Research communication

A 90-minute review

Soorathep Kheawhom

2105620 · Research Communication Skills for Chemical Engineers

Question → Evidence → Claim

The 90-minute review

TIME	DECISIONS TO REVISIT
03-21 min	Contribution, publication, literature and evidence
21-42 min	IMRaD, Introduction, aims and Methods
42-69 min	Results, statistics and reproducible figures
69-90 min	Discussion, Conclusion and application

Weeks **1, 3, 4, 5, 6, 8, 9 and 10**

Choose the genre for the contribution

- **Research paper:** support a new claim.
- **Communication:** present a focused, timely finding.
- **Review:** synthesize existing evidence.
- **Data paper:** enable dataset reuse.
- **Technical report:** inform a client or institution.
- **Thesis:** demonstrate research competence.

Read structure as evidence of purpose

- **IMRaD:** a question answered through methods and results.
- **Thematic headings:** evidence organized around an argument.
- **Dataset description:** enough context for reuse.
- **Executive summary:** a decision maker needs the main message first.

Use several structural clues together. Length alone does not establish the genre.

Fit the venue and the reader

Check four things before drafting:

- **Audience:** who needs this contribution?
- **Scope:** does the venue publish this problem?
- **Article type:** does it accept this form of contribution?
- **Evidence:** can readers inspect and reuse the work?

State one central claim and the evidence that warrants it.

Build a search from concepts

System AND process AND metric

Example concept blocks:

- Zinc anode OR Zn anode
- Dendrite growth OR dendrite suppression
- Cycle life OR coulombic efficiency

Use OR within a concept and AND between concepts. Add spelling variants, older names, and abbreviations. Check database syntax before running the query.

Keep a search log and repair metadata

Search log: database, date, full query, filters, hit count.

Reference record: verify authors, title, year, journal, and DOI against the source.

Capture → check → organize → cite.

Zotero stores and formats records. Accurate records and source verification make the bibliography dependable.

Screen first, then map the evidence

Set inclusion criteria before screening.

1. Title and abstract: include, exclude, or unsure.
2. Full text: resolve uncertainty and record exclusion reasons.

Build one row per study:

Claim · system · conditions · metric with units · limitation

Compare claims only after checking that conditions and definitions are comparable.

Compare the conditions before the claims

Pair task, 60 seconds: Do these outcomes establish a contradiction?

Lifetime gain from additive X versus control:

- **Study A:** 1 mA cm^{-2}, 1 mAh cm^{-2} $\longrightarrow$ +100 cycles.
- **Study B:** 10 mA cm^{-2}, 5 mAh cm^{-2} $\longrightarrow$ 0 cycles.

Synthetic teaching data. Uncertainty is unreported.

Worked answer: the regimes differ

These outcomes do not establish a contradiction.

- Current density and areal capacity both change.
- Uncertainty and failure definitions are missing.
- Keep each outcome within its tested conditions.

Whether the additive’s effect changes remains unresolved.

Next step: compare treatment and control while varying one condition systematically.

IMRaD gives each section a job

- **Introduction:** establish a worthwhile, unresolved question.
- **Methods:** make the answer checkable.
- **Results:** report the observations.
- **Discussion:** explain meaning and bound the claim.

Check alignment: **aim** → **method** → **result** → **interpretation**.

Every link needs a traceable connection to the next.

Reverse-outline paragraph functions

For each paragraph:

1. Number it.
2. Name its function in ten words or fewer.
3. Start with a verb.
4. Read the functions without the original text.

Topic: zinc dendrites.

Function: narrows the problem to high-current zinc operation.

Repeated functions can reveal a stalled argument.

Name the break and the repair

- **Orphan aim:** no matching result. Add evidence or narrow the aim.
- **Unsupported claim:** interpretation outruns results. Add evidence or limit it.
- **Invisible method:** a reported number lacks a defined procedure.
- **Doubled move:** paragraphs repeat a job.
- **Buried gap:** the unresolved problem arrives too late.

An Introduction moves toward one question

1. **Establish** a relevant context.
2. **Narrow** to the specific system.
3. **Synthesize** what is known and where it stops.
4. **State the gap** and its consequence.
5. **State an aim** that a result can answer.

