0
H4: 2 6 4 8	Digits Correct = 2 Digits in Right Position = 2
H5: 1 6 3 8	Digits Correct = 4 Digits in Right Position = 1
H6: 3 6 1 8	Digits Correct = 4 Digits in Right Position = 2

Discussion. The hypothesis tester in this example used "best strategy" and had a good bit of luck as well. After having identified in H1 and H2 that two digits in the 1-2-3-4 sequence and two digits in the 5-6-7-8 sequence were correct, 9 and 0 could be discarded.

The feedback at H3, a test of the odd digits, showed that either the 1-3 pair or the 5-7 pair were correct. Then, at H4, the even digits were tried and the 6 and 8 were positioned as they had been in H2 where it was discovered that two digits were correctly positioned. The results indicated that the digits involved must be 1-3-6-8 and that the 6 and 8 are correctly positioned.

The positioning of the 1 and 3 must be guessed and H5, the wrong guess, leads to H6, the true state of nature.

Appendix C

Illustration of an Alternative Hypothesis Exercise

The Case of Harry Hardworker

You are to imagine that you are a counseling researcher working out of your private office. On one particularly dreary afternoon, Harry Hardworker drags into your office looking like he had just lost his very best friend. You ask Harry what has brought him to see you. He responds:

> You are my last hope! I feel totally depressed and desperate. Despite many long hours of reading and studying for my undergraduate psychology class, I was given a "C" as my final grade. I had planned to make psychology my career, and I must have studied three or four hours every night for that class. I really believe that I did well enough for an "A" or "B." However, when I went to discuss my grade with the graduate assistant in charge of the class, I was told that the grading for the class was done on the curve. Each of the five examinations were weighted equally, and my exam average was barely above the class mean. Thus, as an average student, I deserved a "C."
>
> I know I learned much more than many of the students in the class whose grades were better than mine. Is there anything you can do?

Being the careful thinker that you are, you delay any immediate answer to Harry's question while you collect information. You ask him to give you his scores on each test <u>with</u> the associated means and standard deviations of the class as a whole. This information is reproduced below:

	Test 1	Test 2	Test 3	Test 4	Test 5	Overall Average
Harry's Scores	60	24	31	47	26	37.6
Class Average	56	27	29	45	29	37.2
Standard Dev.	2	6	2	2	6	

Class Size was 100 students.

After careful consideration of these data, you announce: "Harry, I believe that, based on normal curve grading, you do have a good case for a higher grade in the psychology class. I will take your case! Let's go talk to your psychology instructor."

What was it you saw in the data that led you to such a positive assessment in favor of Harry's case for a higher grade?

Solution to the Case of Harry Hardworker

The key to your case in support of Harry Hardworker rests in the fact that the means and standard deviations of these five exams are not at all consistent. By being widely divergent, a simple averaging of scores obscures the underlying differences between students on these examinations. A more fair manner of applying the normal curve distribution to these scores would be to translate each student's score for each test into a score reflecting his/her relative standing on that test. Such a score would create a situation where the class means and standard deviations would be equivalent across tests! This type of score is called a standard score or a *z* score. *Z* scores for the class of 100 would average 0, with a standard deviation of 1. Transformations of raw scores to *z* scores involves the following formula:

$$z = \frac{x - \bar{X}}{S.D.}$$

Thus, transforming Harry's raw scores into *z* scores will give us a better idea of how he has done with respect to other members of the psychology class.

	Test 1	Test 2	Test 3	Test 4	Test 5
raw score	60	24	31	47	26
z score	3	-.5	1	1	-.5

Unlike the raw scores, the *z* scores can reasonably be added together and averaged since they are "measured on the same metric" (i.e., they have the same means and standard deviations, and the observed score differences are, thereby, meaningful quantities).

Harry's average *z* score is +.60! This is six tenths of a standard deviation higher than the class overall mean of zero! Harry had been unlucky enough to score his best on the three examinations with a very low standard deviations, and, thus, using the instructor's raw score average, Harry's outstanding performance on Exam 1 (2 S.D. above the mean) and his very good performances on Exams 3 and 4 (1 S.D. above the mean) were obscured by his average (certainly not bad) performances on Exams 2 and 5 (only a half of a S.D. below the mean).

