

Experimental Design

AP Statistics | Collecting Data | experiments, random assignment, blocking, matched pairs

1. Observational study or experiment?

Observational study	Experiment
researchers only watch and record	researchers <i>impose</i> a treatment
people choose for themselves	the researcher decides who gets what
can show an association only	can show cause and effect

Confounding: two variables are mixed together so their effects on the response cannot be separated. “Students who chose a study app score 8 points higher”: 13 of the 16 highly motivated students chose the app. App, or motivation? You cannot tell. Motivation is a *confounding variable*: it is related to the explanatory variable *and* to the response.

2. The vocabulary

Experimental units	who or what gets the treatment (<i>subjects</i> if people)	40 students
Explanatory variable (factor)	what the researcher changes	app or no app
Treatments	the specific conditions applied	app; no app
Response variable	the outcome that is measured	test score

3. Four principles of a good experiment

Comparison, random assignment, control, replication

1. **Comparison:** at least two groups, often including a *control group*.
2. **Random assignment:** chance decides who gets which treatment. It creates groups that are *roughly equivalent* on every variable, even ones nobody measured (here the motivated students split 9 and 7), so the treatment is the only systematic difference.
3. **Control:** keep everything else the same for all groups.
4. **Replication:** enough units in each group for a real difference to stand out from chance variation.

How to describe it: number the students 1–40; use a random number generator to pick 20 *different* numbers; those students get the app, the other 20 do not.

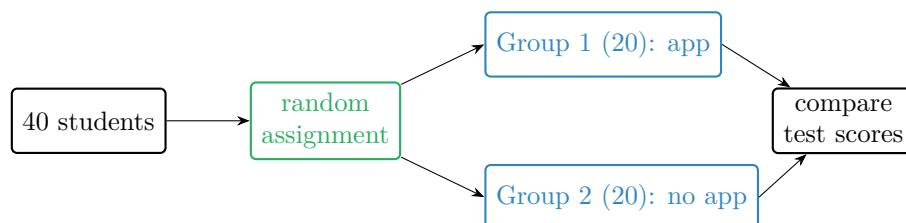
4. Placebo and blinding

- **Placebo effect:** people improve because they *believe* they are being treated. A **placebo** is a fake treatment that looks like the real one.
- **Single-blind:** the subjects do not know which treatment they received (or those measuring the response do not).

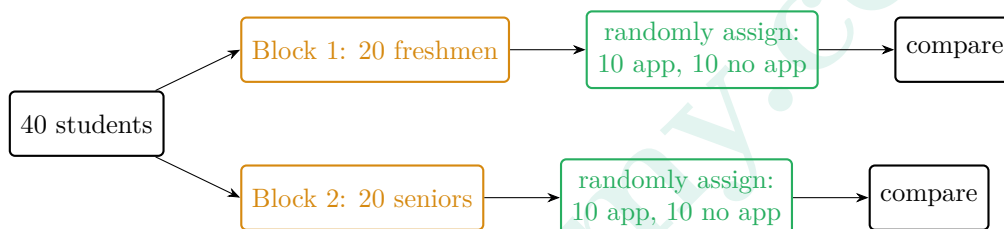
- **Double-blind:** neither the subjects nor the people who interact with them know.

5. Three designs

Completely randomized design: all units are randomly assigned to the treatments in one step.



Randomized block design: first form *blocks* of units that are similar in a way expected to affect the response; then randomly assign treatments *within each block*.



Blocking removes the variation due to the blocking variable, so the treatment effect is easier to see. Blocks are formed on purpose; the randomness happens inside them.

Matched pairs design: blocks of size 2. Either pair similar units and randomly assign the two treatments within each pair, or give each unit *both* treatments in a random *order*.

Where students lose points

1. Confusing random *assignment* (who gets which treatment) with random *sampling* (who is in the study).
2. “Randomly assign” without saying how.
3. Mixing up blocks (formed on purpose) and treatment groups (formed by chance).
4. Naming a confounding variable without linking it to *both* the explanatory variable and the response.
5. Claiming cause and effect from an observational study.

Now practise it

Theory sticks once you use it. On **sad-academy.com** you'll find practice questions for this exact subtopic in the AP format, and an AI that grades your free-response answers against the scoring guidelines, the way an AP reader would.

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