Scientific publishing

Methods of Scientific Working (for Crop Sciences) (3502-440)

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1 Motivation: Why write scientific publications?

Scientific publications are concise and ideally rapid forms of scientific communication.
Their goal is to summarize and disseminate scientific information efficiently.

The most important means of **reputation building** is through scientific publication.
Publish or perish is arguably the single most important principle in scientific career development.
The German equivalent of this proverb is *"Wer schreibt, der bleibt"*[1].

Papers are far more durable than live presentations and can be scanned faster than talks.
They serve as repositories of ideas, data, and scientific methods.
Thus, scientific papers provide the foundation to **reproduce research** conducted by others.

A scientific paper is not a narrative of how the research was conducted but a **summary of the findings**.

[1] "Who writes, remains"

A good paper tells a story, but it tells a **scientific story**.
Writing a research paper also forces one to rethink and refine ideas, often helping to focus and further develop one's scientific reasoning.

Papers pave the way for **collaboration**: they can be read, reviewed, and critiqued by others.
They help you establish a professional network and foster opportunities for collaboration.

2 Learning goals

1. To be able to explain the importance of scientific literature for the goals of the scientific method.
2. Understand the workflow from scientific research to a scientific publication.
3. Know the key stakeholders in the scientific publishing system.
4. Understand that scientific writing is a craft that rests on few generally applicable principles.

3 How does scientific publishing work?

3.1 General outline

Scientific publishing is a highly structured and regulated process and is now usually managed by large publishing companies. For original research papers, the order of events is usually goes like this:

1. Do research and write a manuscript
2. Give it to your advisor and colleagues for an internal review
3. Revise the manuscript. Repeat the review and revision cycle.
4. Select a journal and submit there via an electronic interface. Write a cover letter to the editor to advertise the paper.
5. The paper is reviewed by 1-4 (usually 2) anonymous reviewers.
6. You get the reviews and comments from the editor. If the paper is not rejected, change the paper according to the review. Write another cover letter where you precisely outline your changes to the reviewed manuscript.
7. Re-submit the paper.
8. After a second review, the manuscript is rejected or accepted.
9. The paper is submitted for typesetting. You may have to transfer copyrights to the company.
10. Edit the galley proofs, usually within 48 hrs.
11. The paper is sent to the printer or published as PDF document on the web.

3.2 Peer review

The peer review process is the most important step in the process of scientific publishing because it decides whether a paper gets published in a particular journal or not.

Peer reviewed publications are considered to be gold standard of scientific publishing. In addition, grant proposals are also peer reviewed. The number of peer reviewed papers (coupled with measures of impact) are required to receive funding from funding agencies, to obtain jobs in academic research and to receive job promotion.

The system of peer review originated in the 1700s century when the Royal Society of London installed a **Committee on Papers** that had the power to obtain external and expert opinions to

assess manuscripts submitted for scientific publication. However, the peer review system became standard after the Second World War when the extent of scientific research was greatly expanded and journal editors received many more manuscripts than they could handle. To improve the situation, they solicited help from external scientists, the peer reviewers.

The basic rules for reviews of scientific manuscripts are fairly simple: They should be critical, objective and fair. Reviewers should not attack the authors, and they should declare any conflicts of interest. Reviewers are usually not compensated for their work.

Good peer reviews should also filter out bad experiments and research, as well as low quality and incorrect publications. Interestingly, there are very few studies that evaluated the effect of peer review on the quality of science.

3.3 Problems with the peer review system

There have been some spectacular failures of the peer review system, where publications that violated common sense (i.e., made outrageous claims) were published in established science journals.

One reason for the failure of the peer review system is that in the major journals an interesting story is considered to be more important than the data supporting them. Thus, the important rule that extraordinary claims require extraordinary well-supporting evidence is violated. The peer review system also was not good to detect fraud, or borderline cases of fraud. Many interesting examples and discussions can be found at RetractionWatch.

Peer reviews are usually anonymous, so the authors do not know who wrote the review. Reviews are furthermore voluntary, so their is no pay or professional credit for being a reviewer. There is also no formal system for evaluating reviewers, and the quality of reviews. These issues are usually handled by individual journal editors.

Because of its anonymity and dependence on volunteers, the peer review system is open for abuse. Common problems with the peer review are

- Friends of the authors are often suggested or even chosen as reviewers.
- Reviewers delay the review process to advance their own, competing research.
- Competitors could steal ideas or plagiarize research.
- They could also let their post-docs or graduate students do their research.

Given the expansion of the number of scientific publications, there is the danger that the system breaks down. A historian of science estimated that the National Institutes of Health (NIH), which spends billions of dollars, requests reviews for 40,000 research proposals. The total time used for review was estimated to amount up to 2000 person years (Just for the grant proposals and not for scientific journals).

Once the reviews have been returned to the journal editor, the editor decides whether a paper is rejected or not. It often takes 2-3 rounds of submission and re-submission until a manuscript is accepted for publication.

