Research Methods

Tools to analyze data and communicate knowledge

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Outline

Scientific Communication

Credit: *Routgers*

Motivation

- Communication is an integral part of the research that you do as a scientist. Your **written papers** serve as a gauge of your scientific productivity and provide a long-lasting body of knowledge from which other scientists can build their research. The **oral presentations** you deliver make your latest research known to the community, helping your peers stay up-to-date. **Discussions** enable you to exchange ideas and points of view. Letters, memos, and résumés help you build and maintain relationships with colleagues, suppliers, employers, and so on.
- Scientific communication is not limited to formal papers and presentations for your peers. As a scientist, **you engage in communication activities with yourself**, also. Drafting a research proposal, for example, helps you understand the context and motivation for your future work and helps you focus on specific, realistic objectives. Adding entries in your laboratory notebook helps you crystallize your ideas and creates a track record of your thinking or experiments. Using mathematical or chemical notations helps you tackle complex concepts. Graphing data helps you answer research questions.

(Doumont, 2010)

The importance of the audience

Credit: *Resourcefulselling.com*

The importance of the audience

- An **information** is the answer to the question "What?"
  Example: "What did you find in your research?"
- A **message** is the answer to the question "So what?"
  Example: "What do your findings mean to your audience?"

In your communication, **focus on what your audience needs or wants to learn**. To select your content, consider not only your audience, **but also the inherent qualities of the medium you use**.
i.e. Readers of a document do not need to read everything. They can select what they read, and when they read it, they can read at their own rhythm, and they can reread parts of the document as many times as they wish. In contrast, attendees at a presentation cannot select what they listen to or in what order they listen to it. They are usually less interested in the details that they could more easily read in a document.

(Doumont, 2010)

Type of documents

- **Scientific papers** are for sharing your own original research work with other scientists or to review the research conducted by others. Papers must aim to inform, not impress. They must be highly readable, that is, clear, accurate, and concise. They are more likely to be cited by other scientists if they are helpful rather than cryptic or self-centered.
- **Brief Reports** are small, often preliminary studies, descriptions of unexpected and perhaps unexplained observations or lab protocols that can be described in a short report with a few illustrations (figures/tables), or even a single figure.
- **Oral presentations** allow you to establish stronger contact with the audience and better convince them of your point of view through verbal and non-verbal delivery, as well as ensuring interaction. However, they MUST consider audience's time.

How can I find the topic of my research?

Credit: *Freepick*

- Be a yes man.
- Deepen what strikes you the most.
- Talk to people about it.
- Start working with your new idea!

Is it feasible?

Credit: *Bonusly Blog*

- **Test your theory with some literature**, look for similar studies, think about professors and/or experts who could be interested in helping you as a tutor, and talk to them.
- **Try a first contact with the main actors** of your research in order to understand if they are interested and if it is feasible.

The research question

Research questions help writers focus their research by providing a path through the research and writing process. The specificity of a well-developed research question **helps writers avoid the "all-about"** paper and work toward supporting a specific, arguable thesis. A research question is the question around which you center your research. It should be: **clear, focused, concise, complex, arguable**. Evaluate your question. After you have put a question or even a couple of questions down on paper, evaluate these questions to determine whether they would be effective research questions or whether they need more revising and refining.

- **Is your research question clear?** With so much research available on any given topic, research questions must be as clear as possible in order to be effective in helping the writer direct his or her research.
- **Is your research question focused?** Research questions must be specific enough to be well covered in the space available.
- **Is your research question complex?** Research questions should require both research and analysis on the part of the writer. They often begin with "How" or "Why."

Is it a good theory?

