

The Scientific Investigative 10-Step Loop

An open framework for rigorous inquiry · v1.1.0 · Oct 5, 2026 · @Marie

About this framework

Version 1.1.0 turns the loop into a protocol you can audit: it adds a pre-registration gate, a challenge step before sharing, and explicit replication.

Field	Value
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Changelog

Version	Change
1.1.0	Named author and citation; added pre-registration gate (Step 4b), challenge step (Step 7b) and replication; redrew the loop diagram with its feedback paths; added a protocol log template and a worked example
1.0.0	First draft: ten steps in three phases

Introduction and philosophy

The loop exists to make one thing hard: believing a result because you wanted it. Each step leaves a dated record, so an outsider can check what was planned against what was done.

Science rarely runs in a straight line. The loop treats every investigation as a cycle: the end of one run seeds the question of the next, and analysis can send you back to redesign an experiment.

Three commitments run through every step:

- **Plan before you look.** Hypotheses and analysis plans are fixed and time-stamped before data collection.
- **Try to break your own result.** A conclusion must survive a deliberate attack before it is shared.
- **One result is a finding; a repeated result is evidence.** Replication is part of the loop, not an optional extra.

The framework suits solo investigators and small teams who publish outside traditional peer review, where these safeguards would otherwise be missing.

The loop

Ten steps run in three phases, with two gates added in v1.1: pre-registration (4b) and challenge (7b). Each step names the record it must leave behind.

Phase I: Foundation and formulation

1. **Define the research question.** Isolate the specific problem, anomaly or gap in knowledge. Make it focused, specific and answerable.
 - Record: the question in one sentence, with its scope and what is out of scope.
2. **Conduct background research.** Review prior literature, data and case studies to avoid redundant work and build on what is known.
 - Record: a source list with one line per source on what it establishes.
3. **Develop a hypothesis.** State a clear, testable, falsifiable prediction about the relationship between variables.
 - Record: the hypothesis, plus the result that would prove it wrong.

Phase II: Execution and measurement

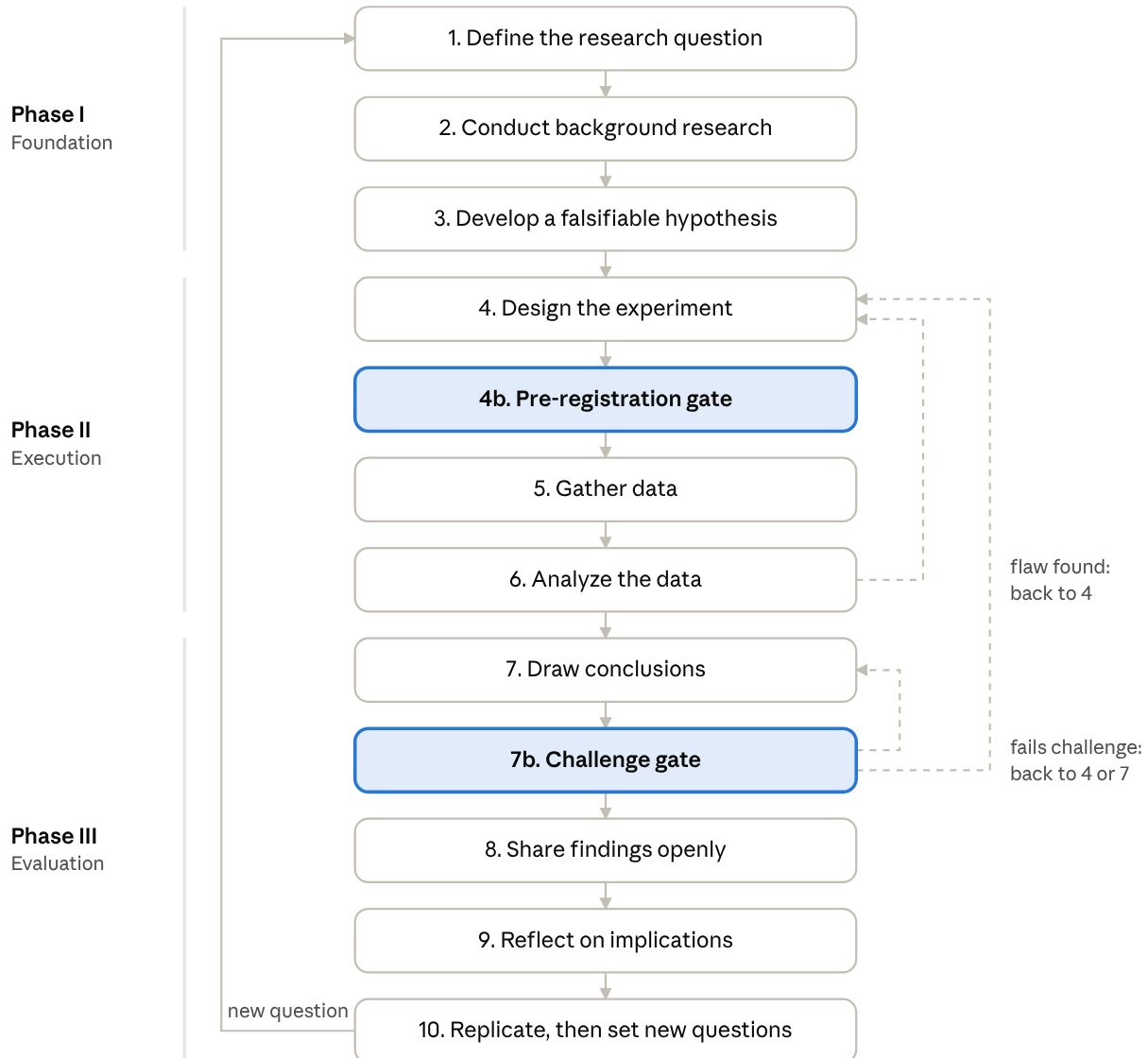
4. **Design the experiment.** Define independent and dependent variables, controls, sample size and a repeatable procedure that can run safely.
 - Record: the protocol, detailed enough for a stranger to repeat it.
- 4b. **Pre-registration gate.** Before any data is collected, publish a time-stamped plan: question, hypothesis, method and analysis plan. Use a public registry such as [OSF Registries](#) or AsPredicted, or a dated, read-only copy in your own archive. Plans may change later; changes are logged, not hidden.
5. **Gather data.** Collect measurements and observations as planned, without filtering out inconvenient results.
 - Record: raw data, kept unedited, with dates and conditions.
6. **Analyze the data.** Apply the analysis named in the pre-registration. Label any extra analysis as exploratory.
 - Record: analysis code or worksheets, and outputs.