Each move should advance the argument. Avoid narrowing to the same point twice.

Turn an absence into a consequential gap

Absence: Few studies report blended-solvent degradation under realistic flue gas.

Gap: Without degradation rates under those conditions, solvent replacement costs cannot be estimated reliably.

Build the argument in three steps:

Known → not known → consequence.

Identify the prediction, explanation, or decision that missing evidence prevents.

Write an aim that a measurement can settle

Weak: Understand solvent degradation.

Operational: Measure the degradation rate of two solvent blends at two oxygen levels under a fixed temperature and gas composition.

This aim requires:

- Defined blends and conditions.
- A degradation metric and calculation.
- Results for the stated comparisons.

Synthetic teaching example.

Methods must produce every reported quantity

Make the work checkable:

- Materials, equipment, and settings.
- Preparation and measurement sequence.
- Treatment, control, and matched conditions.
- Independent units, repeats, and exclusions.
- Metric definitions, calculations, and uncertainty.

Define **failure**, **efficiency**, and **stable** operationally. An instrument name cannot replace a complete procedure.

Identify independent experimental units

Pair task, 60 seconds

Three film batches are prepared independently per formulation. Four coupons are tested from each batch.

Treatment: additive X. Control: the same formulation without X.

For formulation comparison:

- What is the independent **n** per group?
- Which preparation and test conditions must be matched?

Synthetic teaching example.

Worked answer: batches are the independent units

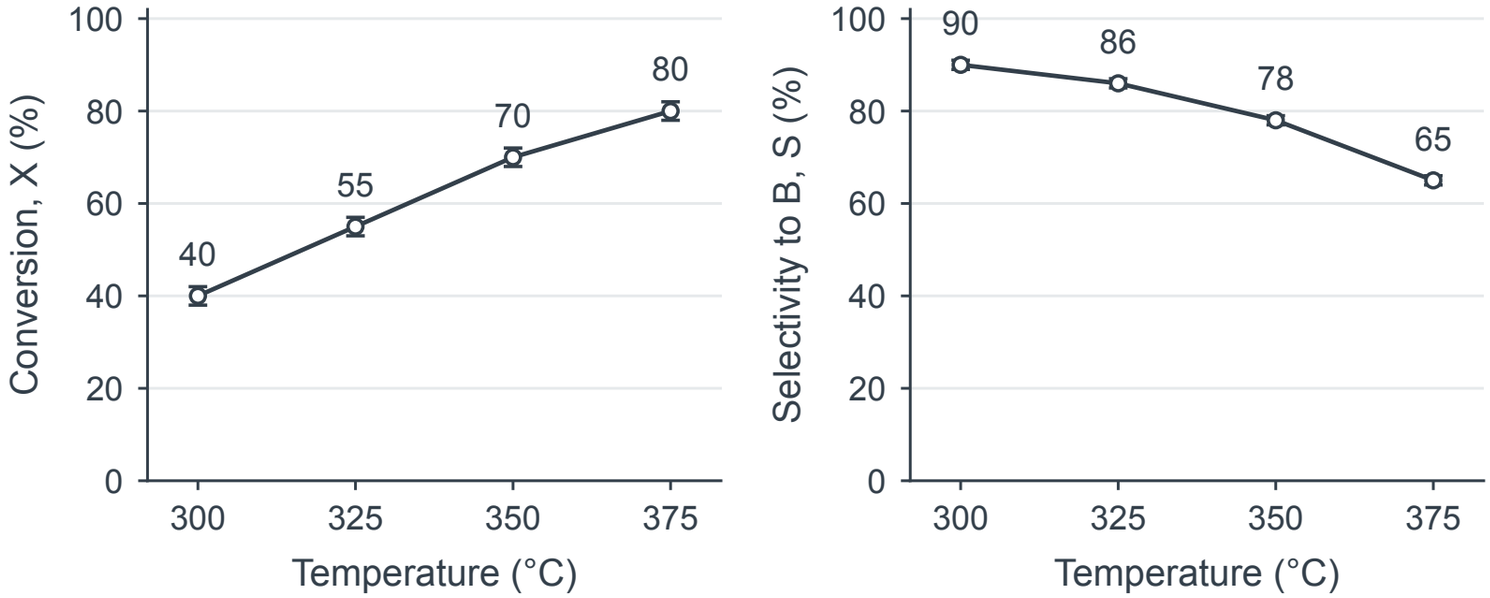
n = 3 independent batches per formulation.