3.4 Changes in the scientific publishing ecosystem

In the last two decades, the internet became an important competitor to the classical scientific publishing system. Although the scientific publishing companies are among the most profitable enterprises worldwide, there are new developments that threaten their old business model and will have profound impact on the future of scientific research.

Research publications can now be published on the internet by anybody, where they are not peer reviewed. Therefore, the printing press, which may be in the hands of powerful companies are now obsolete.

The open access movement proposes to provide a free and unrestricted access to scientific publications. Many research organisations now demand some form of open access publications. The established publishers can not charge for access to their content under such a model and lose profits.

In response to the issues with the peer review system two other important trends are **preprint archives** and **postpublication review** (as opposed to the classical **prepublication review**). Preprint archives store manuscripts and make them publicly available before they have been peer-reviewed and are published in a scientific journal. In mathematics, essentially all papers are published first on preprint archives. The most important preprint sites are bioRxiv or arXiv. Archiving is becoming more common also in the biological and life sciences.

Postpublication (peer) review allows anyone to comment on a scientific publication, not only the (usually 2-3) anonymous reviewers in the classical prepublication reviewers. Also, preprint servers provide the possibility to comment on manuscripts so that authors can incorporate any useful suggestions in the a new version of their manuscript. In consequence, the monopoly of scientific journals (and their editors) to control the publication of scientific results is breaking down. On the other hand, the vast majority of papers on preprint servers never receive a commentary or a review, in contrast to articules that are published in scientific journals after peer review.

The possible breakdown of the classical system which is based on publications in highly prestigious journals also requires to find new means of reputation building. Important components in this are **social media** that are increasingly used by authors to promote their research work. They are therefore important outlets for advertising new research publications, to network with colleagues and to establish new contacts and discuss science. **Blogs** are often used for the more informal discussion of scientific and science-related topics.[2]

Another increasingly popular way of disseminating scientific results and insights about the scientific process are **podcasts** either by scientists themselves or by science journalists. This link leads of a podcast episode of our PhD student Che-Wei Chang on his paper on genetic variation wild barley. An excellent podcast on science and the scientific enterprise is the Night Science podcast (Link) by Itai Yanai and Martin Lercher.

Many scientists are reluctant to spend some time on these activities because they consider them not to be an efficient use of their time and a distraction from research. And it requires the courage to speak to a large public, which may attract extrovert over introvert personalities.

Another important consequence of the internet is that search engines are very powerful in finding scientific content. If content is open access, it does not matter so much anymore, in which journal it is published, because no subscription is needed anymore and modern search engines like Google Scholar highly increase the findability of scientific research.

Another consequence is that *any* scientific object (peer reviewed publication, preprint, data set, figure, table, etc.) gets a **digital object identifier (DOI)**, which turns it into a discrete digital entity that is citable and represents an independent piece of work. Initially, only publications had DOIs, but now tables, figures, media content and scientific data have their DOIs. This is an important development for young scientist because individual contributions to a piece of scientific work can be better indicated and be part of a CV, for example.

[2] A very good example are the writings of the plant pathologist Sophien Kamoun, John Innes Center UK Link

4 Practical aspects of scientific writing and publishing

In the following we will discuss some practical aspects of scientific writing.

Your your next scientific document will likely be your *Master thesis*. In form and style it is not that much different from a scientific paper. It should be written in an engaging style, scientifically and formally correct and sufficiently detailed for a complete understanding of your work and project. Ideally, it should contain the complete information to let others repeat your work.

On the other hand, your thesis will be written by yourself, whereas most scientific papers are the result of collaborations. Hence the writing styles (and personalities) of different authors need to be integrated in a collaborative paper. Furthermore, the language likely is more standardized and much more concise than in a master thesis.

Your aim of scientific work should be a peer-reviewed publication. Treat yourself with a scientific paper: Not writing up your research is like being a farmer who sows the seeds, but does not harvest the plants. The intellectual and emotional rewards of publishing are very large, even though only few people likely read your manuscript. But if you do not publish at all, your work will have less impact (except of course if the result of your work is a product or a patent, but even then you have to probably write some kind of research report).

Most importantly, before writing, record your ideas and your scientific work in a **laboratory notebook**. Use it as a log book to which you can go back and check what you did at a particular day and how. Lab note books are repositories of information by recording everything you did in your work. They free your brain from having to memorizing unnecessary details and allow you to think creatively. When starting two write a paper, a lab notebook helps you to recollect what you actually did. If your research is relevant with respect to patenting or if it is funded by a funding agency, a lab note book is obligatory and you have to keep it for a number of years.

4.1 The how-to of scientific writing

You should treat scientific writing as a craft not as an art.

There are some simple techniques that help you to efficiently produce a legible text. Most importantly, use a structured process for writing:

- Write an outline with the key ideas and key points. Develop the line of arguments.
- Create the figures and the tables.
- Write the first draft of the text.
- Revise the text.

Some people recommend to write the abstract first. The *abstract* is a short summary of 200-300 words. In any case, *define the goals* of your study and of your paper.