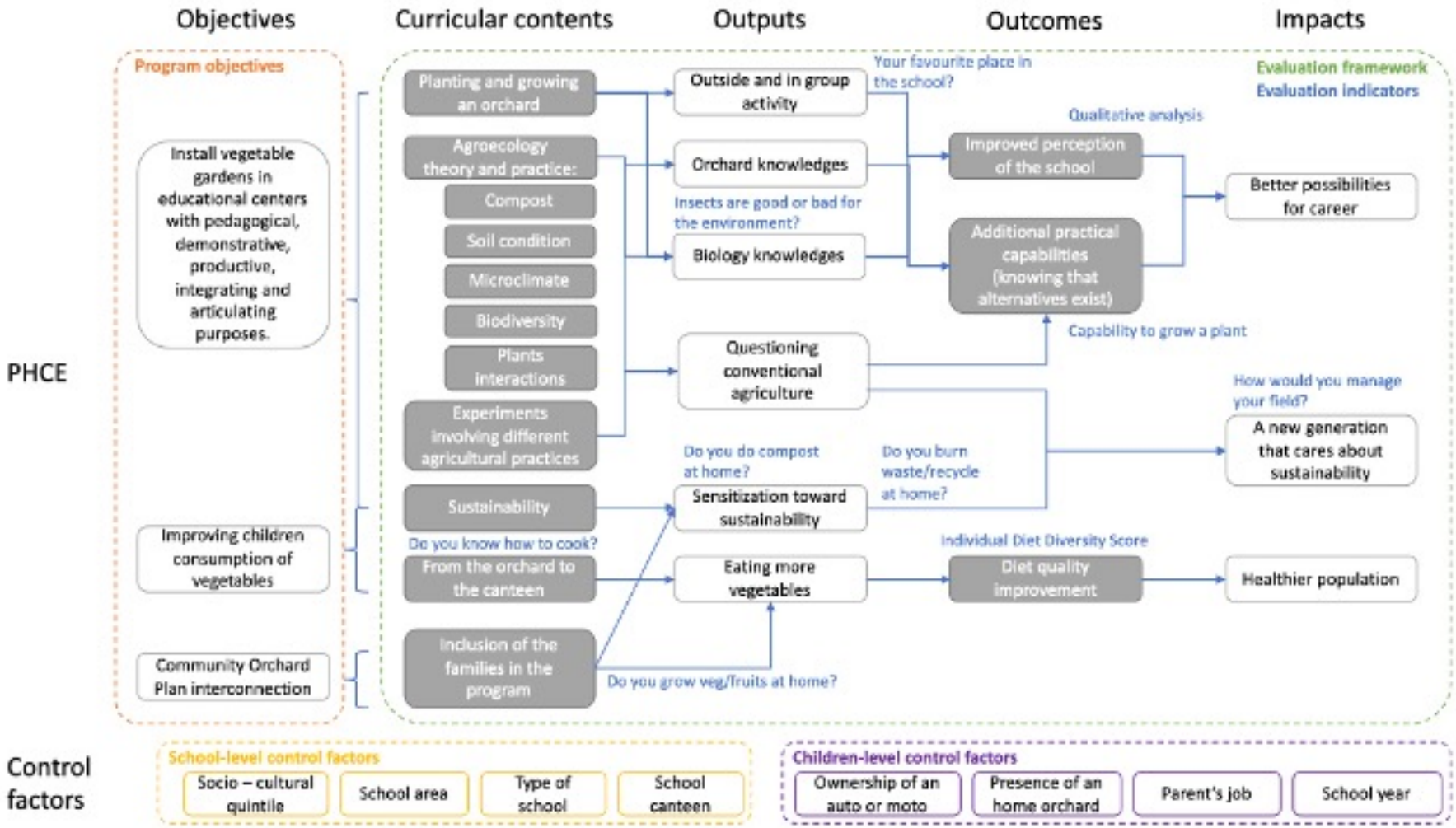
Credit: *Fligby*

- **What**: You need to be able to explain your research briefly and synthetically, to an expert or to a friend who does not have a background on the issue.
- **Why**: You need to be able to justify your research both in terms of scientific interest and of personal interest.
- **How**: You need to choose the appropriate scientific method to prove your theory.

Theory of change

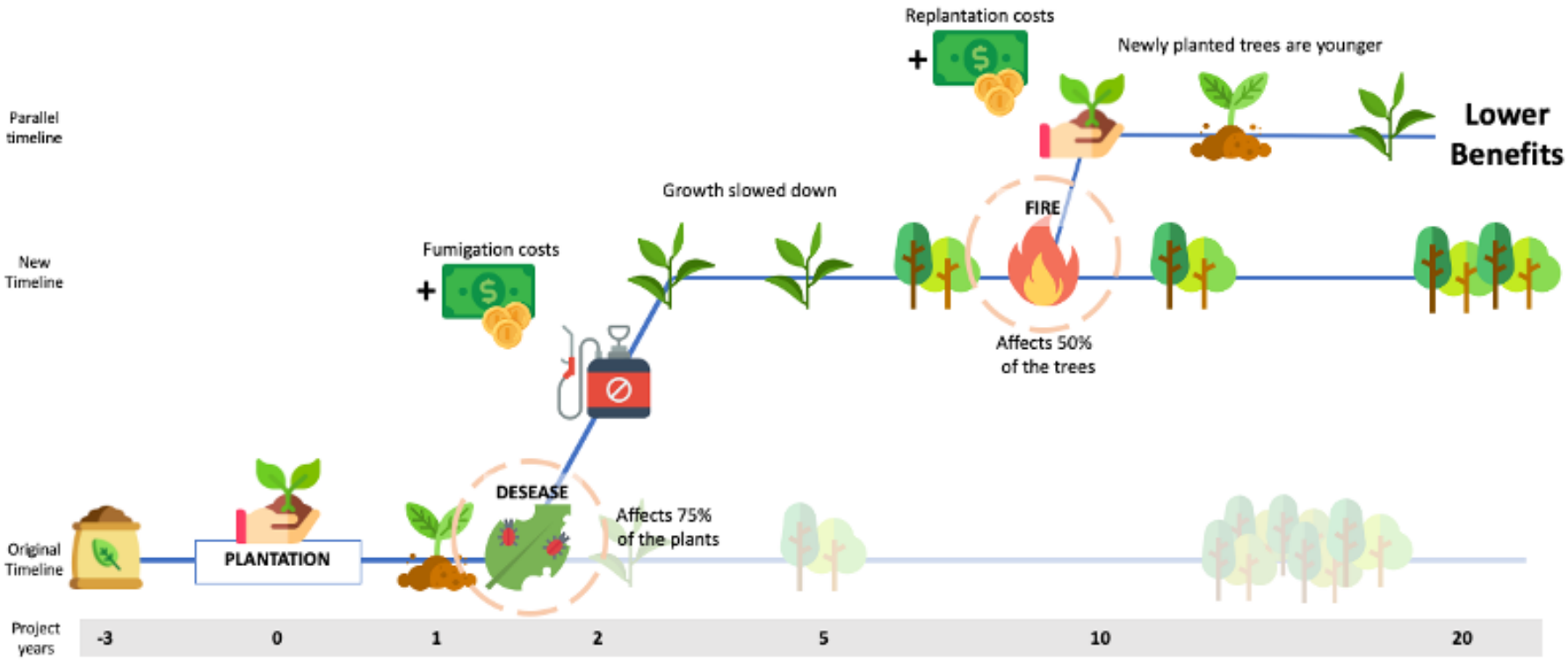
- The theory of change is essentially a comprehensive description and illustration of **how and why a desired change is expected to happen in a particular context**. It is focused, in particular, on mapping out or "filling in" what has been described as the "missing middle" between what a program or change initiative does (its activities or interventions) and how they lead to the achievement of desired goals.
- Through this approach, **the precise link between activities and the achievement of the long-term goals are more fully understood**. This leads to **better planning**, in that activities are linked to a detailed understanding of how change actually happens. It also leads to **better evaluation**, as it is possible to measure progress towards the achievement of longer-term goals that go beyond the identification of program outputs.

