QUANTITATIVE RESEARCH DESIGNS: EXPERIMENTAL

A Definition of Experimental Research, When to Use It, and How It Developed

Experimental researchers test an idea (or practice or procedure) to determine its effect on an outcome. Researchers decide on an idea with which to "experiment," assign individuals to experience it (and have some individuals experience something different), and then determine whether those who experienced the idea or practice performed better on some outcome than those who did not experience it.

The ideas used in experiments today were mostly in place by the first few decades of the 20th century. The procedures of comparing groups, assigning individuals to treatments, and statistically analyzing group comparisons had been developed by 1940. During the 1960s, the types of experimental designs were identified and the strengths (e.g., control over potential threats) of these designs specified by 1980. Since 1980, computers, improved statistical procedures, and more complex designs have advanced experimental research.

Key Characteristics of Experimental Research

Today, several key characteristics help us understand and read experimental research. Experimental researchers randomly assign participants to groups or other units. They provide control over extraneous variables to isolate the effects of the independent variable on the outcomes. They physically manipulate the treatment conditions for one or more groups. They then measure the outcomes for the groups to determine if the experimental treatment had a different effect than the non-experimental treatment. This is accomplished by statistically comparing the groups. Overall, they design an experiment to reduce the threats to internal validity and external validity.

Types of Experimental Designs

Various aspects of these characteristics are included in types of experimental designs. There are several types of between-group designs. A "true" experiment involves random assignment of participants to groups or units. This form of an experiment is the most rigorous and controlled of all types. A quasi-experimental design involves the use of an intervention, but not random assignment of participants to groups. A factorial design also involves two or more groups, but the researcher tests for the interaction of two or more independent variables.

Another type of design involves a within-group or within-individual procedure in which a single group or single individuals are studied. A time series design involves studying a single group and collecting typically more than one outcome measure. A repeated measures experiment also involves only one group, but the researcher tests more than one intervention with this group by alternating administrations of the experimental treatment.

A single-subject design examines one individual at a time by establishing a baseline of behavior for the individual, administering the intervention, and determining the long-term impact of the intervention on behavior when it is withdrawn.

TABLE 10.3

Types of Between-Group Designs

True Experimental Designs

Pre- and Posttest Design **Time** →

Random assignment	Control Group	Pretest	No Treatment	Posttest
Random assignment	Experimental Group	Pretest	Experimental Treatment	Posttest

Posttest-Only Design **Time** →

Random assignment	Control Group	No Treatment	Posttest
Random assignment	Experimental Group	Experimental Treatment	Posttest

Quasi-Experimental Designs

Pre- and Posttest Design **Time** →

Select Control Group	Pretest	No Treatment	Posttest
Select Experimental Group	Pretest	Experimental Treatment	Posttest

Posttest-Only Design **Time** →

Select Control Group	No Treatment	Posttest
Select Experimental Group	Experimental Treatment	Posttest

Ethical Issues in Experimental Research

Ethical issues in conducting experiments relate to withholding the experimental treatment from some individuals who might benefit from receiving it, the disadvantages that might accrue from randomly assigning individuals to groups. This assignment overlooks the potential need of some individuals for beneficial treatment. Ethical issues also arise as to when to conclude an experiment, whether the experiment will provide the best answers to a problem, and considerations about the stakes involved in conducting the experiment.

Steps in Conducting an Experiment

The steps in experimental research involve deciding if an experiment is the best design, forming hypotheses, and selecting the experimental unit and participants to be involved in the experiment. The researchers might randomly assign individuals to groups. They then administer the intervention by conducting the experiment, and they analyze and report results. To evaluate the success of this process, the experimenter assesses the groups, intervention, measures or observations, and extraneous factors and control over threats to validity.

Evaluating an Experiment

A good experiment has a powerful intervention, groups few in number, derived in some systematic way, and where individuals will gain from the experiment. The scores on the measures are both valid and reliable because the researcher has attended to potential threats of validity.

USEFUL INFORMATION FOR PRODUCERS OF RESEARCH

- When you design an experimental study, use the six characteristics as major features of your "Methods" discussion: random assignment, control over extraneous variables, and manipulation of the treatment conditions, outcomes, measures, comparison groups, and threats to validity.
- Use random assignment of participants to groups whenever possible. This equating of groups removes many potential threats to validity in drawing inferences from scores.
- When designing and writing an experiment, distinguish between random selection and random assignment in your discussion—they serve two different purposes in research.
- Consider how you will control for extraneous factors in an experiment. Use pretests, statistically control for covariates, match participants, or select homogeneous samples to better control for characteristics of participants that might influence the relationship between the independent and dependent variables.
- In designing your study, distinguish in the "Methods" section the treatment variable, your intervention, and the actual treatment condition you manipulate.
- Also in designing your study, clarify the experimental outcome (the dependent variable) you seek to measure.
- Select a type of experimental design based on Table 10.1, and identify the potential threats to internal validity that typically relate to this design.
- In most experimental research, the statistical test of choice is a group comparison statistic, such as the t test, ANOVA, or ANCOVA.
- In planning your experiment, it might be helpful to draw a visual picture of the flow of procedures in your experiment, such as is shown in Table 10.3.
- When designing and conducting your experiment, follow the eight-step process as a general guide for your procedures.

