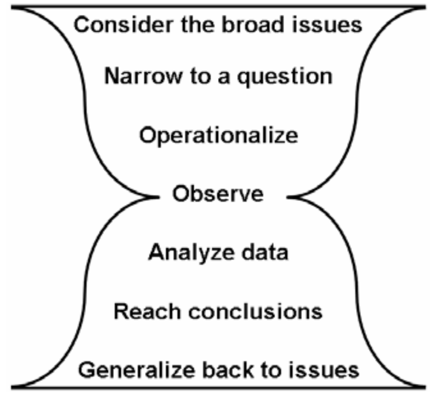
Research Meeting Notes for January 26, 2007

Research process



Trochim likens the process of conducting research to that of passing an idea through an hourglass. The researcher starts with a consideration of the larger issues of interest, and these are then narrowed into a specific question (hypothesis) that can be evaluated with some degree of control. The components of the hypothesis are *operationalized* into observable units and behaviors to ensure that the independent and dependent variables can be observed and measured. Research is then conducted to observe the relationships of interest, in the context of the specified research environment. Observations are made, and data are collected to reflect behaviors, changes, and other indicators of interest. The data are filtered and analyzed in order to generate conclusions that may support or refute the hypothesis, and then everything is considered in the context of the bigger picture, which usually includes reference and association to the broad issues that started the process.

Criteria and considerations necessary for a well-designed research study (all from Wiersma)

Throughout his text, Wiersma presents numerous guidelines and criteria that contribute to a well-designed study. While all of these items should be considered in a logical and thoughtful manner, it is important to note that no experiment can satisfy all of these criteria. In some cases, the criteria are in conflict with one another, so tradeoffs are necessary.

Characteristics of good research design

1. Freedom from bias (ensure that the method of data collection and analysis will not cause the data to vary in a systematic way)
2. Freedom from confounding (ensure that the variables are separated so they do not influence each other)
3. Control of extraneous variables (ensure that variables which are not under scrutiny do not influence the experimental variables in a systematic way – often things like temperature, time of day, etc.)
4. Statistical precision for testing hypotheses (ensure that the data are recorded at a level of precision that will yield statistically meaningful results)

Criteria for a well-designed experiment

1. Adequate experimental control
2. Lack of artificiality
3. Basis for comparison
4. Adequate information from the data
5. Uncontaminated data
6. No confounding of relevant variables
7. Representativeness (generalizability)
8. Parsimony (simpler design is always better than a more complex design, all things being equal)

Characteristics of good hypotheses
(from Borg, W.R. and Gall, M.D. 1989. *Educational research: An introduction*, pp. 68-69):

1. The hypothesis should state an expected relationship between two or more variables.
2. The researcher should have definite reasons based on either theory or evidence for considering the hypothesis worthy of testing.
3. A hypothesis should be testable.
4. A hypothesis should be as brief as possible consistent with clarity.

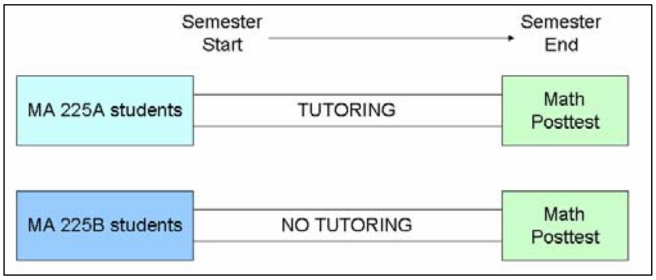
Research designs

While research studies can take many different forms, there are a handful of general research designs that are encountered in educational research. These designs include the following: Posttest-only control group design, pretest-posttest control group design, Solomon four-group design, factorial designs, and repeated measures designs. Note that there is no one "correct" design for a study, but rather a range of design options based on goals and constraints (e.g. timeline, available resources, and data analysis requirements).

The following example scenario will be used to illustrate each design: *Jo is a math instructor who would like to evaluate the effectiveness of a tutoring program for students in an Advanced Calculus course. Jo teaches four course sections (MA225A, MA225B, MA225C, MA225D), and measures performance via student homework and test grades.*

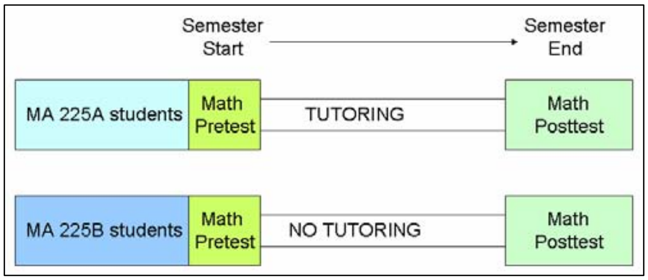
Posttest-only control group design: In this design, all study participants receive a posttest (after treatment) to determine if there are differences between the groups. The main features are that at least one control group and one treatment group are included, and all study participants receive a posttest after the treatment.