Theory of change



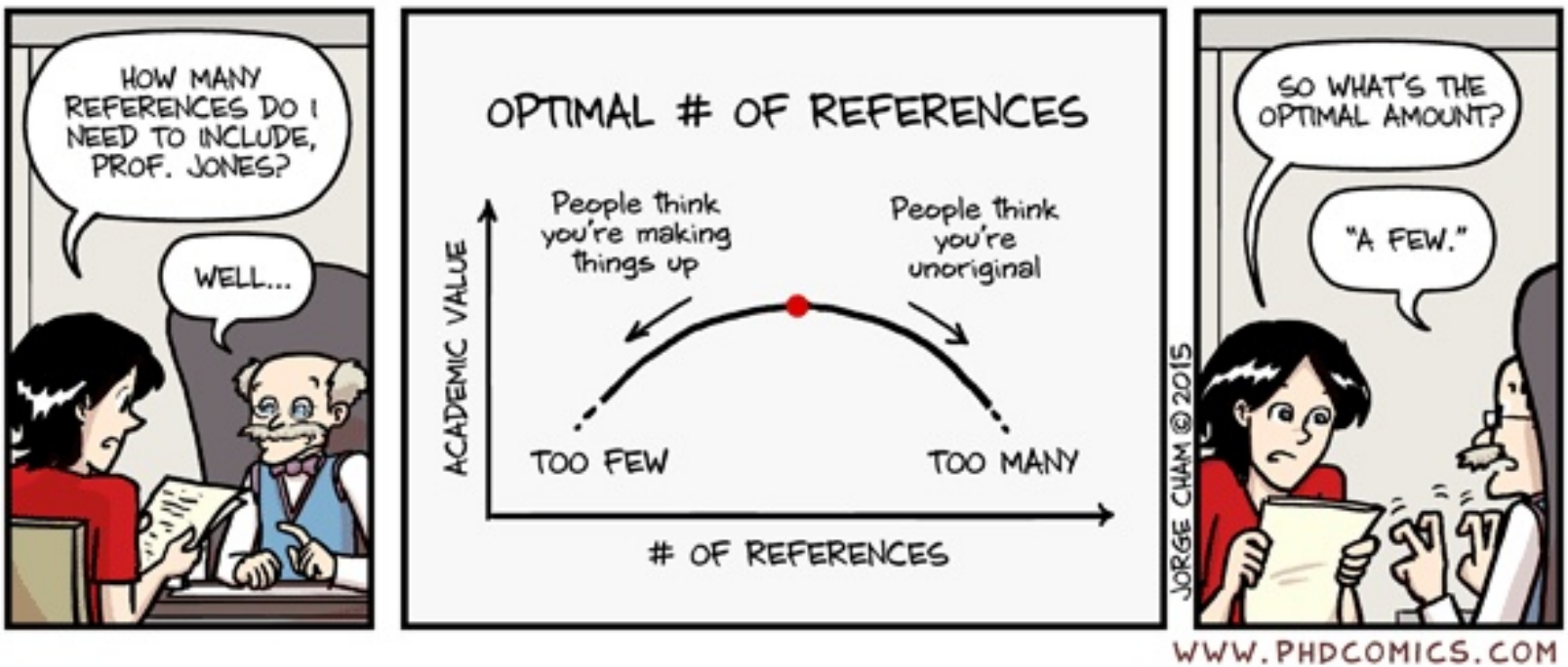
Credit: *Roscioli et al. (2018)*

Theory of change



Credit: *Roscioli*

Literature Review



Credit: *PhDcomics.com*

Motivation

- A literature review is a survey of scholarly sources on a specific topic. Provides an overview of current knowledge, allowing you to identify relevant theories, methods, and gaps in existing research. Writing a literature review involves **finding relevant publications, critically analyzing them, and explaining what you found**.
- A good literature review does not just summarize sources; it **analyzes**, **synthesizes**, and **critically evaluates** to give a clear picture of the state of knowledge on the subject. The literature review gives you a chance to:
  - Demonstrate your familiarity with the topic and scholarly context.
  - Develop a theoretical framework and methodology for your research.
  - Position yourself in relation to other researchers and theorists.
  - Show how your research addresses a gap or contributes to a debate.
- You may also have to write a **literature review as a stand-alone assignment**. In this case, the purpose is to evaluate the current state of research and demonstrate your knowledge of scholarly debates around a topic.

Sources of information

- **Primary sources** are created as close to the original event or phenomenon as possible. They provide firsthand evidence gathered by the author(s) for the purpose of the study. For example, a photograph or video of an event is a primary source. Data from an experiment are a primary source.
- **Secondary sources** describe, interpret or analyze information obtained from other sources (often primary sources). For example, articles and books in which authors interpret data from another research team's experiment or archival footage of an event are usually considered secondary sources.
- **Tertiary sources** summarize or synthesize the research in secondary sources. For example, textbooks, newspaper reports, and reference books are tertiary sources.
- **Grey literature** refers to research that is unpublished or has been published in non-commercial form. For example, government reports, policy statements and issues papers, conference proceedings, pre-prints and post-prints of articles, theses and dissertations, research reports, maps.

Reading as a researcher

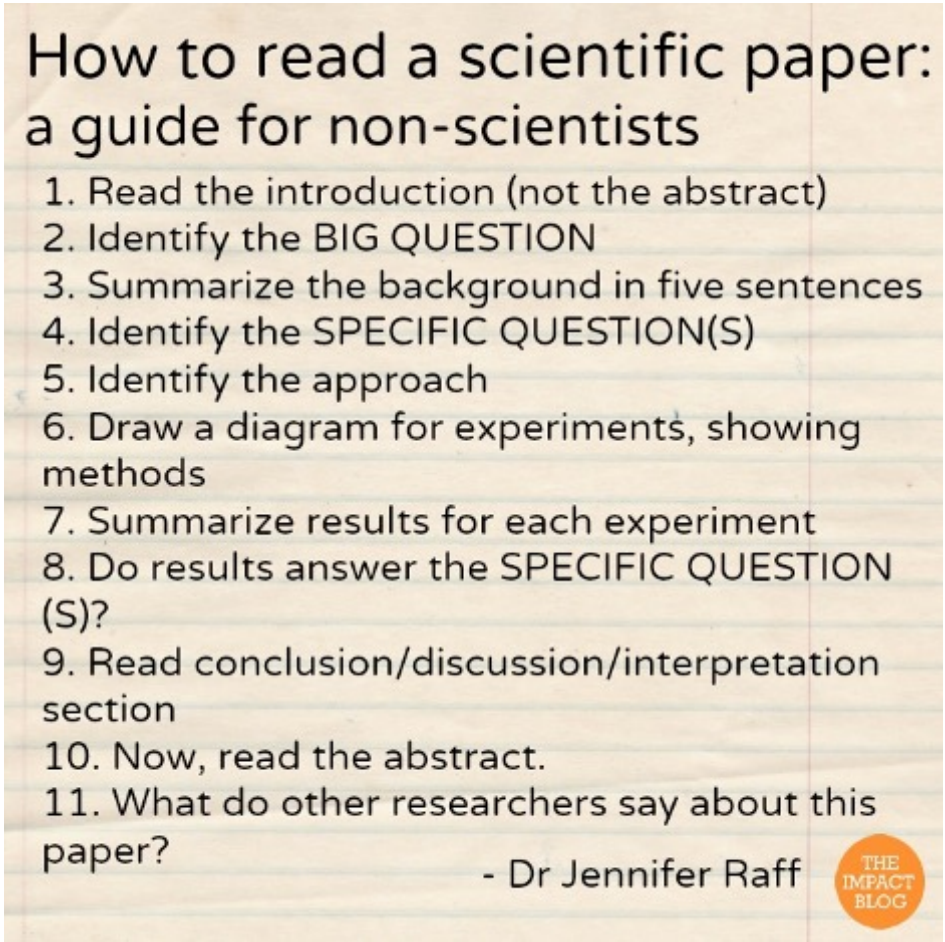


Figure: Raff (2016)