With a class as large as this psychology class, we can reasonably assume that there should be a very close fit between student performance and the normal distribution. Reading from a table describing probabilities at each point on the normal curve, a person score + .60 above the mean will have scored better than 72.6% of the class! Although Harry's grades don't appear to deserve an "A," it does appear that he has attained a solid "B" in this course.

Appendix D

Sample Survey to Generate Data Illustrating Basic Statistics

Indicate, by circling the appropriate response, the extent to which you agree with each of the following statements. Be as honest as possible in your response. VSA = very strongly agree; SA = strongly agree; A = agree; N = neutral; D = disagree; SD = strongly disagree; VSD = very strongly disagree

1. I enjoy reading about research.	VSA	SA	A	N	D	SD	VSD
2. I feel that the other members of this class will understand much more of the text than I will.	VSA	SA	A	N	D	SD	VSD
3. I am likely to tend to do my other homework assignments before I get started on the assignments for this class.	VSA	SA	A	N	D	SD	VSD
4. I am looking forward to Tuesday evenings (class night).	VSA	SA	A	N	D	SD	VSD
5. I see the relevance of the materials covered in this class to a number of activities that I will later need to perform on the job.	VSA	SA	A	N	D	SD	VSD
6. One of the reasons that I have been hesitant to apply for doctoral study has been the research and statistics that would be required in such a program.	VSA	SA	A	N	D	SD	VSD
7. I wish that I could choose to take an extra practicum in counseling rather than take this class.	VSA	SA	A	N	D	SD	VSD
8. I expect to carry out some research after the completion of my graduate program at the University of Cincinnati.	VSA	SA	A	N	D	SD	VSD
9. I do not enjoy reading research articles in journals.	VSA	SA	A	N	D	SD	VSD
10. I don't mind balancing my checkbook every month.	VSA	SA	A	N	D	SD	VSD

My high school algebra grade was approximately ___________. (If you did not take high school algebra, please put an "X" in the space above.)

Please check appropriate space: Male _____ Female _____

Appendix E

Illustration of a Class-Designed Instrument

DO YOU REMEMBER?
SPRING, 1986

For each statement below, give your best approximation as to whether the statement is True of you ("A" on answer sheet) or false ("B").

1. I cannot remember hearing FDR's speeches on the radio.
2. I learned to use a computer in middle school.
3. I used an inkwell in penmanship class.
4. I have watched newsreels in a movie theatre.
5. I have never watched steam locomotives in regular operation.
6. My whole family used to sit in front of the radio listening to our favorite shows.
7. My friends collect Garbage Pail Kids.
8. My friends have never worn zoot suits and saddle shoes.
9. I have watched the Brady Bunch show before reruns.
10. Bob Hope was staring in the movies when I was first becoming interested in films.
11. I never saw a silent film with subtitles.
12. I listened to Fibber McGee and Molly on the radio.
13. I don't remember when the girls at school had poodle skirts.
14. I listened to Paul Dixon and Dottie Mack's D.J. show.
15. I didn't see man walk on the moon for the first time.
16. I remember where I was when it was announced that John Kennedy was shot.
17. I do not remember a time when we were not conducting manned space flights.
18. I have never driven a Model T Ford.
19. I can sing the "Howdy Doody" song.
20. I don't know what an Edsel is.
21. I listen to and enjoy the rock music of today.
22. I don't remember when all passenger cars had running boards.
23. The Star Ship group is one of my favorites.
24. I can remember when leg make-up first became popular because nylon was unavailable.
25. During the depression, I remember people losing many of their family possessions.
26. The American Motors "Rambler" was not a common car when I was young.
27. My father or his friends fought in World War II.
28. Video arcade games have never been particularly attractive to me.
29. I was ineligible to vote in the past three presidential elections.
30. I like my music loud.
31. My grandparents once told me stories about their parents' experiences during the Civil War.
32. I do not often reflect on aging and death.
33. I have written a will.
34. Sesame Street was one of my favorite shows as a child.
35. My youngest sibling is still in high school.
36. My first car is no longer running.

Please indicate your age ________

Appendix F

Statistical Software for Microcomputers

1. Math and Stats 1, Math and Stats 2 (Public Brand Software, P.O.Box 51315, Indianapolis, IN 46251, $5.00 ea. IBM.) These two disks contain several programs: MVSP, multivariate statistics package; SES, simultaneous equation solver; STAT-SAK, collection of basic statistics programs; BASIST, collection of basic statistics programs; and PFSA, programmable math language for development of original programming.