Example: Jo's MA225A students receive tutoring, while Jo's MA22B students do NOT receive tutoring. At the end of the semester, Jo compares the grades of students in MA225A with students from MA225B.



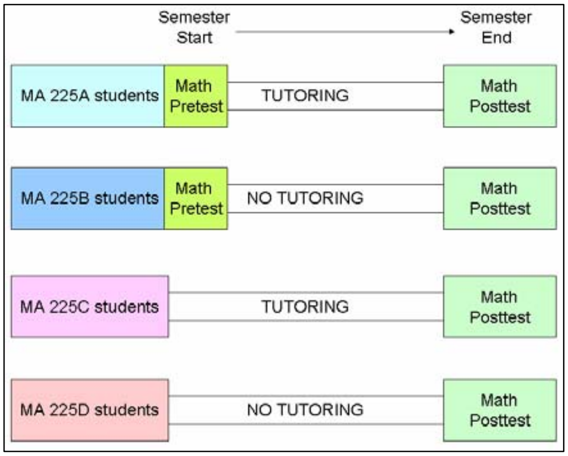
Pretest-Posttest control group design: In this design, all study participants receive a pretest and posttest (after treatment) to determine if there are differences between the groups. Unlike the posttest-only control group design, ALL study participants receive a pretest in addition to a posttest.

Example: At the beginning of the semester, Jo administers an Advanced Calculus exam to students in MA225A and MA22B. Jo's MA225A students receive tutoring, while Jo's MA22B students do NOT receive tutoring. At the end of the semester, Jo again administers an Advanced Calculus exam to students in both sections and compares them.



Solomon Four-Group Design: This design was developed to address the possibility that the administration of a pretest actually serves to bias participants – making participants more likely to perform in a different way than they would if they weren't aware that they were in a study. To examine whether the pretest influences participant performance, two groups of participants are added to the study: One control group and one treatment group that ONLY receive the posttest.

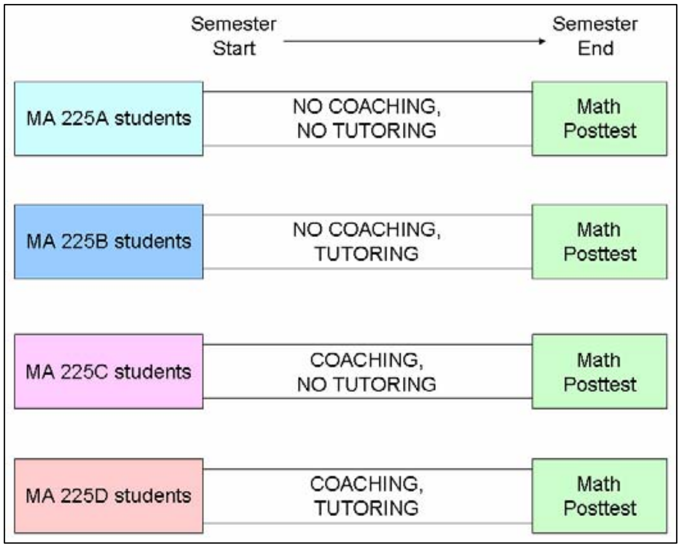
Example: At the beginning of the semester, Jo administers an Advanced Calculus exam to students in MA225A and MA22B. Jo also teaches MA225C and MA225D, and these students do NOT receive the Advanced Calculus exam. Jo's MA225A and MA225C students receive tutoring, while Jo's MA225B and MA225D do not receive tutoring. At the end of the semester, Jo administers the Advanced Calculus exam to ALL students and compares them.



Factorial designs: These designs are common in educational research, and feature at least two variables that have two levels. The variables are measures to identify potential effects associated with treatment, and *interactions* between variables are of great interest. Interactions occur when the effect of one variable does not remain constant with another variable, but instead, the effect is much greater or much less when associated with the other variable.

Example: At the beginning of the semester, Jo decides to provide students with "math coaching" as well as tutoring. Therefore, Jo is studying 2 factors – coaching (present or not present) and tutoring (present or not present). Jo's classes receive the following treatments:

MA225A: No coaching, No tutoring
MA225B: No coaching, Tutoring
MA225C: Coaching, No tutoring
MA225D: Coaching, Tutoring



By comparing the performance of students between different classes, Jo can determine if either coaching or tutoring yields a benefit in performance. In addition, Jo can look for an interaction – perhaps students perform MUCH BETTER when they receive BOTH coaching and tutoring, but only somewhat better when they receive only coaching or only tutoring.

Repeated measures designs: These designs feature the measurement of participants on more than one occasion (e.g. to measure memory retention or learning curves). In other respects, these designs are similar to the designs listed above.

Example: Jo decides to administer math tests every week to determine if student performance will improve over time. MA225A students receive tutoring, while MA225B student do not receive tutoring. By testing every week, Jo can observe whether student performance improves over time (perhaps as an indicator of reduced test anxiety). Jo can also determine if students in the tutoring or no tutoring condition perform better over time.