Reading as a researcher

- **Reading a scientific paper should not be done in a linear way** (from beginning to end); instead, it should be done strategically and with a critical mindset, questioning your understanding and the findings. Sometimes you will have to go backward and forward, take notes, and have multiple tabs opened in your browser.
- However, **there is no perfect way to do it**, and in most cases it depends on your focus at the moment. Here are some examples:
  - What I choose to read is based on relation to my research areas and things that are generating lots of interest and discussion because they are driving the way we do psychology or science more widely in new directions. Most of the time, what I am trying to get out of the articles is the issues of methodology, experimental design, and statistical analysis. And so for me, the most important section is first what the authors did (methods) and second what they found (results).
  - I start by reading the abstract. Then, I skim the introduction and flip through the article to look at the figures. I try to identify the most prominent one or two figures, and I really make sure I understand what is going on in them. Then, I read the conclusion/summary. Only when I have done that will I go back into the technical details to clarify any questions I might have.

(Pain, 2016; Raff, 2016)

Methods and tools

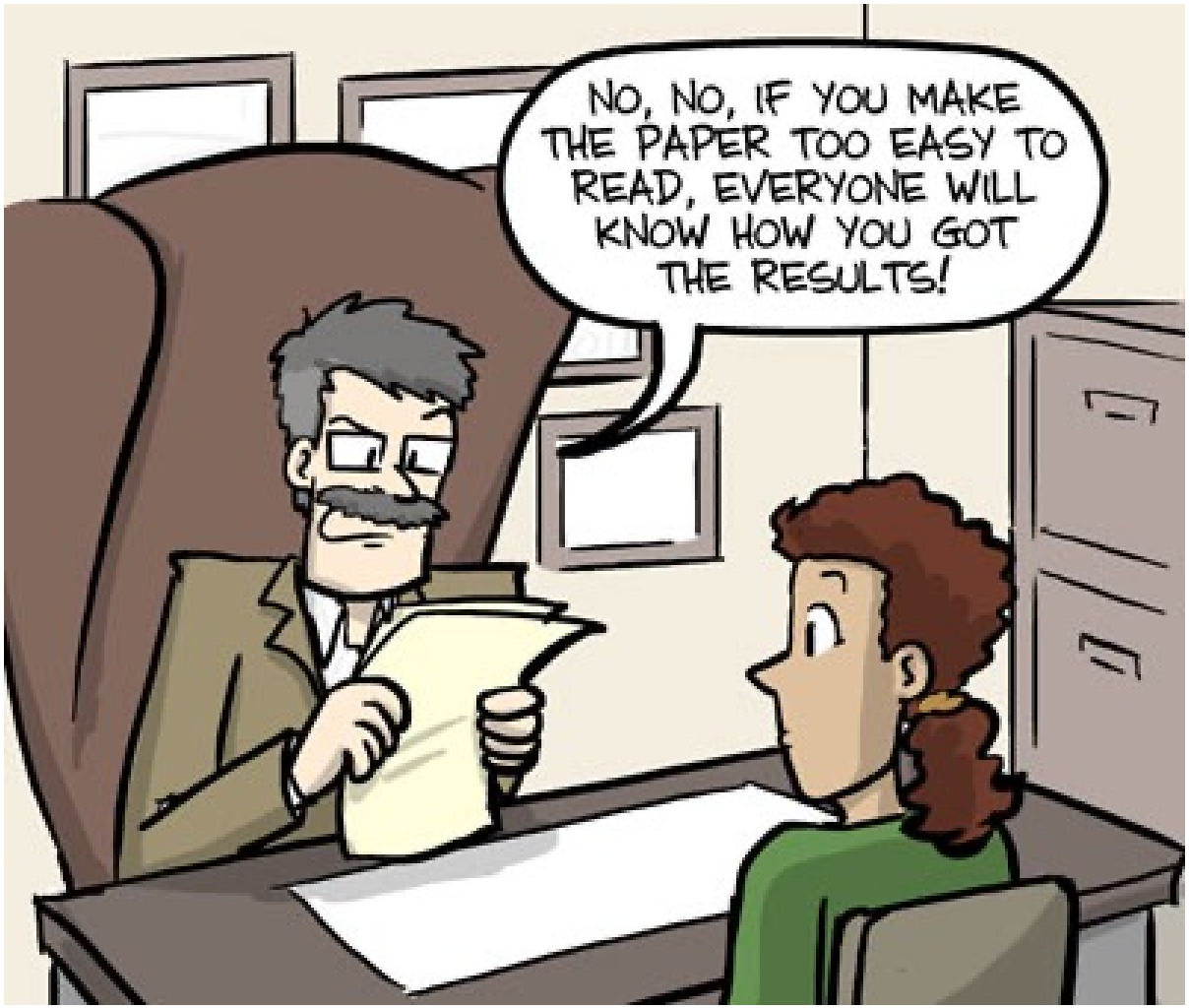
- **Roma Tre Discovery** is the university library through which registered students can have access to most of paid academic publications. Link
- **Google Scholar** is a super powerful search engine for most of sources of information. Link
- **Litmaps** creates a network of scientific citations from a single paper or a set of papers. It is useful to identify the seminal papers in a literature review. Link
- **Elicit** shows relevant papers starting from a research question. Link

- **Sci-Hub** (illegal) allows to download paywalled papers for free.

H-index

- At each level, the number of citations for a paper, a single researcher, or an entire institution determines their perceived influence. At the most basic level, the impact of a paper is measured by its number of citations.
- Citations determine the h-index of a researcher. The impact factor of a journal is determined by how often it is cited. At the most macro-level, the number of citations across a university contribute to its world-wide ranking.
- Despite their flaws, citations are still our gold standard for measuring impact and influence, as well as connection and relevance. After all, finding papers through the citation network (Litmaps) is often faster and more comprehensive than traditional keyword search alone. Yet it begs the question: **given the known issues with citations, does relying on them for search exacerbate these existing biases?**

Article Drafting



The audience

- Scientific papers typically have two audiences: first, **referees**, who help the journal editor decide whether a paper is suitable for publication; and second, the **journal readers** themselves, who may be more or less knowledgeable about the topic addressed in the paper.
- **They must convince their audience that the research presented is important, valid, and relevant** to other scientists in the same field. To this end, they must emphasize both the motivation for the work and the outcome of it, and include just enough evidence to establish the validity of this outcome.