The 12 coupons are subsamples.

- Analyze batch summaries or account for nesting.
- Match polymer lot, casting, thickness, conditioning, and test settings.
- Define exclusions and report uncertainty.

Make the control comparison and the meaning of **n** explicit.

Results report the trade-off



Mean ±1 sample SD; n = 3 independent runs per temperature. Synthetic data.

At **2.0 s**, raising temperature from **300 to 375 °C** increased mean conversion by **40 percentage points** and reduced mean selectivity by **25 percentage points**.

These measurements show a trade-off within the tested range.

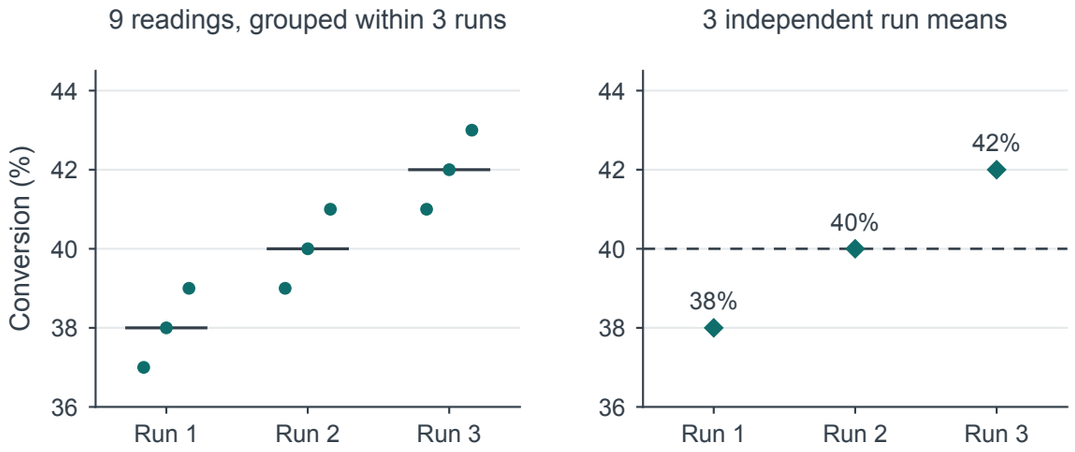
Identify independent experimental units

DESIGN	WHAT DOES THE REPLICATION SUPPORT?
Three independently prepared runs	**n = 3 runs**
One run measured three times	**n = 1 run**, three technical readings

Repeated readings help assess measurement repeatability. They do not create independent experiments.

State the **sampling unit**, not just a number.

SD, SE and CI answer different questions



Run means: mean = 40%; sample SD = 2 pp; SE = 1.15 pp; n = 3.
Separate constructed hierarchy; the 9 readings are not 9 independent runs.

QUANTITY	MEANING
SD	Spread among independent runs
SE	Estimated precision of the mean; SD/√n
95% CI	Uncertainty in the population mean; 95% long-run coverage under stated assumptions

Define the bars. SD-bar overlap alone does not test significance.

Practice: name the change precisely

Work alone, then compare with a partner.