2. Epistat by T. L. Gustafson (PC-SIG, 1556 Halford Ave. Suite 130, Santa Clara, CA 95051, donation $20.00, IBM.) Collection of 21 programs written in BASIC which support 34 common statistical functions.

3. CHIPendale, part of the Kemeny/Kurtz Math Series (available through Chambers & Assoc., 5499 N. Federal Hwy, Suite A, Boca Raton, FL 33431-4963. List price $49.95; educational discount, $36.00. IBM.) Menu-driven; provides statistical analysis of contingency tables.

4. Psychostat-3 (StatSoft, 2832 East 10th St., Suite 4, Tulsa, OK 74104. $99.00. IBM, Apple II , Macintosh, and CP/M computers.) Menu-driven program provides data editor, all basic statistics, graphics, and advanced statistical analyses including general multiple regression and general analysis of variance and covariance.

5. Stat 1 - A Statistical Toolbox (Sugar Mill Software Corp. 1180 Kika Place, Kailua, Hawaii 96734. Student version, $29.95; Pro. Version, $129.95; Lab Licence, $500.00. IBM.) Menu-driven; provides data entry and management, transformations, basic statistics, regression including ANOVA/ANCOVA, and smallest space analysis; imports and exports ASCII and .PRN files. Student version limited to saving 100 cases.

6. A-Stat by R. Grandon (Available through Psychologists' Software Club, 1151 Cheshire, Casper, WY 82609. List price, $200.00; club discount, $180.00. Apple.) General purpose statistical package reads data and computes basic statistics, ANOVA, multiple regression, and path analysis.

7. PC-Statistician (Human Systems Dynamics, 9010 Reseda Blvd, Suite 222/Dept. APA, Northridge, CA 91324. $300.00. IBM.) Interactive; provides data editing and transformations, basic statistics, polynomial curve fitting, regression. Will accept input from DIF files.