(Bellemare, 2020; Doumont, 2010)

The structure

- For **scientific papers** the standard length varies between 6.500 and 10.000 words, including references, annexes, figures, and tables. Whether for **brief papers** it is about 2.500 words.
- Scientific papers follow the well-known **IMRD format**:
  1. Abstract
  2. Introduction
  3. Materials and Methods
  4. Results and Discussion
  5. Conclusions
  6. References
  7. Annexes
- An example of a good paper is Lucas, R. E. (1988). On the mechanics of economic development. *Journal of Monetary Economics*, *22*(1), 3–42. https://doi.org/https://doi.org/10.1016/0304-3932(88)90168-7

(Bellemare, 2020; Doumont, 2010)

Abstract

- A good abstract normally contains:
  1. A sentence to provide context or background information.
  2. What information currently exists in the field to provide context to your problem statement.
  3. The primary problem that your paper solves and why current research does not address it.
  4. A brief summary of the research methods.
  5. Your main finding, results, or assertions.
  6. The implications of your research findings and significance for the reader.
- A good abstract needs to be **simple, specific, clear, unbiased, honest, self-sufficient, comprehensive, scholarly, and not misleading**.
- The readers of a scientific paper read the abstract for two purposes: to decide whether they want to read the full paper and to prepare themselves for the details presented in that paper. An effective abstract helps the reader achieve these two objectives.

(JAMA, 2011; Stapleton, 2023)

Introduction

- Establish your reasons for reading/writing your paper.
- Provide an appropriate context to your article (small literature review) linking your research to existing knowledge. This will orient those readers who are less familiar with your topic and establish the importance of your work.
- State the need for your work as an opposition between what the scientific community currently has and what it wants.
- Indicate what you have done in an effort to address the need (example: "this is the task").
- List your main results, findings, or assertions (optional).
- Preview the remainder of the paper to mentally prepare the reader for its structure in the object of the document.

(Bellemare, 2020; Doumont, 2010)

Body

- **Materials and Methods** should describe the specific data and design of the study and provide a clear and concise description of the procedures that were performed. To make this section interesting, explain the choices you made in your experimental procedure. What justifies using a given compound, concentration, or dimension? What is special, unexpected, or different in your approach? Mention these things early in your paragraph, ideally in the first sentence.
- **Results** should report your results neutrally using tables and figures and explaining them in the text.
- **Discussion** should carefully discuss where your information is similar or different from other published evidence and why this could be so (justify the results). Stick to your topic and do not overstretch your discussion!

(Bellemare, 2020; Doumont, 2010)

Conclusions

- Describe the most important result of your work. Do not simply summarize the points already made in the body, instead, interpret your findings at a higher level of abstraction. Show whether or to what extent you have succeeded in addressing the need stated in the Introduction.
- Suggest the policy implications of your findings.
- Identify significant flaws or gaps in the research.
- Consider including perspectives. That is, an idea of what could or should still be done in relation to the issue addressed in the paper.

(Bellemare, 2020; Doumont, 2010)

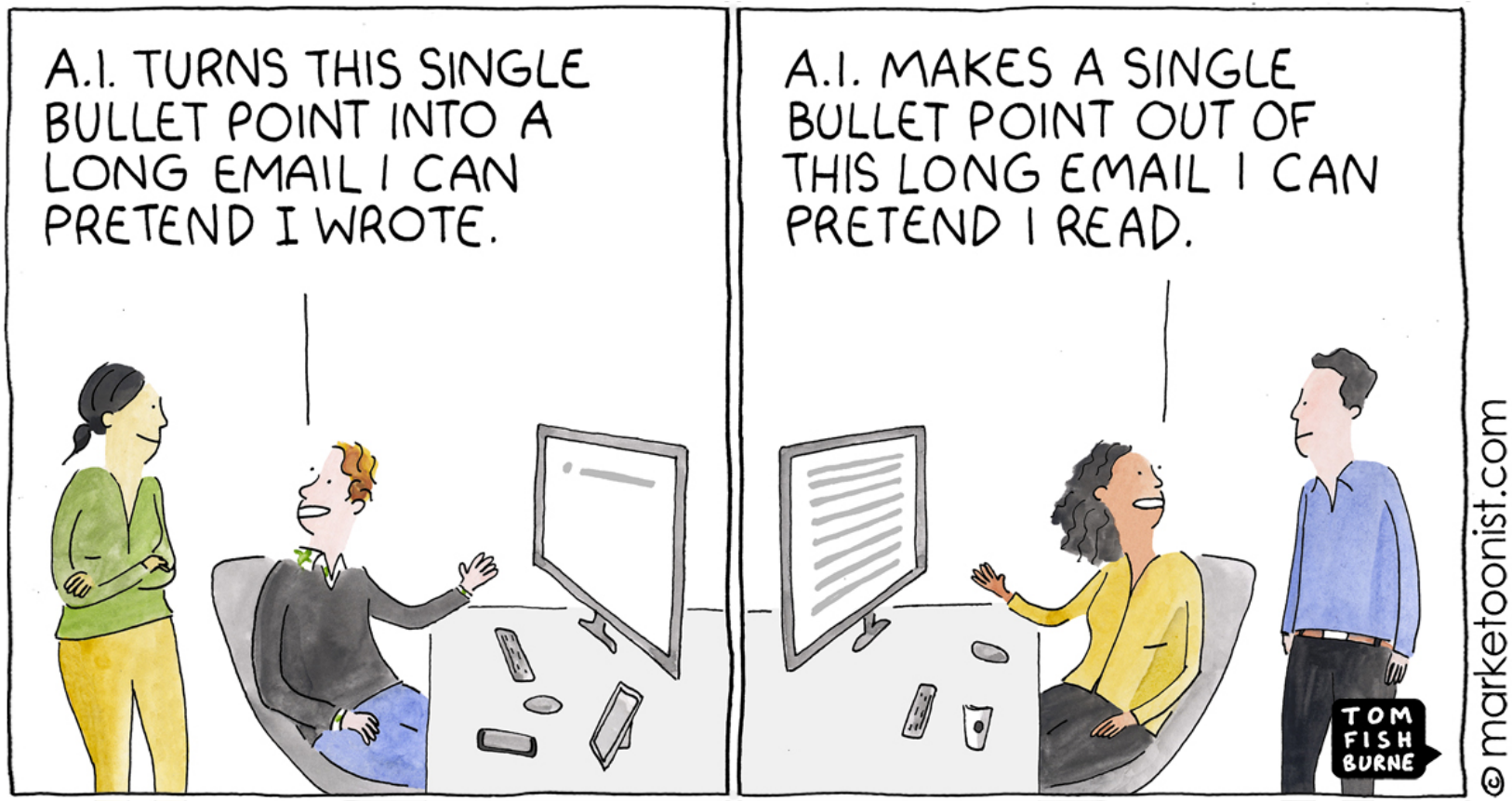
Writing tools

Credit: *PhDcomics.com*

Writing tools

- The writing software **must be a shared decision** between you and your coauthors / supervisors.
- **A writing software must** allow you to:
  - Write formulas in Latex.
  - Insert images and tables flexibly.
  - Work in revision mode, adding comments to the text.
  - Connect with the reference manager software. Go to section
  - Have a proper sharing platform.
- **Microsoft Word** is the most commonly used software. It is easy to use and has the full set of tools; however, some more advanced features are complex to be controlled.
- **Overleaf** is a great alternative that is being increasingly used in academia. It is code-based, so not properly user-friendly, but completely flexible.
- Open Office and Google Docs may lack connection with the reference manager software and/or are less commonly used.