TABLE 10.1

Types of Experimental Designs

	True Experiment	Quasi-Experiment	Factorial	Time Series	Repeated Measures	Single Subject
Random assignment?	Yes	No	May be used	No	No	No
Number of groups/ individuals compared?	Two or more	Two or more	Two or more	One group	One group	One individual studied at a time
Number of interventions used?	One or more interventions	One or more interventions	Two or more interventions	One or more interventions	Two or more interventions	One or more interventions
Number of times the dependent variables measured/ observed?	Once	Once	Once	After each intervention	After each intervention	Multiple points
Controls typically used?	Pretest, matching, blocking, covariates	Pretest, matching, blocking, covariates	Pretest, matching, blocking, covariates	Group becomes its own controls	Covariates	Individuals become their own control

USEFUL INFORMATION FOR CONSUMERS OF RESEARCH

- In reviewing an experimental study, recognize that researchers study different experimental units, such as individuals, groups, or entire organizations.
- When you read an experiment, realize that the researcher may not have randomly assigned individuals to groups because of practical limitations in the experimental situation. These experiments, called quasi-experiments, are still valuable, but they do not have the same rigor as true experiments.
- Recognize that all types of experiments involve an intervention where the investigator manipulates a treatment variable. Ask yourself as you read an experimental study, "What variable does the researcher physically manipulate?"
- Researchers should identify the type of experimental design they use in a research report. If this is unclear, use Table 10.1 and the criteria differentiating the designs as a guide to determine the type they use.
- Also useful in determining the type of experimental design in a study is to recognize that there are two broad types: between-group (in which the researcher compares several groups) and within-group (in which the researcher compares only one group or its variation, a within-individual design).

CORRELATIONTAL

The Definition, Use, and Development of Correlational Research

In some educational situations, neither the treatment nor the ability to manipulate the conditions are conducive to an experiment. In this case, educators turn to a correlational design. In correlational research, investigators use a correlation statistical technique to describe and measure the degree of association (or relationship) between two or more variables or sets of scores. You use a correlational design to study the relationship between two or more variables or to predict an outcome.

The history of correlational research draws on the themes of the origin and development of the correlation statistical test and the procedures for using and interpreting the statistical test. Statisticians first identified the procedures for calculating the correlation statistics in the late 19th century. In the late 1800s, Karl Pearson developed the familiar correlation formula we use today. With the use of multiple statistical procedures such as factor analysis, reliability estimates, and regression, researchers can test elaborate models of variables using correlational statistical procedures.

Types of Correlational Designs

Although a correlation is a statistic, its use in research has contributed to a specific research design called correlational research. This research has taken two primary forms of research design: explanation and prediction. An explanatory correlational design explains or clarifies the degree of association among two or more variables at one point in time. Researchers are interested in whether two variables co-vary, in which a change in one variable is reflected in changes in the other. An example is whether motivation is associated with academic performance. In the second form of design, a prediction design, the investigator identifies variables that will positively predict an outcome or criterion. In this form of research, the researcher uses one or more predictor variables and a criterion (or outcome) variable. A prediction permits us to forecast future performance, such as whether a student's GPA in college can be predicted from his or her high school performance.

Key Characteristics of Correlational Designs

Underlying both of these designs are key characteristics of correlational research. Researchers create displays of scores correlated for participants. These displays are scatterplots, a graphic representation of the data, and correlation matrices, a table that shows the correlation among all the variables. To interpret correlations, researchers examine the positive or negative direction of the correlation of scores, a plot of the distribution of scores to see if they are normally or non-normally distributed, the degree of association between scores, and the strength of the association of the scores. When more than two variables are correlated, the researcher is interested in controlling for the effects of the third variable, and in examining a prediction equation of multiple variables that explains the outcome.

Ethical Issues in Conducting Correlational Research

Ethical issues arise in many phases of the correlational research process. In data collection, ethics relate to adequate sample size, lack of control, and the inclusion of as many predictors as possible. In data analysis, researchers need a complete statement of findings to include effect size and the use of appropriate statistics. Analysis cannot include making up data. In recording and presenting studies, the write-up should include statements about relationships rather than causation, a willingness to share data, and publishing in scholarly outlets.