Appendix G

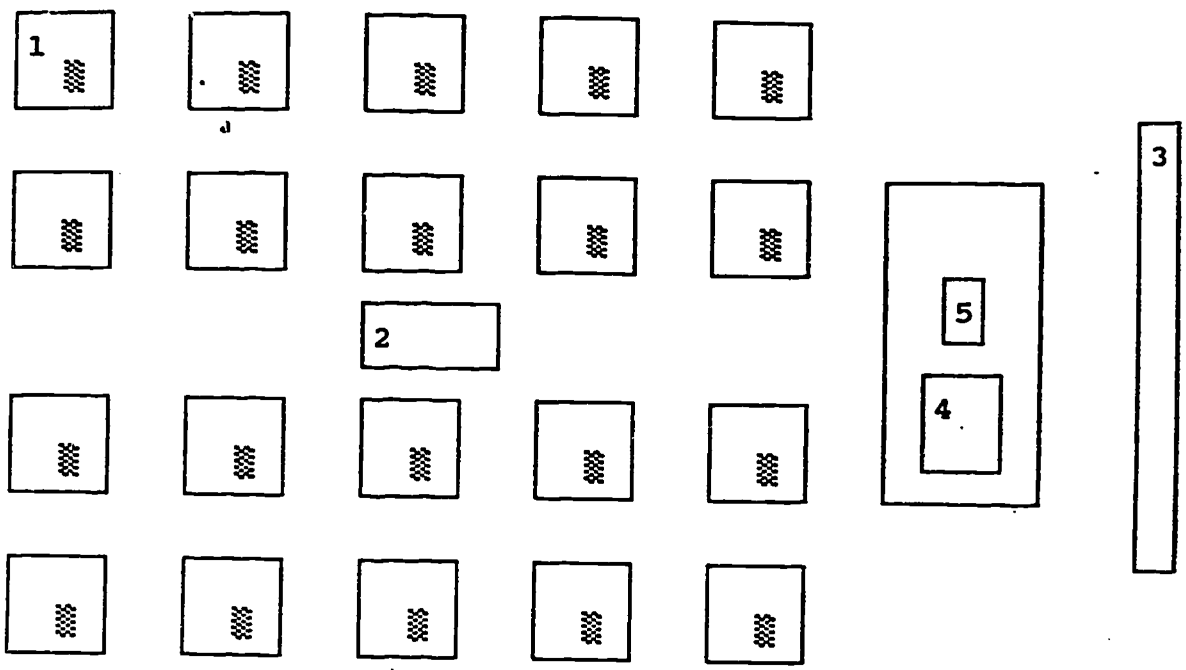
Demonstration Program in BASIC for Teaching Estimation of Covariation from Fourfold Tables

```
 10 REM ----------------------------------------------------------------------
 20 REM --- ESTIMATING COVARIATION  FROM FOURFOLD CONTINGENCY TABLES ---
 30 REM ---          PROGRAM (C) 1984 BY F. ROBERT WILSON, PH.D.          ---
 40 REM ---           DEPT. OF SCHOOL PSYCHOLOGY AND COUNSELING           ---
 50 REM ---         UNIV. OF CINCINNATI, CINCINNATI OH 45221-0002         ---
 60 REM ----------------------------------------------------------------------
 70 CLS: KEY OFF
 79 REM ----------------------------------------------------------------------
 80 REM ---                        FILL CELLS                              ---
 81 REM ----------------------------------------------------------------------
 90 RANDOMIZE 3
100 DEF FNCELL(NSEED) = INT((INT(.80*NSEED)+1)*RND)
110 A = FNCELL(100)
120 D = FNCELL(100-A)
130 B = FNCELL(100-(A+D))
140 C = 100-(A+B+C+D)
149 REM ----------------------------------------------------------------------
150 REM ---                   PRINT FOURFOLD TABLE                         ---
151 REM ----------------------------------------------------------------------
160 L$ = "************************************************************"
170 LOCATE 2,22: PRINT "Does The Symptom Predict The Disorder?"
180 LOCATE  4,10:PRINT L$;
190 LOCATE  6,47:PRINT "Disorder Y": LOCATE 15,10:PRINT "Symptom X"
200 LOCATE  8,40:PRINT USING "\        \"; "Present", " Absent", "  Total
210 LOCATE 12,25:PRINT "Present"
220 LOCATE 12,35:PRINT USING "##########";   A,    B,      A+B
230 LOCATE 15,25:PRINT " Absent"
240 LOCATE 15,35:PRINT USING "##########";   C,    D,      C+D
250 LOCATE 18,25:PRINT "  Total"
260 LOCATE 18,35:PRINT USING "##########"; A+C, B+D, A+B+C+D
270 LOCATE 20,10: PRINT L$;
279 REM ----------------------------------------------------------------------
280 REM ---              PAUSE UNTIL RETURN IS PRESSED                     ---
281 REM ----------------------------------------------------------------------
290 LOCATE 23,25: INPUT "Press Return To Display PHI", A$
299 REM ----------------------------------------------------------------------
300 REM ---                 CALCULATE AND PRINT PHI                        ---
301 REM ----------------------------------------------------------------------
310 PHI = ((B*C)-(A*D)) / (SQR((A+B)*(C+D)*(A+C)*(B+D)))
320 LOCATE 23,25: PRINT "   The Value of PHI is      ";
330 LOCATE 23,48: PRINT USING "##.##"; PHI;:PRINT "      ";
339 REM ----------------------------------------------------------------------
340 REM ---            CHOOSE WHETHER TO RECYCLE OR QUIT                   ---
341 REM ----------------------------------------------------------------------
360 LOCATE 25,32: INPUT "<R>ecycle - <Q>uit", R$
370 IF (R$ = "R") OR (R$ = "r") THEN 10 ELSE 380
380 END
390 REM ----------------------------------------------------------------------
```

Appendix H

An Electronic Classroom

Any classroom may be configured as an electronic classroom with the addition of (a) a microcomputer station with appropriate software to display questionnaire, test, or scale items and receive and process keypad input, (b) a large screen projector to permit audience viewing of the information appearing on the microcomputer's video display, and (c) student response keypads.



1. Student work stations equipped with numeric keypad response units.
2. Large screen projector unit.
3. Reflective screen on which to project the computer display.
4. Instructor's station equipped with a microcomputer (optional additional equipment might include a modem hookup to a mainframe computer, a printer, a videocasette player/recorder, and multiple microcomputers to permit running software based on different operating systems).
5. Appropriate software (statistical demonstration software, communications software, software to interface with the student response units).