Research methodology

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Learning outcomes

You know the aims and requirements for doctoral degree in AIENG; you understand the basic principles of science and the importance of research method, which helps you to guide your own research and production of scientific knowledge; you improve your skills in scientific writing and in outlining the structure of a scientific manuscript; you understand the demanding nature of the thesis process and the importance of mitigating excess stress; you recognise the importance of fostering creativity and intuition as part of productive research process; and you become aware of your future career interests and how you could use your time in the university to serve these interests. In addition, you improve your interaction, group working and reflection skills.

Your own learning objectives?
What is scientific research like?

Guided by a method?

HOW TO BE IMPARTIAL AND LOGICAL?

The most common problems and tools

INDUCTION VS. DEDUCTION

COMMON FALLACIES

IT IS HARDER THAN YOU THINK
Thinking, Fast and Slow; Daniel Kahneman (2011)

17 x 24
An individual has been described by a neighbor as follows: “Steve is very shy and withdrawn, invariably helpful but with little interest in people or in the world of reality. A meek and tidy soul, he has a need for order and structure, and a passion for detail.” Is Steve more likely to be a librarian or a farmer?
CERN scientists 'break the speed of light'

Scientists said on Thursday they recorded particles travelling faster than light - a finding that could overturn one of Einstein's fundamental laws of the universe.

Antonio Erediato, spokesman for the international group of researchers, said that measurements taken over three years showed neutrinos pumped from CERN near Geneva to Gran Sasso in Italy had arrived 60 nanoseconds quicker than light would have done.

Scientists did not break speed of light - it was a faulty wire

Physicists who shocked the scientific world by claiming to have shown particles could move faster than the speed of light have admitted it was a mistake due to a faulty wire connection.

Einstein's theory of special relativity, proposed in 1905, states that nothing in the universe can travel faster than the speed of light.

It was Albert Einstein who proposed more than 100 years ago that nothing could travel faster than the speed of light.

Einstein's theory of special relativity, proposed in 1905, states that nothing in the universe can travel faster than the speed of light in a vacuum.

But researchers at the CERN lab near Geneva claimed they had recorded neutrinos, a type of tiny particle, traveling faster than the barrier of 186,282 miles (299,792 kilometers) per second.

Now it seems Einstein's reputation has been restored after a source close to the experiment told the US journal Science Insider that "A bad connection between a GPS unit and a computer may be to blame."
Killer-Flu Debate: Should Mutant H5N1 Have Been Created?
by Wynne Parry | December 23, 2011 10:11 am ET

Controversial research found a way to make bird flu spread easily among mammals.

News of two separate research projects that altered the bird flu virus so it could potentially spread between humans has some experts asking: Should this research have been done at all?

Other scientists, however, are defending the projects as important progress in understanding how the virus, called H5N1, could adapt to cause a devastating pandemic.

"I wouldn't do it," said W. Ian Lipkin, director of the Center for Infection and Immunity at Columbia University Mailman School of Public Health. "I think it is one thing to study the pathology of an organism to try to understand it, but to engineer it to be more transmissible... makes me uncomfortable".

Why a pandemic flu shot caused narcolepsy
by Gretchen Vogel | Jul 2, 2009, 2:39 PM

The 2009 H1N1 influenza pandemic left a troubling legacy in Europe: More than 1300 people who received a vaccine to prevent the flu developed narcolepsy, an incurable, debilitating condition that causes overpowering daytime sleepiness, sometimes accompanied by a sudden muscle weakness in response to strong emotions such as laughter or anger. The manufacturers, GlaxoSmithKline (GSK), has acknowledged the link, and some patients and their families have already been awarded compensation. But how the vaccine might have triggered the condition has been unclear.

In a paper in Science Translational Medicine (STM) this week, researchers offer a possible explanation. They show that the vaccine, called Pandemrix, triggers antibodies that can also bind to a receptor in brain cells that help regulate sleepiness. The work strongly suggests that Pandemrix, which was given to more than 30 million Europeans, triggered an autoimmune reaction that led to narcolepsy in some people who are genetically at risk.
What is scientific research needed for?

Describe
Explain
Predict
Control
Engineer
Understand
Re-engineer
Evaluate

An nescis, mi fili, quantilla prudentia mundus regatur?
"Do you not know, my son, with how little wisdom the world is governed?"
Axel Oxenstierna 1648 (1583 – 1654)
Who is allowed to do scientific research?
Group work

What research methods and tools you are using in your own work or, in general, are used on your field?

5 min independent reflection
• Write down on Post It notes

Group discussion 15 min
• Place and organise your thoughts on a ”methods map”
  - What methods you can identify?
  - What type of research are they used for?
  - What connects or separates different methods?

If you are interested to support others or discuss with others about the method, put your name on the note as well
Research process

1. Idea
2. Literature research
3. Research topic
4. Research strategy
5. Design of experiments
6. Data collection
7. Data analysis
8. Publishing of results

Research process vs Writing process

Introduction
1. Start with the perspective
2. Select a theory
3. Derive a proposition
4. Ask a question
5. Derive Hypotheses

Methods
6. Find and collect data
7. Analyse data

Results
8. Report results & answer question

Discussion
9. Interpret results in terms of theory
10. Draw implications for theory

(Lynch 2013)
Hypothetico-deductive method

Problem → Hypothesis

Confirmation → Falsification

Prediction → Comparison

Reality
Scientific methods

Hypothesis-driven research
• The Scientific Method

Experimental research
• Measure a value
• Measure a function or relationship

Construct a model
• Theoretical sciences and applied mathematics

Observational and exploratory research

Improve a product or process
• Industrial and applied research

1. Identify a well-defined quantity
2. Design a procedure to measure it
3. Perform the experiments
4. Analyse and report on the accuracy of the results

1. Observe a phenomenon and develop testable questions
2. Identify control variables and response functions
3. Design an experimental procedure to vary the control variables, measure the response variables, and keep other factors constant
4. Perform the experiments
5. Analyse the relation between control variables and response variables, and characterise the relation mathematically

Engineering sciences

Method groups
- Modeling
- Computational methods
- Experimental methods
- Case studies
- Statistical methods

Qualitative research

• There is only little or no prior knowledge on the subject
• A new viewpoint or deeper knowledge on the subject is searched
• Conceptions, experiences, meanings etc. are studied
• No cause and effects
Quantitative research

- What, where, how many, how often, how large, … ?
- Phenomenon or parts of it are systematically measurable
- Emphasises cause and effect
- Based on prior research and theory
- Aims to test hypotheses
- Requires enough data
- Data brought in statistically analysed form
- Data and relations between parameters are statistically analysed
- Deductions based on analysis and generalised results
Classification of research

Research approaches

Approaches studying reality
- Researches stressing "what is reality"
  - Conceptual-analytical approaches
  - Empirical studies
    - Theory testing approaches
    - Theory creating approaches
- Researches stressing utility of innovations (designs and evaluations)
  - Innovation building approaches
  - Innovation evaluation approaches

Mathematical & philosophical approaches

Järvinen, P. & Järvinen, A., On research methods, Opinpajan kirja, Tampere, 2004
Library updates

Need more information about research methods? If you answered yes, you should explore the SAGE Research Methods Online database, which includes more than 640 SAGE research method books, encyclopedias, reference books, scientific articles, and videos.

http://srmo.sagepub.com/