Phase III: Evaluation and dissemination

7. **Draw conclusions.** Judge whether the data supports or refutes the hypothesis. State limitations and anomalies.
 - Record: a verdict (supported, refuted or inconclusive) and the reasons.
- 7b. **Challenge gate.** Before sharing, try to break the conclusion. Ask someone outside the work, or list the three strongest objections yourself and answer each one. A conclusion that fails goes back to Step 4 or Step 7.
8. **Share findings.** Publish openly with the raw data, protocol and pre-registration link so others can check and repeat the work.
 - Record: the publication, with a persistent identifier such as a DOI.
9. **Reflect on implications.** Assess the practical and theoretical consequences, and the limits on how far the result generalizes.
 - Record: a short implications note.
10. **Replicate and suggest further research.** Plan an independent repeat of the key result, then list the new questions it raised. Each becomes a candidate Step 1.
 - Record: a replication plan and a ranked list of next questions.

The loop at a glance

Two gates guard the loop: one before data, one before sharing



the loop · 12 stages, 3 feedback paths

Work runs top to bottom, and Step 10 feeds a new question back to Step 1. Dashed lines are the loop-backs: a flaw found in analysis returns to design, and a failed challenge returns to design or conclusions.

Execution guidelines

Five rules keep the loop honest; the first two do most of the work.

- **Falsifiability first.** If no result could prove the hypothesis wrong, it is not ready. Confirmation bias is the main way investigations fail.
- **Pre-register confirmatory work.** Fixing the plan before data arrives separates testing a hypothesis from generating one, and guards against hypothesizing after results are known (HARKing). Exploratory work can be registered too, labelled as such.
- **Log everything with a date.** Keep every step time-stamped so an independent investigator can audit or repeat it. Never overwrite raw data; add corrections as new entries.
- **Replicate before you rely.** Do not build further work on a single unreplicated result. A replication can be your own repeat run, but an independent one counts for more.
- **Loop back when the evidence says so.** Analysis may send you back to the design (6 to 4); a failed challenge sends you back to the design or the conclusions (7b to 4 or 7). Record each loop-back and the reason.

Protocol log template

Copy this table once per run and fill each row as the step closes. A row with no date has not happened.

Step	Date	Record	Link or location	Notes
1. Question		One-sentence question and scope		
2. Background		Source list		
3. Hypothesis		Prediction and falsifying result		
4. Design		Protocol		
4b. Pre-registration		Registry entry or dated archive copy		
5. Data		Raw data files		
6. Analysis		Code or worksheets; exploratory work labelled		
7. Conclusions		Verdict and limitations		
7b. Challenge		Objections and answers		

Step	Date	Record	Link or location	Notes
8. Share		Publication with persistent identifier		
9. Implications		Implications note		
10. Replicate and next		Replication plan; next questions		

Log each loop-back as an extra row: the date, which step you returned to, and why.

Worked example

This illustrative run shows how each step's record looks in practice. It is a teaching example, not a reported result; the numbers are placeholders.

Step	What the investigator records
1. Question	Does a longer post-cure raise the tensile strength of a bio-based epoxy composite? Out of scope: other resin systems.
2. Background	Prior studies on post-cure time and crosslink density, one line each on what they show.
3. Hypothesis	A 4-hour post-cure gives higher mean tensile strength than a 1-hour post-cure. Falsified if the 4-hour mean is equal or lower.
4. Design	Independent variable: post-cure time (1 h, 4 h). Dependent: tensile strength (MPa). Controls: same batch, temperature and specimen geometry; specimens assigned to groups at random.
4b. Pre-registration	Plan registered with the sample size, test standard and the statistical test chosen in advance.
5. Data	Every specimen's result logged, including any that broke early, with the date and conditions.
6. Analysis	The pre-registered test is run. An extra look at failure modes is labelled exploratory.

Step	What the investigator records
7. Conclusions	Verdict stated as supported, refuted or inconclusive, with limits (one batch, one lab).
7b. Challenge	Objections answered: Was the test machine calibrated? Could batch age explain the difference? Were groups truly random?
8. Share	Report, raw data and pre-registration link published together with a DOI.
9. Implications	What the result means for processing time and cost, and what it does not show.
10. Replicate and next	Repeat on a second batch; new questions, such as whether the effect holds at a higher post-cure temperature.

References

- Creative Commons. [Attribution 4.0 International \(CC BY 4.0\) deed](#).
- OSF Support. [Preregistration](#). Center for Open Science.
- University of Oxford, Open WIN. [Preregistration](#): exploratory versus confirmatory research and HARKing.
- ZBW Open Economics. [How preregistrations work](#): registries including OSF, AsPredicted and the AEA RCT Registry.