

Algebra 2 - Sampling, Surveys and Experiments - Lesson

Common Core S-IC.A.1, S-IC.A.2, S-IC.B.3, S-IC.B.4, S-IC.B.5, S-IC.B.6 · maths-pdf.fr/en/

A random sample lets you use a statistic to estimate a population parameter, while a biased sample misleads. Surveys and observational studies describe, but only a randomized experiment can show cause and effect. The margin of error of a proportion is about 1 over the square root of the sample size, and simulations show whether a result is unusual.

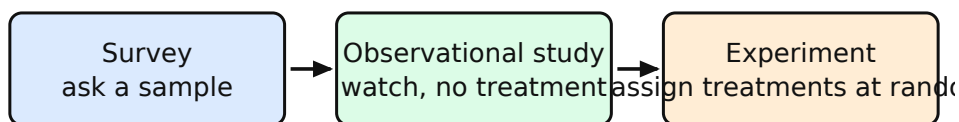
Algebra 2 · Common Core State Standards: **S-IC.A.1, S-IC.A.2, S-IC.B.3, S-IC.B.4, S-IC.B.5, S-IC.B.6**

Key facts

- A random sample is representative; a convenience sample is biased.
- Surveys, observational studies, and experiments answer different questions.
- Random assignment supports cause-and-effect conclusions.
- Margin of error for a proportion $\approx 1/\sqrt{n}$.
- Simulation shows how likely a result is by chance.

What is the difference between a population and a sample?

A **population** is the whole group you want to learn about, and a **sample** is the part you actually measure. A **parameter** describes a population, and a **statistic** describes a sample. Statistics are used to estimate parameters. A **random sample** gives every member an equal chance of being chosen, so the sample is likely to be representative. A sample chosen for convenience, such as only asking friends, is **biased** and can give misleading results.

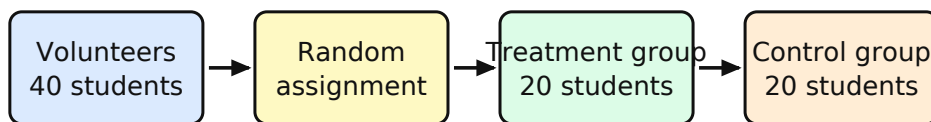


Only an experiment with random assignment can show cause and effect.

Survey, observational study, experiment

A **sample survey** collects responses from a sample. An **observational study** measures subjects without changing anything. In an **experiment**, researchers assign treatments to

subjects. Random assignment to a treatment group and a control group is what allows conclusions about cause and effect.

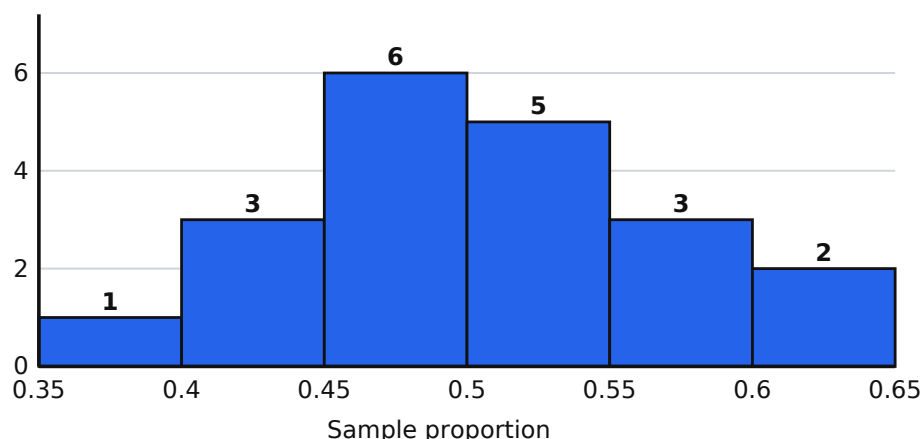


A randomized experiment compares a treatment group with a control group.

Random assignment balances other variables across the groups, so differences in outcomes are likely due to the treatment. In an observational study, hidden **confounding variables** can explain a pattern: ice cream sales and drownings both rise in summer, but ice cream does not cause drowning.

How do you estimate a population value and the margin of error?

If 45 of 150 randomly chosen students prefer an early start time, the sample proportion is $\frac{45}{150} = 0.30$. A simple estimate of the **margin of error** for a proportion is $\frac{1}{\sqrt{n}}$. For $n = 100$, the margin of error is about 0.10, or 10 percentage points. For $n = 400$ it is about 0.05. The sample size matters, not the size of the population, and to cut the margin in half you need four times as many people.

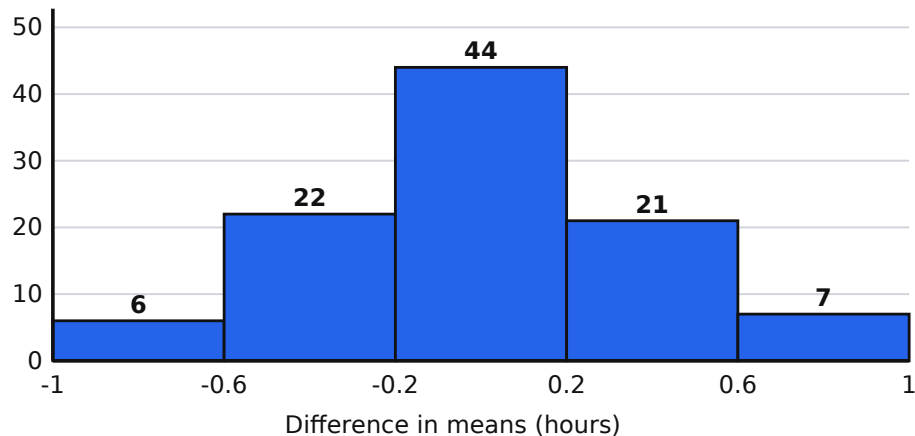


Simulated sample proportions vary from sample to sample: the middle values cluster near the true value.

How can simulation help decide whether a result is unusual?

A **simulation** uses random digits or software to model a chance process many times. Suppose a claim says half of voters support a measure. Simulate many random samples of size 100 from a population where $p = 0.5$. If a sample result such as 68 out of 100 almost never appears in the simulated results, then the claim is not believable. Similarly, in a randomized experiment, re-randomize the group labels many times and see how often a difference as

large as the observed one appears by chance alone.



100 differences in group means after random re-assignment.

Type of study	Who assigns treatment	Can show cause?
Survey	No one	No
Observational study	No one	No (confounding)
Randomized experiment	Researchers, at random	Yes

Which studies can show cause and effect.

Questions about sampling, surveys and experiments

What is a random sample?

A random sample is chosen so that every member of the population has an equal chance of being selected. It tends to represent the population and allows inferences.

What is bias in sampling?

Bias is a systematic error that makes a sample unrepresentative, such as surveying only people who volunteer or only students at one lunch table.

What is the difference between an experiment and an observational study?

In an experiment the researcher assigns the treatments, ideally at random. In an observational study the researcher only measures what already happens.

What is margin of error?

The margin of error describes how far a sample statistic is likely to be from the population value. For a proportion it is about 1 divided by the square root of the sample size.

Why use a simulation?

A simulation shows how much a statistic varies by chance. If an observed result rarely appears in the simulation, it is unlikely to be due to chance alone.