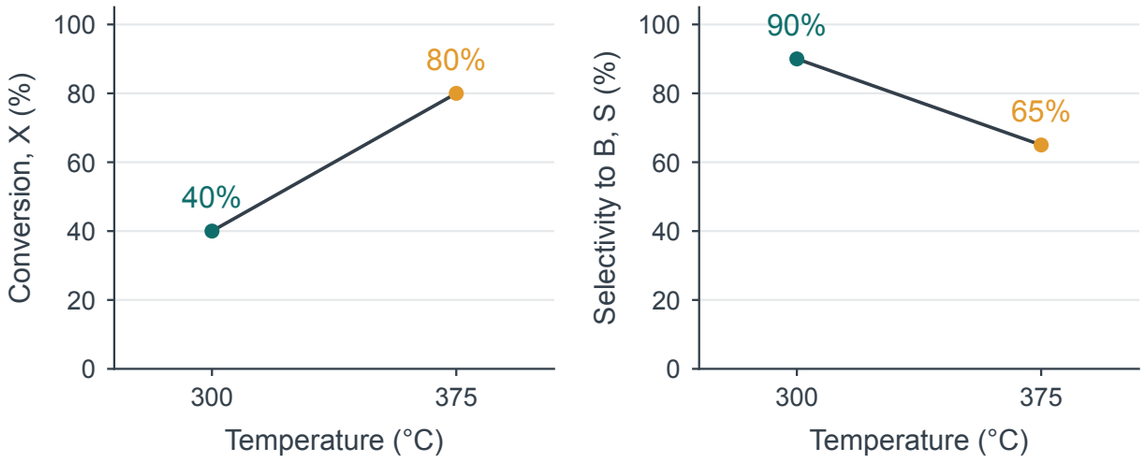
Conversion changes from **40% to 80%**. Selectivity changes from **90% to 65%**.

For each response, write:

1. The change in **percentage points**.
2. The **relative percentage change**, using the initial value as the denominator.

Which wording makes the denominator explicit?

Worked answer: points and relative change

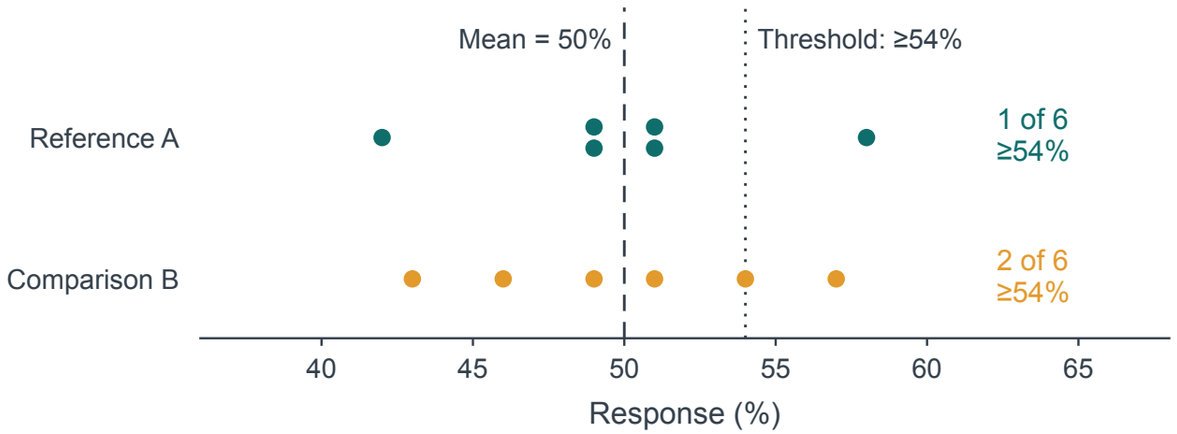


Selected mean endpoints from the original synthetic teaching case; variability omitted.

RESPONSE	PERCENTAGE-POINT CHANGE	RELATIVE CHANGE
Conversion	80 − 40 = **+40 pp**	40/40 × 100 = **+100%**
Selectivity	65 − 90 = **−25 pp**	−25/90 × 100 = **−27.8%**

“Conversion doubled” and “conversion increased by 40 percentage points” describe the same comparison.

