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ABSTRACT

Understanding correlation coefficients is difficult for students. A free computer program that helps introductory psychology students distinguish between positive and negative correlation, and which also teaches them to understand the differences between correlation coefficients of different size is described in this paper. The program is desirable in teaching this topic, not only because the computer is a patient, private tutor, but it also allows the teacher to spend his or her time on other material. Contrary to some popular misconceptions, the computer can offer a variety of feedback responses, can present a broad selection of problems, can be given a "personality," can supply a wide range of visual material, and can incorporate pedagogical aids. The program prints out a detailed record of each student's behavior, and students typically master the basic concepts of correlation. Students seem to enjoy the program and it is often used to introduce students to using computers. (RJM)

Running head: COMPUTERS AS TUTORS

Snapping Sharks, Maddening Mindreaders, and Interactive Images: Teaching Correlation

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Abstract

This paper describes a free Macintosh software program that helps introductory psychology students distinguish between positive and negative correlations and understand the differences between correlation coefficients of different sizes. Myths that may prevent novices from developing effective software are also addressed.

Snapping Sharks, Maddening Mindreaders, and Interactive Images: Teaching Correlation

Understanding correlation coefficients is important even for those students who never see a correlation coefficient. As Duke (1978) pointed out, students who don't understand correlation coefficients may either believe that psychological research is inaccurate and irrelevant (because such research says that there are relationships between variables whereas the student knows of cases that run counter to that relationship) or they are likely to form inappropriate overgeneralizations from research findings. For example, a lecture on sex differences could lead some class members to decide that psychological research is invalid, while leading others to embrace gender stereotypes. However, as Duke (1978) also pointed out, correlation is a difficult topic for students to understand, even when the professor uses diagrams, verbal labels, and examples.

Despite the importance of understanding correlations, professors may be tempted to skip it in favor of more interesting topics for at least two reasons. First, it is difficult to cover an entire textbook in a single semester. Second, spending considerable class time on the topic often results in only a few students being able to meaningfully interpret correlation coefficients (Duke, 1978). Fortunately, because of the Correlator program, the professor can now have students understand correlations without spending any class time on the topic.

Part of the reason the Correlator program does a better job of teaching correlations than would be done in class is due to the well-known fact that the computer is a gentle, patient, private tutor (Desberg, 1994). At a minimum, each student going through this program answers 20 questions about correlation. Imagine a professor spending class time to orally ask each student in the class 20 questions about correlation! The computer, on certain exercises, keeps asking the student questions until the student gets three questions correct in a row. Imagine the embarrassment a professor would cause if he or she kept asking a student questions until the student answered correctly three times in a row!

Although some of the success of the program follows from well-known advantages of computerized instruction, perhaps its greatest success is due to countering six myths about computerized instruction. These myths, if unchallenged, have the potential for being self-perpetuating.

1. Computers don't give a variety of feedback. Computers are able to give just as many different responses to a wrong answer as a human. In this program, we often have the computer generate a random number following a student's incorrect response. The value of that random number determines which of a variety of feedback responses the student receives. These statements incorporate the entire range of feedback we have given students about that type of error in our 33 years of combined teaching experience.

2. Computers present only a limited number of problems. If computers present only a limited number of questions, the student may simply memorize the answers to those questions. In this program, we avoid this problem in two ways. First, we often use the random number function to help generate questions. For example, the computer will generate a random positive correlation coefficient and the student will be asked to generate a negative correlation coefficient that is larger than that positive correlation. Second, we have the student perform activities, such as going through a computer maze. The student's behavior then becomes the basis for questions that students are asked. For instance, they may be asked what they think the correlation is between their speed and their accuracy in going through the maze.

3. Computers can't have a personality. The computer can adopt a variety of personalities, including that of the professor. For example, the computer can use the professor's pet phrases, and even present the voice and photo of the professor (Desberg, 1994). In this program, we have a section in which the student meets up with a bragging, carnival barker, con artist. The computer claims to read the student's mind, shows that the student can't read the computer's "mind," and then actively resists the student's attempts to

manipulate the computer's mind. Data from these exercises serve to illustrate positive, zero, and negative correlations, respectively.

4. Computerized tutorials only produce multiple-choice questions. In this program, students do respond to some multiple-choice questions. However, students also engage in a variety of other tasks. For example, students generate hypotheses about relationships between variables by selecting variables from lists and estimate correlations from actual data.

5. Computer tutorials are not visual. Although many tutorials are merely workbooks on the computer, the Correlator frequently displays dynamic visuals. On the second screen, for example, students can decide which type of correlation they wish to observe. If they choose a positive correlation, they see two variables inside boxes. The boxes go up and down together like two connected elevators. If they choose a negative correlation, the two boxes go in different directions. Later, students are presented with a series of dynamic visuals that allow them to understand the difference in the sizes of correlation coefficients without presenting them with mathematical formulas or using such phrases as "proportion of variance accounted for." For one of these visuals, the student selects a correlation coefficient. Then, as the student drags the mouse across the x axis, the predicted value of y is displayed, along with a bar displaying the range in which the value of y is likely to fall. Students can readily observe that smaller correlations produce more uncertainty.

6. Translating pedagogical aids to the computer is ineffective. The computer, because of its visual and interactive capabilities, can be an ideal way of incorporating other pedagogical techniques. For example, the Correlator incorporates Boatright-Horowitz's (1995) demonstration of Nuttin's (1985) name letter effect. Students rate their liking of all the vowels, then the computer displays a chart comparing the number of times a vowel occurs in their first name and their liking of that vowel. Next, students are asked to estimate

the correlation between those two variables. Then, the computer gives them feedback about the accuracy of their estimate.

The program also incorporates the basic idea from Duke's (1978) article on using tables to help students grasp size differences in correlations. Duke employed a table titled "Minimum Probable Percentages of Above and Below Median Cases on a Second Variable of All Cases Above the Median on the First Variable (Assuming True Correlations from 0.00 to 1.00)." The title alone confuses some students. Rather than confusing students with rows of numbers, the Correlator shows students pictures instead. First, students are introduced to the concept of the median. They see that with 10 people, five will be above the median and five will be below the median. In this case, the median is depicted as a line with five "x's" above the line and five "x's" below the line. Then, they can click on a button to see how many "x's" would be above the median, given that "y" was above the median and given a certain correlation coefficient. Clicking on the buttons provides a dramatic illustration of the weakness of correlations between -.3 and +.3 as well as the strength of a -1 correlation. On the next screen, students repeat the exercise with "y" being below the median.

In addition to incorporating demonstrations that we read about in Teaching of Psychology (Boatright-Horowitz, 1995; Duke, 1978), we also incorporated some simple, almost universal, pedagogical aids. For example, most psychology teachers have probably, at one point or another, drawn a line with -1 on one end, 0 in the middle, and +1 at the other end, and gone on to explain that correlation coefficients are strongest at either end, and get weaker as we go toward zero. In the Correlator, we take this a step further by having the line be interactive. As the student moves the mouse along the line, a verbal label describing the strength of the correlation "pops up."

Conclusions

Although the Correlator prints out a detailed record of each student's behavior, we rarely need to look at the log. Once students get started, they complete the program and they master the basic concepts of correlation. Furthermore, regardless of whether it takes them 20 minutes or 40 minutes to get through the Correlator, students seem to enjoy the program. Therefore, we often use the Correlator to introduce students to using computers.

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Author Notes

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