

Making Good Research Questions

Physics and Methodology of Research

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April 10, 2025

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Understanding Research Questions

What Is a Research Question?

A **Research Question (RQ)** explores an existing **uncertainty** in a field of study and highlights the **need for deliberate investigation**.

A well-crafted RQ supports the development of a **focused, arguable thesis** and the construction of a **coherent, logical argument**.

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What Makes a Good Research Question?

*“The most successful research topics are **narrowly focused** and **carefully defined**, yet they address **important aspects** of a broad, complex problem.”*

Why a Good Research Question Matters

- **Clarifies** the problem statement
- Refines and defines the research issue
- Sharpens the focus of the study
- Guides data collection and analysis
- Establishes the research context

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Crafting Better Questions: FINERMAPS

FINERMAPS Structure

- Feasible
- Interesting
- Novel
- Ethical
- Relevant
- Manageable
- Appropriate
- Potential Value and Publishability
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Be realistic about the **scope** and **scale** of the project. Document unexpected problems and reflect on them.

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Interest must be backed by **academic** and **intellectual** engagement.

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The RQ must be **relevant** to the academic and professional field.

It may:

- Fill knowledge gaps
- Analyse assumptions
- Monitor developments
- Compare approaches
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Research should follow a **structured sequence of steps**.

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Developing Strong Research Questions

Developing a Research Question

A RQ can take different formats depending on what you evaluate:

Existence: Confirm a phenomenon or rule out rival explanations.

Description and Classification: State uniqueness or categorize features.

Composition: Break down a whole into its components.

Relationship: Evaluate connections between variables.

Causality: Determine cause-effect links.

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Identify a broader topic of interest (e.g., tau neutrinos).

Do preliminary research: What is known? What is missing?

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Identify implied questions arising from gaps or needs.

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- Is it **focused**?
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- Is it **interesting** and **useful**?
- Is it **researchable** and **measurable**?
- Is it **appropriately scoped**?

Evaluating the RQ

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After formulating a RQ, think about potential directions for the research.

Consider arguments to support or refute based on possible outcomes.

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Reflect on how your research fills a gap in knowledge.

Assess the potential practical applications of the results.

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Divide the RQ into two or three main concepts.

Focus on keeping it simple, clear, and manageable.

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Going Beyond: Broader Research Perspectives

A good RQ requires a **thorough literature review** and **deep insight** into the specific area or problem.

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Example

For example, Dirac posed the RQ: *What is a relativistic wave equation for the electron compatible with quantum mechanics?*

Initial attempts had led to the Klein-Gordon equation:

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Dirac hypothesized that **spin is intrinsic** to a relativistic wave equation, leading to a first-order formulation using Clifford algebra:

$$(i\hbar\partial - mc)\psi = 0 \quad \text{with} \quad \partial = \gamma_\mu \partial_\mu$$

where γ_μ are the generators of the Clifford algebra $\text{Cl}(1,3)$, satisfying

$$\gamma_\mu \gamma_\nu + \gamma_\nu \gamma_\mu = 2\eta_{\mu\nu}$$

and $\eta_{\mu\nu} = \text{diag}(1, -1, -1, -1)$. Also $\sigma_i = \gamma_i \gamma_0$, this implies intrinsic spin.

This illustrates how a precise RQ, identifying gaps in current models, can drive groundbreaking hypotheses.

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References

References

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Thank you!

Questions or comments?