Choose the display for the question

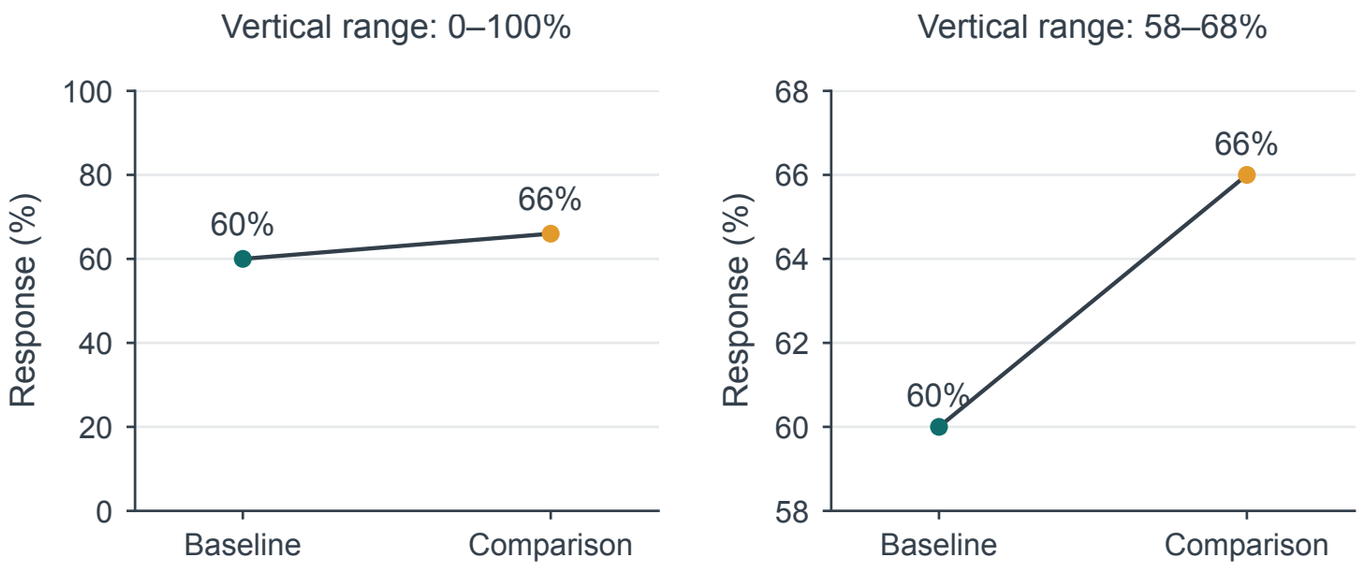


Both sets: mean = 50.0%; sample SD = 5.14 pp; n = 6 independent units.
Separate constructed sets; points show every observation.

READER'S QUESTION	USEFUL DISPLAY
How does response vary with temperature?	Points; optional connecting lines
How variable are the runs?	Individual points plus a defined summary
What are the exact values?	A table with units and uncertainty

These separate n = 6 examples share mean 50% and SD 5.14 pp, but counts at or above 54% differ. Lines guide the eye unless a model is stated.

Honest axes preserve the comparison



Identical values (60% → 66%) and equal panel heights; only the vertical range differs.

Bars encode length from a zero baseline. Points and lines can use a clearly labeled restricted range.

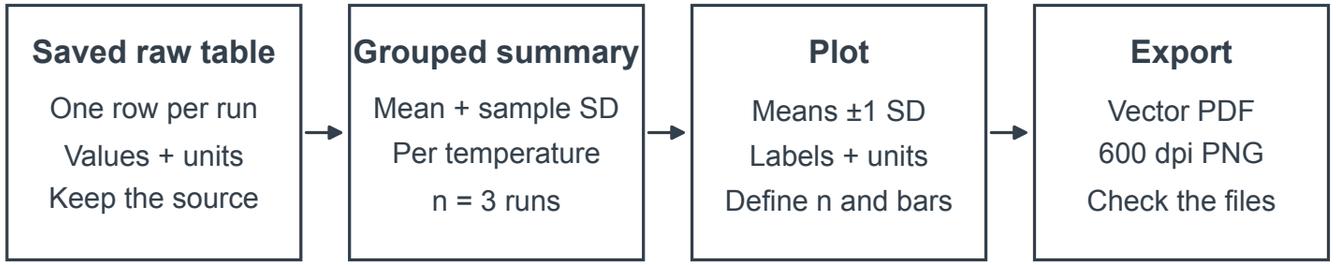
Check axes, dual axes, uncertainty, selected ranges, false resolution and image provenance.

A caption defines every mark

Figure 1. Conversion of A and selectivity to B versus temperature at a residence time of 2.0 s. Points are means of three independent runs per temperature. Bars show ±1 sample SD. Lines guide the eye. Values are synthetic teaching data.

Check: quantity, conditions, summary, uncertainty, independent unit and other marks.

Start with one row per independent run



Rebuild the summary and figure from the saved table.

