

# The Research Process and Statistical Elements

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## Outline

- The Research process
- Objectives/Hypothesis/ Research questions
- Methodology
- Data collection and exploratory analysis
- Statistical Data analysis and assumptions

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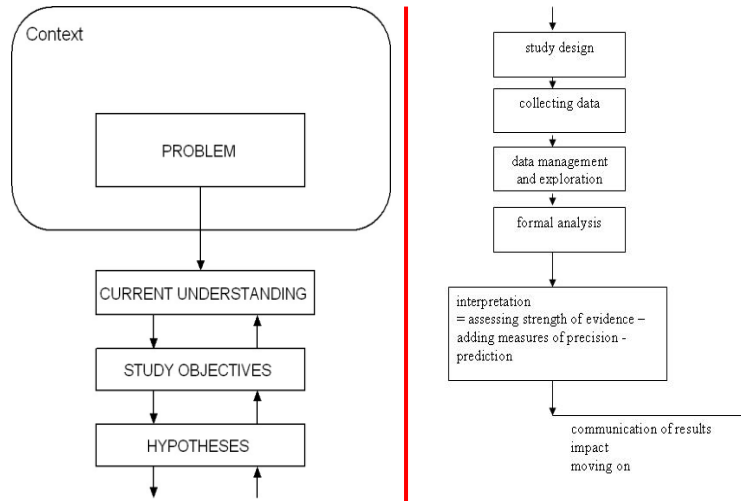


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## Research = learning to solve problems



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## Steps of the research process

- Research problem
- Current understanding/Literature review
- Objectives/Hypothesis/Research questions
- Research Design/Methodology
- Collecting data
- Data management and exploration
- Formal data analysis
- Results and findings

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# Objectives / Hypothesis / Research Questions

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## Importance of setting objectives

The objectives drive the rest of the study.

- your hypotheses
- the kind of study that needs to be done (experiment, survey, ....)
- the treatments that have to be compared
- the population to be sampled
- the data to be collected
- the formal statistical analysis needed
- ....

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## The confusion

- research questions – could be an alternative to objectives.
- overall objective
- specific objectives
- one hypothesis
- several hypotheses
- null-hypothesis
- hypothesis testing
- ..... and their order

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## Basically ...

### Objectives

- Why you are doing the work
- What you would like to achieve

### Hypotheses

- Elements of theory you will test
- A testable hunch

### (Research questions)

- Overall statement of what you are going to research

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# Objectives

- Must be...
  - Clear
  - Complete
  - Relevant
  - Reasonable
  - Capable of being met by the activities (surveys & experiments)
  - *NOT* 'To compare treatments' or 'To compare populations'...
- Objectives must be clearly phrased in **operational terms** specifying what you are going to do, where and for what purpose
- Use **action verbs** that are specific enough to be evaluated.  
**Examples: to determine, to compare, to verify, to evaluate, to describe**
- Avoid the use of vague **non-action verbs** such as: to appreciate, to understand, or to study, to strengthen, to enhance.

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# 'Perfect' objective?...

- Title: Effect of the earth-to-air heat exchanger in ... buildings
- Objective  
*To evaluate the passive heating and cooling capacity of an air to earth heat exchanger and its influence over the energy demand reduction of an office building.*

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## 'Perfect' objective?...

- Title: The fabrication and characterization of TiO<sub>2</sub> based dye-sensitized solar cells

- Objective

*To investigate electrical and optical properties of dye-sensitized solar cells with an amorphous TiO<sub>2</sub> layer to introduce electrons at trap levels in acceptor and donor levels*

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## Another one...

### Objective

- *To investigating the molecular epidemiology of the ASFV strains circulating in Burundi, DRC, Kenya, Malawi, Mozambique, Rwanda, Tanzania, Uganda, and Zambia.*

### Reference

- Hakizimana, J.N.; Yona, C.; Kamana, O.; Nauwynck, H.; Misinzog, G. (2021). **African Swine Fever Virus Circulation between Tanzania and Neighboring Countries: A Systematic Review and Meta-Analysis.** *Viruses* 13, 306.

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## Another one .....

### Objective

To examine the spatial and socio-environmental dimensions of “small-scale” gold mining in Ghana

### Reference

Hausermann *et al.* (2018) Land-grabbing, land-use transformation and social differentiation: Deconstructing "small-scale" in Ghana's recent gold rush. *World Development* 108, 103-114

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## Another one .....

- To explore the effects of cement stabilization (5, 10, 15 and 20 wt%) on the structural and mechanical properties (compressive/flexural strengths and fracture toughness) of abandoned termite mound soil.

### Reference

Mahamat, A.A.; Linda Bih,N.; Ayeni, O.; Azikiwe Onwualu, P.;Savastano, H., Jr.; Oluwole Soboyejo,W. **Development of Sustainable and Eco-Friendly Materials from TermiteHill Soil Stabilized with Cement forLow-Cost Housing in Chad. Buildings** 2021,11, 86. <https://doi.org/10.3390/buildings11030086>

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# Hypothesis

- A *tentative guess* to research problem
- A hypothesis reflects what you think is true but which still needs to be proved
- A hypothesis is a statement of what you think is true based on available evidence
- Your research will then set out to ‘prove’ or ‘disprove’ the validity of this hypothesis.
- Usually stated as a ‘rule’ or a cause-effect relationship.
- Hypothesis should be **testable**

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# Most useful hypotheses...

Most useful hypotheses

- Include ‘How?’ or ‘Why?’

Adoptability of Integrated Pest Management (IPM) in horticultural production varies by gender

Women find IPM in horticultural production less adoptable than men because of labour shortages and lack of information

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## Remark

- Hypothesis/research questions stem from objectives
- BUT not all objectives have hypotheses, e.g. descriptive studies (molecular studies) & characterisation studies

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## Research questions

- Is there a significant difference between electric vehicles and conversional (with combustion engines)
- What is the impact of climate change on potato pests and diseases?

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## *In practice...*

- Expect to cycle through ***problem-objectives-hypotheses*** several times until it all makes sense
- Do '**thought experiments**'. Write down (in tables or graphs) the sort of results which would confirm or refute your hypotheses.
- Share your *problem-objectives-hypotheses* statements with as many people as possible who may give constructive help.

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## *And finally...*

- Recognise that the finished product of ***problem-objectives-hypotheses-design-results-conclusion*** you read in a paper rarely started out that way as the research was conceived and designed
- Read books on Scientific method

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# Questions and Answers

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# Thank you

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For more information contact

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