AI's role



Credit: *Tom Fishburne*

AI's role

- So far, there is a clear distinction between using these **tools to assist in writing** versus using ChatGPT to generate and submit text as your own. At their core, AI writing assistants are meant to support writing, leaving you in charge. **Try to remain mindful when using these tools, and make sure you're confident that it's you who's driving the writing process, not the assistant!**
- **Grammarly** and **Writefull** are two of the most well-known writing assistants out there. They flag issues in a given text, helping with grammar, spelling, style, and so on. They fully integrate with the most common writing software.

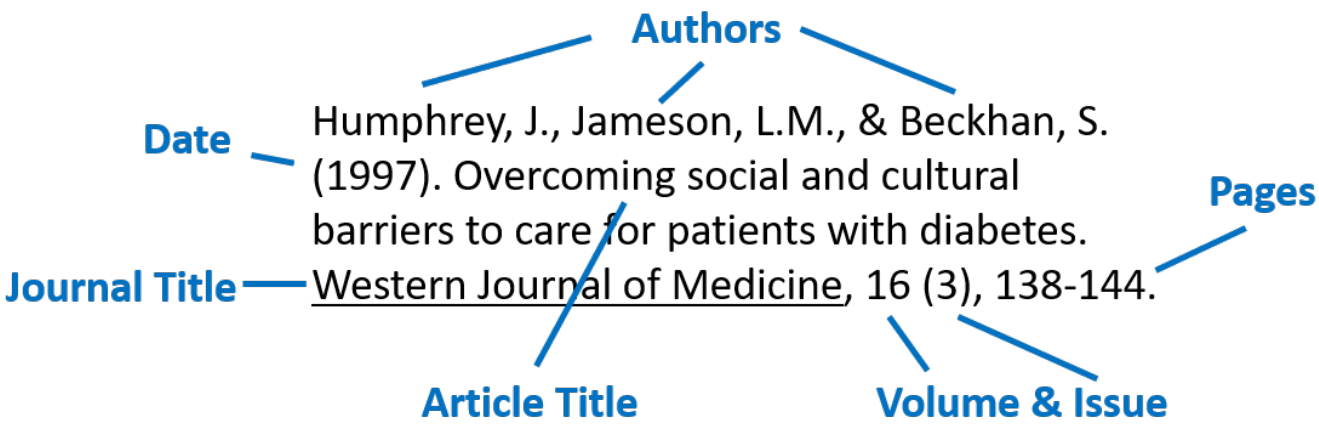
(Digl, 2023b)

Chat GPT

- ChatGPT is revolutionizing the way academic research is conducted. Although it is yet unclear how academia will handle AI-assisted research, the use cases for these tools have become clearer in the past few months.
- **Do use ChatGPT to**:
  - **Summarize existing papers.** Use handy tricks like "Give me 5 bullet points with a 300 word maximum" to get swift responses.
  - Create a paper outline based on your ideas and contents.
  - **Rephrase and fix grammar.** In addition, you can **ask for explanations**.
  - Write code (it doesn't always work).
- **Don't use ChatGPT to**:
  - Find references or articles. ChatGPT is notorious for making up references, including author names, titles, and years of publication. You can even accuse it of doing so and it happily fesses up.
  - Learn new information. Use summaries as guidelines or pointers to prioritize. Not checking ChatGPT's responses means potentially trusting its hallucinations.
  - Write your finished text for you.
  - Math, maybe. This was a more serious issue at the launch of ChatGPT, but has since potentially been resolved with recent updates.

(Digl, 2023a)

Motivation



Credit: *SJSU Library*

The rule of good practice is **a citation must contain all of the information that readers need to locate and use a particular reference for themselves**. If someone would like to read and review the same thing that you did, they need to be able to actually find it. And a good reference citation tells them exactly where it is.

Using the words of another author without proper quoting is a crime!

Citation vs Quotation

- A **citation** is used for a particular idea that you got from another author. Note that some people refer to a "citation" as a "paraphrase."
- A **quotation** is using the exact words of another author.
- Examples:
  - The Government of Canada explains that industrial designs are products with unique features/products that are different in shape, pattern, or design (Trudeau, 2021).
  - The Government of Canada explains that "[i]ndustrial designs are product features that appeal to the eye. They can be a new shape for the hood or fenders of a car, the original pattern in a woven sweater or all of the visual features of a computer monitor. A product's visual appeal gives it a competitive edge, setting it apart from others and making it the one people will buy". (Trudeau, 2021)