Steps in Conducting a Correlational Study

Steps in conducting a correlational study are to use the design for associating variables or making predictions, to identify individuals to study, to specify two or more measures for each individual, to collect data and monitor potential threats to the validity of the scores, to analyze the data using the correlation statistic for either continuous or categorical data, and to interpret the strength and the direction of the results.

Criteria for Evaluating a Correlational Study

Evaluate a correlational study in terms of the strength of its data collection, analysis, and interpretations. These factors include adequate sample size, good presentations in graphs and matrices, clear procedures, and an interpretation about the relationship among variables.

USEFUL INFORMATION FOR PRODUCERS OF RESEARCH

- Identify whether you plan to examine the association between or among variables or use correlational research to make predictions about an outcome.
- Plot on a graph the association between your variables so that you can determine the direction, form, and strength of the association.
- Use appropriate correlational statistics in your design based on whether the data are continuous or categorical and whether the form of the data is linear or nonlinear.
- Present a correlation matrix of the Pearson coefficients in your study.

USEFUL INFORMATION FOR CONSUMERS OF RESEARCH

- Recognize that a correlation study is not as rigorous as an experiment because the researcher can only control statistically for variables rather than physically manipulate variables. Correlational studies do not “prove” relationships; rather, they indicate an association between or among variables or sets of scores.
- Correlational studies are research in which the investigator seeks to explain the association or relationship among variables or to predict outcomes.
- Realize that all correlational studies, no matter how advanced the statistics, use a correlation coefficient as their base for analysis. Understanding the intent of this coefficient helps you determine the results in a correlational study.

SURVEY

Defining Survey Research, When to Use It, and How It Developed

Although broad in scope, survey research is a form of quantitative research in which the investigator identifies the sample and the population, collects data through questionnaires or interviews, and draws conclusions or makes inferences about the population. It is a useful design to use when researchers seek to collect data quickly and economically, study attitudes and opinions, and survey geographically dispersed individuals.

Types of Survey Designs

Surveys are also useful for assessing information at one point in time (a cross-sectional study) or over time (a longitudinal study). Cross-sectional studies are of several types. They can:

- examine current attitudes, beliefs, opinions, or practices.
- compare two or more educational groups in terms of attitudes, beliefs, opinions, or practices.
- assess community needs for educational services.
- be used to evaluate programs.
- be used statewide or nationally to survey many participants across a large geographic area.

Longitudinal surveys may assess changes over time with trends of a population, changes in a cohort group or subpopulation of a population, or changes in a panel of the same individuals over time.

Key Characteristics of Survey Research

Survey researchers emphasize sample selection of a sample from a population to which they can generalize results; collect data using questionnaires and interviews that vary in forms (e.g., mailed questionnaires, Web-based questionnaires, one-on-one interviews, telephone interviews, and focus group interviews) and weigh the advantages and disadvantages of each; administer well-tested instruments with good questions and scales; and seek a high response rate from participants using procedures that will ensure a high return rate and will not be biased.

Constructing and Using a Mailed Questionnaire

The design of a mailed questionnaire involves several components. It consists of a cover letter to invite participants to complete the questions, and the construction of an instrument that is of appropriate length and that contains an opening beginning with demographic questions, a series of closed-ended questions, and closing statements. The data analysis consists of checking for response rate and bias, descriptive statistics, and inferential statistics to analyze the research hypotheses or questions.

Designing and Conducting an Interview Survey

When interview surveys are used, researchers need to establish rapport and gain the confidence of the interviewee. This often requires training for the interviewee, attending to issues in the process of interviewing, and using an interview guide.

Potential Ethical Issues in Survey Research

Ethical issues in survey research involve engaging in good practices. Often survey research is exempt by institutional review boards. During data collection, attention needs to be given to using appropriate incentives and delivering on benefits guaranteed. The survey data collection procedure cannot put data collectors at risk for their safety. Safety applies to the respondents or participants as well. Confidentiality of their responses needs to be protected, along with minimizing links between data respondents and participants. IDs linked to responses can be an effective means of protecting individual identity. Also, the researcher has an obligation to destroy survey instruments after the conclusion of the study.

Steps in Conducting Survey Research

The steps in conducting a survey consist of determining if a survey design is the best design to use, forming questions or hypotheses, and identifying a population and a sample to study. Then the researcher selects the type of survey to reach this sample or population, collects data to ensure a good rate of response and minimal response bias, and statistically analyzes the data to answer descriptive questions or to address relationship or comparison questions or hypotheses.