TEMPERATURE (°C)	RUN	CONVERSION (%)	SELECTIVITY (%)
300	1	38	91
300	2	40	90
300	3	42	89

Keep conversion and selectivity paired within each run. Preserve the original table.

Check the grouped summary before plotting

TEMPERATURE (°C)	MEAN X ± SD (%)	MEAN S ± SD (%)	N
300	40 ± 2	90 ± 1	3
325	55 ± 2	86 ± 1	3
350	70 ± 2	78 ± 1	3
375	80 ± 2	65 ± 1	3

Check one group by hand. Keep means and SDs in the same temperature order. Then label, export and reopen the figure.

Keep a package that recreates the figure

Keep together:

- Original run table and its units
- Analysis and figure instructions
- Required tools, versions and palette
- Caption and exported figure

Rebuild from a fresh start. Confirm that the same inputs recreate the summary and figure without hidden steps.

Another person should be able to follow the package.

Inspect the exported figure at its final size

- Prefer **vector** output for lines and text.
- For raster output, use **600 dpi or more** at the intended size.
- Check labels, markers, bars and embedded fonts.
- Use symbols or direct labels to preserve meaning in grayscale.
- Use color consistently: teal for a reference; amber for the effect.

Conversion, selectivity and estimated yield

For this **1:1 reaction**, estimated yield = mean conversion × mean selectivity / 100.

TEMPERATURE (°C)	MEAN X (%)	MEAN S (%)	ESTIMATED YIELD (%)
300	40	90	36.0
325	55	86	47.3
350	70	78	**54.6**
375	**80**	65	52.0

At 2.0 s, 350 °C has the highest estimate among those tested. The preferred condition depends on the objective and constraints.

Explanations need a control and a prediction

The temperature trend alone does not establish a mechanism.

POSSIBLE EXPLANATION	CONTROLLED COMPARISON	PREDICTED OUTCOME IF IT CONTRIBUTES
B undergoes further reaction	Vary residence time at fixed temperature	Lower S and more byproducts would be consistent with further reaction
Sampling or analysis bias	Process known mixtures through the same procedure	Measured recovery depends on procedure or condition

A predicted pattern supports an explanation; one test rarely excludes every alternative.

Compare literature on the same basis

Before claiming agreement or improvement, check:

- Feed, catalyst, reactor and operating range
- Definitions and denominators for conversion, selectivity and yield
- Measurement basis, independent units and uncertainty
- Differences that could explain the comparison

Cite a verified source. If evidence is missing, state what must be found; do not invent a literature result.

A limitation must change the claim

EVIDENCE BOUNDARY	CONSEQUENCE FOR WORDING
Four temperatures	“Highest among those tested”
Only 2.0 s residence time	Keep “at 2.0 s” in the claim
Three independent runs per temperature	Acknowledge uncertain variability estimates
No energy or stability measurements	Reserve judgment on industrial suitability

A useful limitation changes interpretation or identifies the next test.

A conclusion answers within the tested scope

Use three moves:

1. **Answer:** state the central finding and magnitude.
2. **Bound:** name the conditions and remaining uncertainty.
3. **Implication:** state the decision supported, or the next useful test.

Keep every result traceable to Results. A Conclusion should not introduce a new result or an untested promise.

Practice: turn a claim into a conclusion

Revise this claim in two sentences:

> 375 °C is the best condition because conversion is highest. The selectivity trend proves that B decomposes.

Include:

- One numerical comparison and the tested condition
- A defensible implication or next test

Use the table: estimated yield is **54.6% at 350 °C**, versus **52.0% at 375 °C**.

Worked answer: evidence sets the boundary

At **2.0 s**, the yield estimate from mean conversion and selectivity was highest among the four temperatures at **350 °C**: **54.6%**, versus **52.0% at 375 °C**.

This comparison identifies a condition for further testing; a controlled residence-time study with byproduct measurements could test further reaction of B as one possible explanation.

Apply the review to one paper

- Trace **aim** → **method** → **result** → **claim**.
- Check the independent unit, **n**, uncertainty and denominator.
- Read each figure with its caption and original data.
- Compare studies on an explicit basis.
- Write one scoped finding and one next test with a predicted outcome.