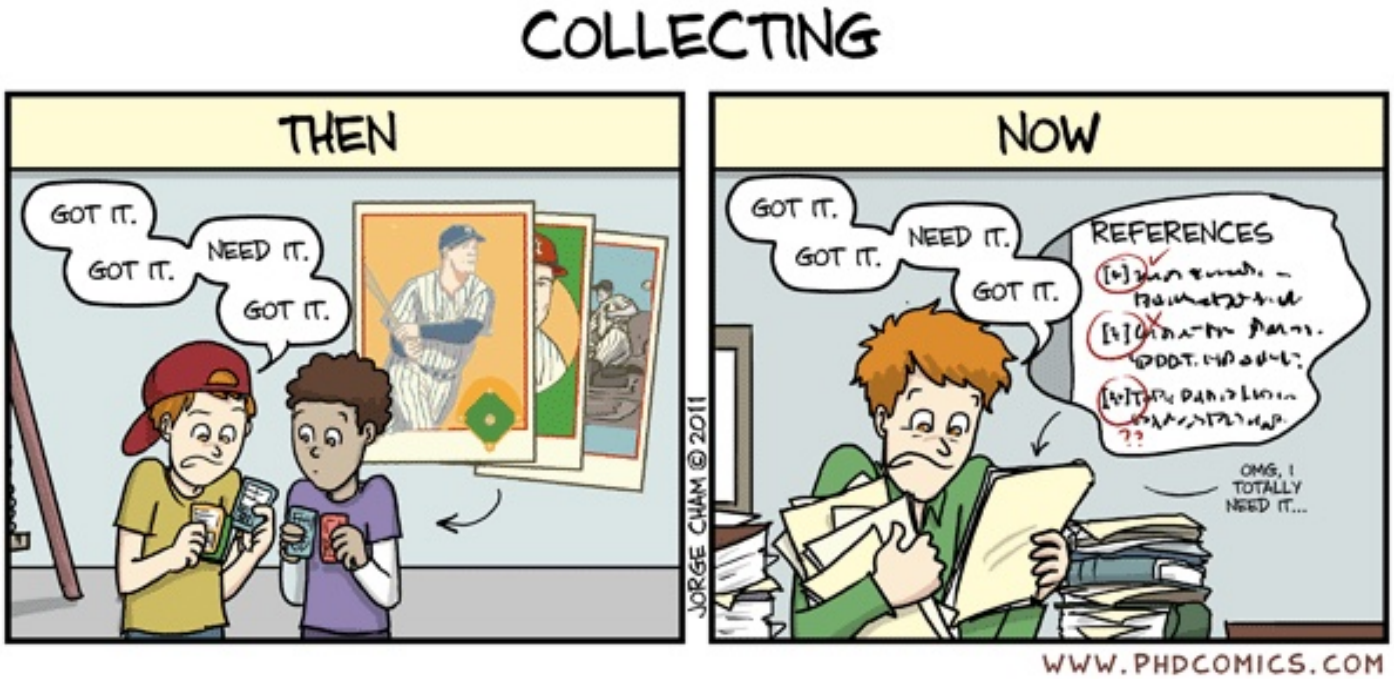
How to cite properly?

- **Official citations of academic literature** are generally provided explicitly or through metadata. However, it is always important to check the veridicity of the citation and correct it if needed. Here are some examples:
  - Provided by Google Scholar. Link
  - Provided in the document. Link
  - Provided by the editor's website. Link
  - Downloadable from the editor's website. Link
- **When a citation is not provided**, we can build it by providing the information needed to retrieve the information we mention.
- **References to webpages** ideally should identify the institutional owner / author of the website, as well as the date that the information was accessed. i.e.: Union of Concerned Scientists (n.d.). "Clean Energy: Choose Renewables First!" accessed 29 April 2014, http://www.ucsusa.org/clean_energy/

Reference styles

- The most common citation styles are the following:
  - **MLA** style in the humanities (e.g. literature or languages).
  - **APA** style in the social sciences (e.g. psychology, education, economics).
  - **Chicago notes and bibliography** in history.
  - **Chicago author-date** in the sciences.
- Here are some style examples. ▸ Link
- Academic journals provide the guide for authors. ▸ Link

Reference Management

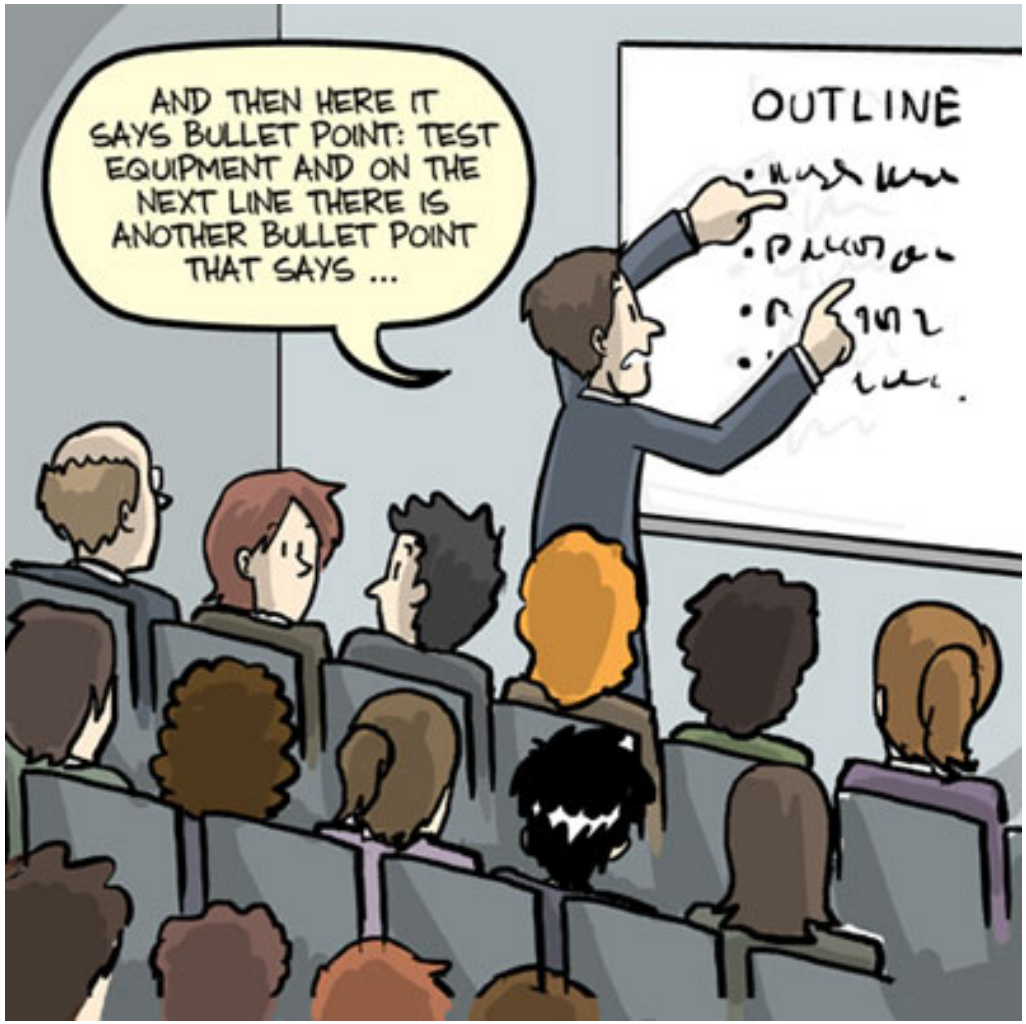


Credit: *PhDcomics.com*

Reference managers

- Reference management software, citation management software, or bibliographic management software is software for scholars and authors to use for recording and utilising bibliographic citations (references) as well as managing project references either as a company or as an individual. Once a citation has been recorded, it can be used time and again in generating bibliographies, such as lists of references in scholarly books, articles, and essays.
- The most common reference manages are: **Mendeley** (freeware from Elsevier), **Zotero** (opensource), **Endnote** (paywalled), and **JabRef** (opensource).

