MBG 106 - Complementary Skills
(Ανάπτυξη ακαδημαϊκών δεξιοτήτων)

ACADEMIC SKILLS DEVELOPMENT

I. Methodology

(M. Chatzaki, MB&G, Duth)

Methodology *vs.* Method

Method = the tools one may use to complete a task, or the steps this may take

… SPSS, ANOVA, Mantel Test etc….

Methodology = the study of the general configuration or approach of a research project, including the method or methods to be used and its justification.

… Statistical analyses….

Decisions on:

- Data to include/exclude
- Relational and ethical concerns
- Representation of findings

A philosophy of research

Research does not:

- Consist of mere information gathering
- Simply transport facts

Research does:

- Originate with a question or problem
- Require a clear articulation of a goal
- Follow a specific plan or procedure (a method)
- Require collection and interpretation of data

In addition, empirical research consists of:

- Experimentation

How to choose your topic

Do not pick up a topic:

- Just because it is lined with “trendy” research
- Just because you have to pick up something
- If it is too complicated and hard to understand (and this makes it attractive!)
- If you do not really like it

Do pick up a topic:

- Because you really like it and find it interesting
- It goes with your talents
- It is simple, but somehow intriguing
- It is consistent with existing relevant studies
- It is analyzable, understandable and you may get somewhere with it

About your topic…

- Know what you're doing and why
- Be rational about it
- Do not be afraid to take on challenges – but these should be "calculated risks"
- Good mentorship is vital to success

On questions and hypotheses

- Questions form the basis for hypotheses
- Hypotheses should be falsifiable (H*o* = bla bla…, H*a*= NOT bla bla…)
- Once you have a hypothesis, you can test it -> **This forms the basis of your scientific research**

Well-posed Questions

- Questions should be clear, precise, and to the point
- Questions should center around the problem domain
- Clear, justifiable results stem from experiments addressing a precise, well-posed question

On Method

What is included in the method chapter of a scientific paper?

- Clear, organized approach to scientific experimentation (i.e. methodology followed)
- Plan containing a source, goal, and path to get there
- Set of decisions about:
    - conducting experiments
    - obtaining/interpreting results

A vaguely supported method:

- Restricted to mainly exploratory experimentation (i.e. the initial, observational phase of experimentation, basically used to help generate hypotheses)
- Can gain intuition, but no real answers
- Makes it difficult to justify results to others

A clearly supported method:

- Allows full range of types of experimentation
- Can be used to determine clear answers
- Facilitates justification of results

Experimental design

Before you start

- Relevant **literature** (what people have done when trying to answer similar questions? What tools did they use?)
- Protocol/s choice, also depending on available technical support (i.e. instrumentation)
- Is your method validated (e.g. ISO methods)?
- Does your method satisfy criteria of REPEATABILITY and REPRODUCIBILITY?

Experimental design

What should be clear from the beginning:

- What are the assumptions and their potential ramifications?
- What will hopefully be learned? What will **not** be learned?
- What is being measured (i.e. factors)?
- What statistical tests will be run (why)?
- How many trials will be run?
- What are the levels of the experiment?

Experimental design

What should be clear from the beginning (*continued*…):

- What will be the control groups/specimens?
- What is meant by qualitative terms (e.g., “better” or “best”)?
- How will outliers be removed?
- How will you avoid type I and type II errors (false positives, false negatives) or other bias?

When executing

Turning around results quickly

- Gradually increasing the resolution of parameter values
- Gradually increasing the number of trials per test/group
- Decide if:
  - You need most results from few groups first! (*layer tests*)

    or…
  - You need some results from most groups first! (*layer groups*)

If something goes wrong or just in case…:

- Flexibility!
- Validating with dual implementations
- Duplication *vs*. Replication

Organizing your data:

- Ensure reproducibility of experiments
- Keep a clear note-book
- Everything is important and will be soon forgotten if not written down!
- Keep a protocol box
- Data storing:
  - Name the study appropriately [e.g. drug A effect study]
  - Correlate with levels & categories within the study

    [e.g. patients cat.1, cat.2 etc..or.. cytologically, histologically… or ..test 1, test 2 etc..]
  - Match your file & directory names accordingly

Statistics

- Choose a statistical package that you are familiar with
- Most simple statistical analyses start in excel
  (google drive might help in case of multiple users)
- Choose something others use & be confident in its validity
- Do not exaggerate, but be sure to have done enough
- "*Significant*" is a statistical term with clear & accurate meaning (*p*-value < 0,01-0,05). Use it like this!
- You are not obliged to know everything from the beginning: ask for some expert advise – consult a biostatistician/epidemiologist/bioinformatician

Results

- Think in publication terms: you only describe data/facts
- Try to figure out what your results mean
- Be careful on statistic results interpretations – get advise from experts!
- Do they answer your research question/s?
- Do they prove/point towards a new hypothesis?
- **If you torture them they will speak!**
- Remember: no positive results – “proof” of null hypothesis is still an important finding!!!! Do not consider it a scrap or useless!

Results interpretation

- Try to make “A story”…
- ...based on the main question from the ones you posed
- If it is hard to pose a single question that captures the point of the story, it may suggest that the research questions are too vague
- If the results do not make sense, it may suggest a problem in the hypothesis formulation or experimental design or implementation
- Or…
- **You just need holidays! Take a break before you look at them again!**

….

- You are not finished till these are fixed!

Results presentation

Visualizing results

- Choose the most illustrative, clear and simple graphics
- Consider production quality of graphics
- Remember: one (good) image equals 1000 words!
- Avoid repetition in wording
- You may need graphs and images other than the ones you used during the research
- Do not claim anything empirically that you cannot defend statistically

While presenting or writing

- The “story” doesn’t only have to **be** interesting; it has to **look like** interesting too!
- The “story” may be different than the “experimental history”
- Don't need to include every experiment
- Present only what is relevant to the story and the questions posed from the beginning
- Avoid presenting experiments or details that confuse the point, but…
- Do not omit experiments that weaken the conclusion
- **DO NOT CHEAT! -** others may use your data/results
- Provide enough detail to replicate the experiment – **REPRODUCIBILITY**
- Try to keep meticulous and concise

Always keep in mind that:

You cannot:

- Answer a question ***not*** (or poorly) posed
- Convince an audience of ***fact(s)***
- Provide **absolute** answers

[e.g., Algorithm A is always better than B]

You can:

- Answer a question ***clearly*** posed
- Convince an audience of ***probable fact(s)***
- Provide **conditional** answers

[e.g., Algorithm A is usually better than B in relation to property X].

Final tips

- If you are unconvinced, so is the audience/reader
- If you are convinced, the audience/reader may still not be
- Experimental facts lose in interest if they remain demonstrative
- A deeper explanatory element is an add-on that finalizes your story and makes a SYNTHESIS out of the whole project!

Ready to begin????

Good luck!!!