Criteria for Evaluating Survey Research

A good survey study includes the identification of the population and the sample, contains an adequate-sized sample systematically derived, employs a cross-sectional or longitudinal design, specifies the instruments (and includes sample questions), determines whether scores from them will likely be reliable and valid, uses appropriate data analysis procedures to answer the questions or hypotheses, and is written acknowledging ethical issues and using a standard structure.

USEFUL INFORMATION FOR PRODUCERS OF RESEARCH

- Identify whether your study is cross-sectional or longitudinal. Longitudinal surveys take more time to complete because you are studying individuals over time.
- In your research, distinguish between the population, the target population, and your sample. Choose a random sample so that you can generalize to your population.
- Consider the sources of error that may affect your ability to generalize findings or results to the population.
- Specify the type of data collection instrument that you use, such as questionnaires or interviews.
- Conduct a pilot test of your questions, whatever your type of data collection instrument, so that it can provide useful information.

- Be aware of how you pose sensitive questions to participants. Realize that they may need some introductory comments before you ask participants to respond to sensitive questions.
- A number of potential problems arise when you create your own questions. Study Table 12.1 for a list of problems you should avoid when writing your own questions.

TABLE 12.1

Common Problems in Item Construction in Survey Designs

Example of a Poor Question	Problem	Example of an Improved Question
Do you support gun control? _____ Yes _____ No _____ Don't know	Unclear question because of vague words	Do you believe that guns do not belong in schools? _____ Yes _____ No _____ Don't know
Do you believe that guns and knives do not belong in schools? _____ Yes _____ No _____ Don't know	Two or more questions (see the conjunction "and")	Do you believe that knives do not belong in schools? _____ Yes _____ No _____ Don't know
Whenever violence occurs in schools, weapons are typically found in school lockers. Do you believe that students should have guns in their lockers? _____ Yes _____ No _____ Don't know	Wordy or lengthy questions	Should students have guns in their lockers? _____ Yes _____ No _____ Don't know
Students should not carry weapons and not have them in their lockers. Do you agree? _____ Strongly agree _____ Agree _____ Undecided _____ Disagree _____ Strongly disagree	Question contains negatives	Should students have guns in their lockers? _____ Yes _____ No _____ Don't know
Should students pack a .45 at school? _____ Yes _____ No _____ Don't know	Question contains jargon	Should students carry a handgun at school? _____ Yes _____ No _____ Don't know
How many times have you seen a student carry a handgun? _____ 0 times _____ 1–2 times _____ 2–3 times _____ More than 3 times	Response categories overlap	How many times have you seen a student carry a handgun? _____ 0 times _____ 1–2 times _____ 3–4 times _____ More than 4 times
To what extent do you feel that handguns are a problem at your school? _____ A great extent _____ Some _____ Not very important _____ Not a problem	Unbalanced response options	To what extent do you feel that handguns are a problem at your school? _____ A great extent _____ Some extent _____ Little extent
To what extent do you feel that handguns are a problem at your school? _____ Very important _____ Important _____ Little importance	Mismatch between the question and the responses	To what extent do you feel that handguns are a problem at your school? _____ A great extent _____ Some extent _____ Little extent

TABLE 12.1

(Continued)

Example of a Poor Question	Problem	Example of an Improved Question
How often have you seen students carry semi-automatic weapons at school? _____ None _____ 1 time _____ 2 times _____ 3 or more times	Respondent does not have understanding to answer question	How often have you seen students carry a rifle at school? _____ None _____ 1 time _____ 2 times _____ 3 or more times
How many students have you seen carrying guns at school? _____ 1 student _____ 2 students _____ 3 students _____ More than 3 students	Not all respondents can answer the question—branching needed	Have you seen students carrying guns at school? _____ Yes _____ No → If Yes, how many students? _____ 1 student _____ 2 students _____ 3 students _____ More than 3 students

- A typical high response rate is above 50%, but check for response bias through wave analysis when you use a mailed questionnaire.
- Design a mailed questionnaire to include a cover letter, a clear layout of questions, and instructions to the participant. You should keep your instrument as short as possible.
- If you conduct an interview, adopt a neutral stance and record responses accurately.

USEFUL INFORMATION FOR CONSUMERS OF RESEARCH

- Surveys are used for many purposes in research. When evaluating a study, consider the intent of the author to describe trends, determine attitudes or opinions, describe characteristics of a population, identify practices, evaluate programs, or follow up on individuals over time.
- Mailed questionnaires are a popular form of data collection in educational research. However, these instruments need to be carefully designed. Determine whether the researcher used attitudinal, behavioral, or demographic questions in the instrument.
- A questionnaire response rate of 50% is considered adequate for most surveys. Examine the response rate of a survey study published in the literature and determine if it reaches this percentage. Also consider whether survey researchers addressed the question of response bias and checked to determine if their responses were biased.