Using Single-Case Design and Personalized Behavior Change Projects to Teach Research Methods

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Students in research methods courses, especially those taught in an intense format, might be hard pressed to actually conduct research studies due to logistics and time constraints. I describe the use of single-case research design and a personalized behavior project as an alternative research project for students in an undergraduate psychology methods course. Students were able to complete the project, including the collection, analysis, and interpretation of data, within the confines of an intensive, 6-week course.

Research methods courses can be among the most challenging to teach to psychology majors, in part because these students’ interests in psychology tend to run toward clinical and applied areas, not empirical research (Rottinghaus, Gaffey, Borgen, & Ralston, 2006). In addition to the technical and often overwhelming nature of the content, students are often unable to actually experience the research process within the temporal restraints of an academic semester, particularly in intensive courses. Several years ago, Spalding University (Louisville, KY) reformed its undergraduate programs, initiating an academic format in which students take classes in intense 6-week (100 min × 4 days a week) sessions. This new, intense format rendered the objective of having students conduct actual research projects untenable, eliminating the opportunity for a hands-on research experience.

The logistics of actually conducting research within a classroom context have always been somewhat daunting, with major constraints being the requirement to secure institutional review board approval prior to data collection and the substantial sizes of participant samples needed to allow for meaningful statistical analyses. At Spalding, the 6-week session format, coupled with the historical obstacles of conducting research, left little room for students in research methods courses to experience research firsthand.

Fortunately, recent years have seen an upsurge in methodological innovation, and alternative strategies for conducting empirical research, even within the constraints of an intensive academic course, are available to faculty teaching methods courses. One such innovation is the single-case research design, also known variously as single-case, small-\(n\), or \(N=1\) research design. Single-case research design actually has a long and storied history within psychology (e.g., Kazdin, 1982; Morgan & Morgan, 2001; Sidman, 1960), but is perhaps less familiar to many university faculty. Single-case research boasts several advantages, however, over conventional null-hypothesis testing group designs. Among these advantages are the small participant samples required to conduct such research and repeated measurement of dependent variables in real time. These design features encourage a fine-tuned analysis of behavior both prior to and following independent variable manipulations. Large-group, statistically driven studies relying on aggregated summary measures seldom accommodate the degree of measurement resolution typical of single-case studies.

This project involved introducing students in a sophomore-level research methods course to single-case design, with the requirement that students conduct a personalized research project aimed at bringing about change in a personally relevant behavior. Students chose a simple, operationally defined target behavior that was easy to observe and record, such as exercise, caffeine consumption, or study time. For the first 2 weeks of the academic session, students collected baseline measures of the target behavior and...
plotted these data on a standard time-series (real-time) graph. Students then devised their personal intervention strategies for changing the target behavior in a desirable direction. For the next 10 to 14 days, students collected and plotted data on the target behavior during this intervention phase. Finally, students conducted an analysis and interpretation of the data from their personalized project, using statistical process control (SPC) procedures (Hart & Hart, 2002).

SPC analysis, and control charts in general, are common strategies within manufacturing to evaluate and maintain quality control of products. Shewhart (1931) introduced the method to manufacturing in the 1920s, and SPC analysis eventually became the gold standard for evaluating product quality, initiating the total quality management revolution (Berman, 1995). In recent years, behavioral scientists and health care professionals have argued the merits of SPC for evaluating behavioral data, including clinical interventions (Callahan & Barisa, 2005; Carey & Lloyd, 1995; Orme & Cox, 2001; Pfadt & Wheeler, 1995).

As is often the case, many students chose target behaviors they considered to have health consequences, including exercise and dietary habits. Actual data from one student’s project, plotted on a time-series graph with SPC analysis, appear in Figure 1. The graph depicts the number of calories consumed by snacking in the evening following dinner. For this student, evening snacking was undesirable and the goal of the project was to reduce this postmeal consumption. Horizontal lines running through both the baseline and intervention phases of the graph depict the mean evening calories consumed during baseline (solid line) and a 2 SD band or confidence interval (referred to as upper and lower control limits in SPC language) about this mean. In SPC analysis, control limits calculated on baseline data serve as criteria for interpreting behavior change during the intervention phase. Data that fall outside the control limits, as evident especially in later portions of the intervention phase in Figure 1, indicate statistically rare, or “special cause,” data. Such deviations from baseline responding are usually interpreted as evidence of an independent variable or intervention effect. The results depicted in Figure 1 are fairly typical of those collected by students in the current class project.

Students completed a 10-item multiple-choice quiz (pretest) specific to single-case research design and statistical process control during the first day of class. Most of the instruction regarding single-case epistemology and data collection, including discussion of how to plot data on a time-series graph, occurred late in the session, as single-case research is among the last chapters in the text used in this class (Leary, 2008). On the last day of class, students completed the same quiz (posttest) for a second time. Although data for only 10 students were available for both pretest ($M = 6.8$) and posttest ($M = 7.8$), the results of a dependent $t$ test indicated a significant increase in mastery of single-case research design and statistical process control, $t(9) = -3.35$, $p < .004$, $d = .70$.

The single-case behavior change project recommends itself to instructors of research methods courses for several reasons. First, students are necessarily actively involved in their project, a variable known to enhance learning (Menges & Dobroski, 1977; Yoder & Hoechevar, 2005). Second, because students collect

![Student Calorie Consumption](image)

**Figure 1.** Control chart for actual student’s evening calorie consumption. The solid line represents the mean calorie consumption calculated for the baseline data, and the two dotted lines represent upper and lower control limits, or a 2SD confidence interval about the mean.
personally relevant data, their attention to the project and their interest in the actual data generated are nearly guaranteed. Third, the project is quite manageable, even within the considerable constraints of the intensive format, because students are able to accomplish all phases of data collection and analysis within the necessary time frame. Because students are collecting personal data not intended for public dissemination, no institutional review board review is necessary. Consequently, students can identify a target behavior and begin data collection soon after they receive the assignment. Fourth, SPC analysis allows students to use predetermined quantitative criteria, rather than personal judgment, to evaluate behavior change. Perhaps most important, the project allows for an intimate, hands-on experience, making the scientific enterprise less amorphous and mysterious to the student.

Although students in the course studied here conducted their behavior change projects in a short, intensive format, longer academic sessions would afford students an opportunity to explore additional features of single-case designs. Single-case designs are experimental designs, and like other experimental strategies, they vary in their ability to control for threats to internal validity. With additional course time, students could collect data across several phase changes, allowing for potential replication of the treatment effect. Additional project phases also set the stage for discussions of the value of replication in research, and the various advantages and disadvantages of single-case design alternatives, such as reversal, multiple-baseline, and changing criterion designs (Morgan & Morgan, 2009). Finally, students can be encouraged to compare the results of their SPC analyses to alternative analyses. Numerous strategies for analyzing single-case data exist, some having been introduced quite recently. Some of these analyses require fairly simple calculations and lead to intuitive interpretation, and students engaged in a comparative exercise would be making contact with state-of-the-art developments in the field of single-case design and analysis (Fisher, Kelley, & Lomas, 2003; Parker & Brossart, 2003; Parker & Hagan-Burke, 2007).

References


Note

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