

Exercise walk-through

1.2

The Scientific Method

GAC Science

Method — Key knowledge: define what changes, what is measured and what stays comparable

The **independent variable** 自变量 is the factor deliberately changed. The **dependent variable** 因变量 is the measured response. **Control variables** 控制变量 are conditions kept comparable so they do not explain the difference instead. A testable hypothesis predicts a response that observations could challenge. Repeat trials to study variation and report the actual results; a neat average does not remove every source of uncertainty.

Method — Source A: text or task brief

Fictional teacher-approved room-temperature paper investigation: compare water retained by paper types A and B. Each fresh square is 10 cm by 10 cm. Record its dry mass, immerse it for 60 s in the same water conditions, let it drain for 10 s without squeezing, then record wet mass using the same checked balance. Handle spills as instructed; use no electrical device near wet materials. The teacher provides the prepared results for this written task.

Recorded retained-water masses from three fresh squares of each type: A, 3.0 g, 3.2 g, 2.8 g; B, 4.2 g, 4.0 g, 4.4 g. Retained mass is wet mass minus dry mass. No other brands, immersion times or area sizes were tested.

Method — Source B: response or review record

Review record: one student proposes squeezing type A before weighing but not B. Another writes: “B absorbed exactly 1.200000 g more in every trial, so it is always best for every cleaning job. We can discard any result below our prediction.” The class has not tested strength, cost, cleaning performance or other paper batches.

Method — Worked example: calculate a mean while keeping variation visible

Known: type A retained 3.0 g, 3.2 g and 2.8 g. Why use a mean? It summarises these three trials without pretending they are identical.

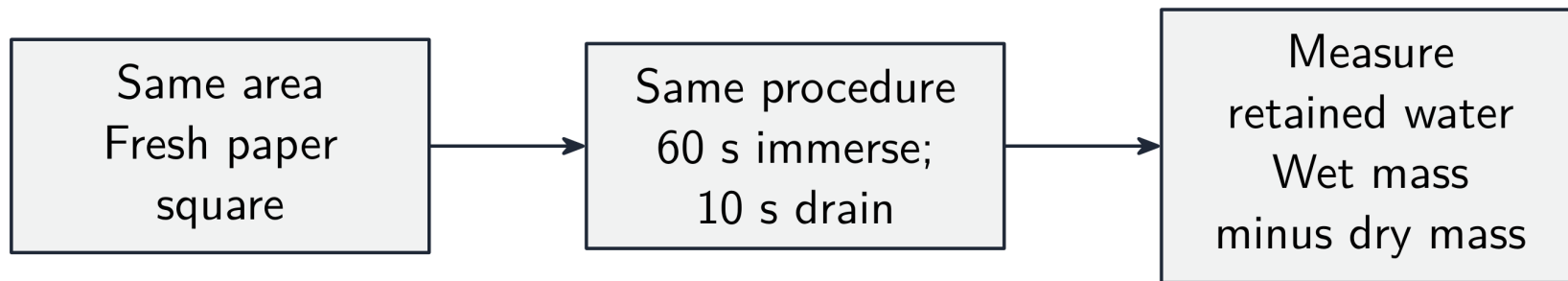
$$\overline{m} = \frac{m_1 + m_2 + m_3}{3}$$

$$\overline{m}_A = \frac{3.0 + 3.2 + 2.8}{3} = 3.0 \text{ g}$$

The spread remains relevant. Keep the same draining method for both types; squeezing one would change the comparison.

Method — Worked example: calculate a mean while keeping variation visible

Known: type A retained 3.0 g, 3.2 g and 2.8 g.



Exercises 2.1-2.3

2.1 Identify the independent variable and dependent variable.

[2]

2.2 State TWO conditions that must be kept comparable.

[2]

2.3 Calculate the mean for B and the difference between the two means, with units. [3]

Exercises 2.1-2.3

2.1 Identify the independent variable and dependent variable. [2]

2.1

: paper type.: retained-water mass, measured as wet mass minus dry mass after the stated procedure.

2.2 State TWO conditions that must be kept comparable. [2]

2.2

each: square area; immersion time; draining time/method; water conditions; checked balance/weighing procedure. Credit distinct relevant controls.

2.3 Calculate the mean for B and the difference between the two means, with units. [3]

2.3

: mean retained mass equals sum divided by three.: $\text{mean B} = (4.2 + 4.0 + 4.4)/3 = 4.2 \text{ g.}$: difference $= 4.2 - 3.0 = 1.2 \text{ g.}$ The difference is between means, not identical in every trial.

Exercises 2.4·3.1

2.4 Explain why squeezing A alone undermines the comparison and why repeats do not repair it. [3]

3.1 Evaluate the student's result claim and data handling using six points. [6]

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2.4

: squeezing can remove retained water.: it changes a condition alongside paper type, so the result cannot isolate that factor.: repeating a systematically unequal procedure does not remove the unequal treatment.

3.1 Evaluate the student's result claim and data handling using six points. [6]

3.1

each: observed B mean is larger; trials vary rather than every difference being 1.2 g; six extra decimal places are unjustified; findings apply to supplied types/procedure/trials; strength/cost/other jobs were untested; retain and explain unexpected data rather than discarding it to match a prediction.

Exercise 3.2

3.2 Write an 80–110-word investigation conclusion with a defensible follow-up.

[8]

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3.2

Local analytic rubric, 8 ×: identify comparison; state both means; state 1.2 g difference; distinguish means from identical trials; keep procedure controls; bound scope; reject selective deletion; propose approved testing of another relevant property; coherent truthful 80–110 word response. Example: “Under the supplied procedure, paper A retained a mean of 3.0 grams of water and paper B a mean of 4.2 grams. The difference between these means is 1.2 grams, but the individual trials varied. This supports a bounded comparison of the tested squares, not a claim that B is best for every cleaning task. Both types need the same immersion and draining conditions. Squeezing A alone would undermine that comparison. Unexpected readings should be retained and investigated, not deleted to fit a prediction. A teacher-approved follow-up could compare strength or cost alongside retained water.”