Experimental Research

Chapter 13

Definition

- The only type that can test hypotheses to establish cause-and-effect relationship
- Permits global predictions
  - “If you use approach A you will probably get better results than if you use approach B.”

Defining Characteristics

- Research designed to investigate cause and effect relationships through the direct manipulation of an independent variable and control of extraneous variables
  - Independent variable
  - Dependent variable
  - Researcher manipulation and control – choice of treatments, choice of a research design, use of specific procedures, etc.
Experimental Process

- Hypothesis states an expected causal relationship between two variables
- Findings support or do not support hypothesis

Experimental Process

- Random selection of participants
- Random assignment of participants to groups
  - Experimental Group receives the new treatment
  - Control Group receives the current treatment
  - Groups also called comparison groups, treatment groups, or Group A and Group B

Experimental Process

- Groups must be equated on all variables the might influence the dependent variable
  - The groups should start as equivalently as possible on every variable except the independent variable.
  - This is mainly accomplished through simple or stratified random sampling
Experimental Process
- Selection of instrument(s)
- Selection of research plan
  - Comparison of two approaches
  - Comparison of new versus existing approaches
- Comparison of different amounts of single approach
- After the groups have been exposed to the treatment, collect data on the dependent variable.
- Analysis of data to determine if there is a true (significant) difference between their performance
- Formulation of conclusions

Manipulation and Control
- Manipulation
  - The researcher decides what treatments will make up the independent variable and which group will be randomly assigned to which treatment
- Control
  - The researcher’s efforts to remove the influence of any extraneous variables that might have an effect on the dependent variable.
  - The goal is to assure the only differences between groups is that related to the independent variable

Independent Variable
- Also called treatment, causal, or experimental variable
- The treatment or characteristic believed to make the difference
  - Method of instruction, type of reinforcement, arrangement of learning environment, type of learning materials, length of treatment
Dependent Variable

- Also called *criterion, effect, or posttest variable*
- The outcome of the study; the change or difference in groups that occurs as a result of the independent variable
- Must be measurable
  - Test scores, attendance, number of suspensions, attention span

Manipulation of Independent Variable

- Manipulation of the independent variable differentiates experimental research from other designs
- Researcher determines "who gets what"
- Researcher decides what treatments will make up the independent variable and which group will be randomly assigned to which treatment

Random Sampling

- Researcher controls *selection and assignment* of participants
  - *Selection* – participants randomly selected from a single population
  - *Assignment* – researcher randomly assigns participants into the different treatment groups (contrast with causal-comparative)
Control of Experimental Validity

Experimental Validity

- An experiment is valid if
  - the results are due to the manipulated independent variable and
  - if the results are generalizable

Types of Experimental Validity

- Internal Validity – the degree to which the results are attributable to the independent variable and not some other rival explanation (e.g., IQ not instructional method)

- External Validity – the extent to which the results of a study are generalizable (e.g., participants were all high SES)
“Catch-22”
- Maximizing internal validity endangers external validity and vice versa
- Compromise between a highly controlled and a highly natural study environment
- Err on the side of control
- Without internal validity, the study is worthless

Threats to Internal Validity

History
- Unexpected events occurring during the study (e.g., measles outbreak)
- The longer the study, the more likely that this will be a threat

Maturation
- Participants naturally change physically, intellectually, emotionally during the study
- Threat for long-lasting studies

Threats to Internal Validity

Testing
- Taking a pretest may improve posttest performance, regardless of treatment
- Threat when time between testing is short or when test measures factual information that can be recalled
Threats to Internal Validity

- **Instrumentation**
  - Measuring instrument is changed between pre- and posttest, or instrument is unreliable.

- **Statistical Regression**
  - Extremely high or low scores tend to regress toward the mean on posttesting.

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Threats to Internal Validity

- **Differential Selection of Participants**
  - Already formed groups are compared (cluster sampling)
  - Initial differences may account for posttest changes

- **Mortality**
  - Participants drop out of study
  - Changes the characteristics of the groups

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Threats to Internal Validity

- **Selection-Maturation Interaction, etc.**
  - Deals with cluster sampling
  - Participants have different maturation rates
  - Less common – different histories and test factors
Threats to External Validity

- **Pretest – Treatment Interaction**
  - Participants react differently to treatment because they have been pretested
  - May be alerted or sensitized to nature of treatment
  - Self-report measures (attitude, interest) are particularly susceptible
    - Unobtrusive measures – gather data from inanimate sources, such as records, transcripts

Threats to External Validity

- **Multiple-Treatment Interference**
  - Participants receive more than one treatment in succession, or
  - Participants have already participated in a previous study.
  - Allow sufficient time to elapse between treatments, and
  - Investigate distinctly different independent variables

Minimizing Threats to Interval Validity

Control of Extraneous Variables
Control of Extraneous Variables

- Randomization
  - Randomly selected from the population
  - Randomly assigned to treatment groups
- Matching
  - Pairs of subjects “matched” on specific characteristics of interest (e.g., IQ)
  - Randomly assigning subjects from each pair to different groups
  - Difficulty with subjects for whom no match

Control of Extraneous Variables

- Compare homogeneous groups
  - Restricting subjects to those with similar characteristics (e.g., IQ)
  - Problems related to restriction of generalization
- Compare homogeneous subgroups
  - By using stratified random sampling (e.g., low, medium, and high IQ in each treatment group; analyze subgroup results if subgroups contain enough participants)

Control of Extraneous Variables

- Analysis of Covariance (ANCOVA)
  - Statistical method for equating groups
- Participants as own controls
  - Expose a single group to different treatments one treatment at a time
  - Helps control for participants differences
  - Carryover effect (Multiple-Treatment Interference)
Experimental Designs

Types

- **Group**
  - Each treatment group contains a minimum of 30 participants
- **Single Subject**
  - Study behavior change in an individual as the result of some treatment
  - Research is focused on therapeutic impact in clinical settings, not contribution to a research base

Group Designs

- **Pre-experimental Design**
  - Uses only one group
  - Does poor job of controlling threats to validity
  - May be useful for preliminary investigation
- **Quasi-experimental Design**
  - Used when random assignment of individual participants is not possible or not feasible
  - Cluster Sampling
True Experimental Design
- Random assignment of individual participants to treatment groups
- Has a control group
- May have more than two groups

True Experimental Design
- Types
  - Pretest-posttest control group design
  - Posttest only control group design
  - Solomon four-group comparison
  - Figure 13.2, p. 375

Solomon Four-Group Design
- 2 X 2 factorial with treatment and control groups crossed with pretesting and nonpretesting
- If the pretested experimental group performs differently on the posttest than the unpretested experimental group, there is probably a pretest-treatment interaction (threat to external validity)