Presentation Drafting



Credit: *Nature*

Motivation

- Slide creation is less important than planning the presentation, structuring it, and delivering it well.
- **Slides are for the audience**. They should not be designed as a memory aid for the speaker. If you feel you need a tool to help you decide or remember what to say, create notes for yourself, but do not project these in front of the audience. Slides created for the speaker tend to be overcrowded and cryptic.
- **Slides are for getting messages across**. On each slide, state your message as a short sentence (in a maximum of two lines, corresponding to about 10–15 words), normally in the title area.
- **Slides are visual aids**. The audience cannot listen to what you say and read the text at the same time, except for a few words or a short statement. Because of this limitation, be as visual as possible as you develop the message you stated in the title area.

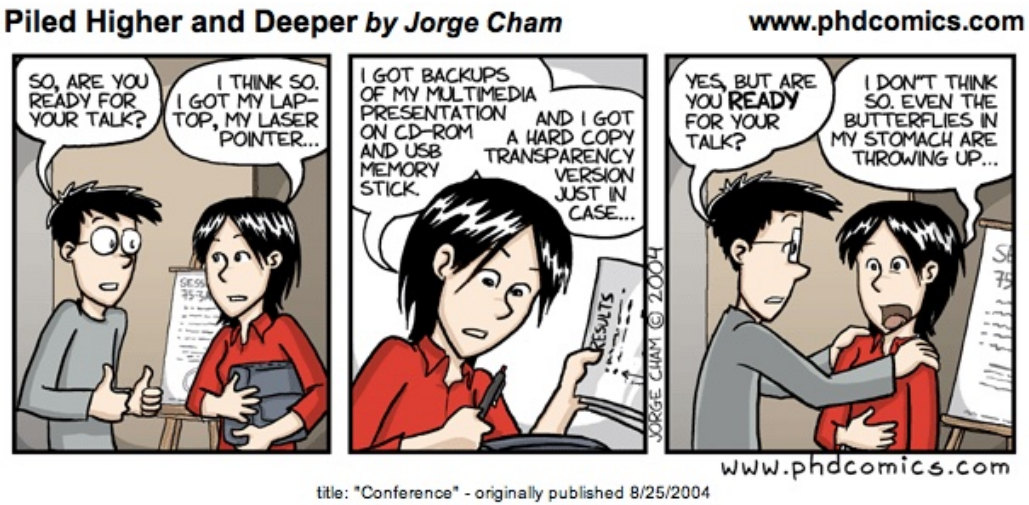
(Doumont, 2010)

The structure

- Follow the structure of the paper:
  - Offer a body of evidence.
  - Sum up with key takeaways.
  - **Limit the number of slides** (rule of thumb: 1 slide every 2-3 minutes).
  - **Limit the amount of text** on each slide.
  - **Present only the most important graphs** and (only if needed) tables.
- Make it appealing:
  - Use the colors most relevant to your message (**no more than 2**).
  - Be consistent with your font.
  - Format font and figures at your best.
  - Use logos instead of bullet points (when you can).
  - **Don't use animations.**

(Doumont, 2010)

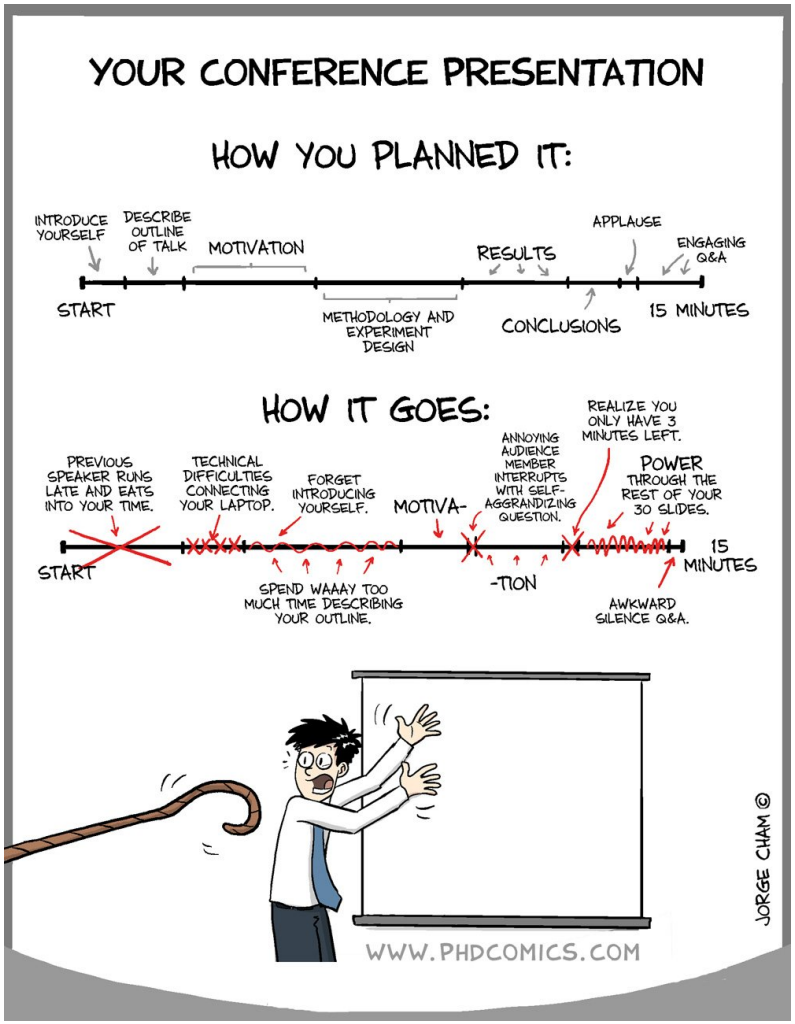
The oral presentation



Credit: *PhDcomics.com*

- Have a **strong opening**, ask a rhetorical question, explain your reasons for choosing that project.
- Be genuine, have fun, and make the audience enjoy the presentation, **tell stories**.
- **Try it at home with a timer** and some friends/family.
- **DO NOT READ!!!** It distract your audience and makes you look like you do not know what you are talking about.

The oral presentation



Credit: *PhDcomics.com*

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