When you start composing the manuscript, begin with an **outline** to structure your ideas and your reasoning. An outline helps you to define independent units of thinking and writing. Try to find a **topic sentence** for each section. This helps you to define the logical structure of the paper and to find loose ends in the story. You can start to write the different sections of a paper, not necessarily in the final order. Make an outline early, even before starting your actual research, and work goal oriented (i.e., envision the paper you would like to write). It is then possible to start writing the paper during the research work and to fill in the bits and pieces. Most text editors have now an outlining function that are great for structuring your documents.

4.2 Techniques to keep you writing

Writing is laborious, sometimes tedious, and always much harder than just reading. There are numerous tactics available to keep you writing and and to get distracted and let yourself distracted. Here are some of the most commonly recommended ones.

Start early Do not write under pressure before deadlines. You are not a journalist. Good writing needs to mature like wine.

Write regularly Set aside some time every day during which you write. It can be short as 15 min, but it should be regularly, ideally at a fixed time of the day. Record when you have written. Do not wait to find time for the large big junks of time, only at the end of your thesis.

Isolate yourself Find a writing location which you like and where you are undisturbed. Make yourself unreachable. Reduce distractions: Turn off the email program, social media apps, etc., and use the full-screen mode of your text program.

Just write Do not search endlessly for the best phrase and not get any writing done. Just keep writing, let your thoughts flow. If you have a hard time writing English, write in your mother tongue and translate later. It is important to get your ideas and results out. You can (and will have to) edit later, anyway.

Copy, but do not paste Read some articles from the journal in which you want to publish. Get a feeling for the formatting and the style of the publications. Imagine the ideal reader of your manuscript and write for him or her.

Do something else if you are stuck If you really feel you don't move on, do something else. My favorites: Visualize your ideas using paper and pen; read a few pages of a good non-scientific book to get some ideas about new phrases; go for a short walk and let your thoughts fly (do not forget to carry a notebook with you); take a nap.

Use artificial intelligence like ChatGPT responsibly and wisely Never use these tools to develop your primary text, which is based on your original and creative thinking, but it is fine to use these tools for correcting your grammar or translate your writing into English.

Once you have written a larger piece of text like a chapter of your thesis, let it mature. Leave it away for a couple of days before you start editing it.

4.3 Revising your work

There are numerous techniques for proofreading and editing scientific manuscripts. The most useful are:[3]

- Use a spell checker in your writing program.
- Use =Courier, or some other non-proportional typeface.= Mistakes (especially punctuation errors) often seem to show themselves more often when your writing appears in this form. Do not try to lay the piece out in its final format - concentrate on the words, not the appearance.
- Print out your work *double-spaced*, and *leave wide margins* at left and right for comments and corrections. Number the pages, especially if you print double-sided.
- Don't make the corrections on the computer as you find them. *Move away from the computer*, or at least close the file. When you have finished proofreading the entire piece, make the corrections on the computer, crossing them off on paper as you go.
- *Read your work out loud.* It forces a higher level of concentration than silent reading.

[3] Note that these are to some degree old-fashioned as they assume you print out your work and do the revision with the print out, which has some advantages over reading text on the screen. However, modern tools such as spell checker, the ability to add comments to your text as well as AI-based grammar checkers, change the revision workflow of publications significantly.

- Use a red (or at least a color other than black) pen or pencil to *mark up your text*. When you come to make the corrections on the computer, use another color (say blue) to check off the corrections as you make them. :::{.content-hidden .comment}
- Take the trouble to *learn the standard proofreading signs* and symbols. It means that you will be able to work on other people's work, and they on yours when necessary. :::
- For proofreading (i.e. basic spell-checking in context), *read backwards* (i.e. from the bottom of the page upwards). Since the words come in an unfamiliar and unnatural order, you are more likely to find mistakes than if you read forwards and read what you expect to see, instead of what is already there.

4.4 The structure of a scientific report or document

The scientific report such as a master thesis or a peer reviewed scientific publication usually follow the same structure, which is outlined below. However, some journals expect a different structure of a paper, and for this reason, it is always recommended to look at the information for authors provided by a scientific journal before starting with the writing of a paper.

If you have outlined a manuscript, it is not necessary to start with the introduction and move on to the other chapters. Rather, fill those parts that are fit for writing. A frequently used order is Materials & Methods, Results, Discussion, and, finally, the introduction.

- Abstract
- Introduction
  - Literature review
  - Pose the scientific problem and hypothesis
- Materials and Methods
- Results
- Discussion
- Conclusion (sometimes)
- References
- Supplementary material

Abstract

The abstract is usually written as the last part. Start by assembling the first lines of paragraphs in the Introduction and Methods section, then improve. The abstract is the most read part of a paper in addition to the title.

Introduction

The introduction can be written in three paragraphs:

1. Outline the overall scientific area.
2. Introduce the specific part of the field investigated in the manuscript.
3. Pose the research question or the hypothesis, and briefly outline the results and the conclusions.

Materials and Methods

Describe your research methods. Frequently the passive voice is used. Make sure that the reader understands what you did and that he or she is able to repeat the experiments given the information provided.

Results

The results section should describe the the hypotheses, and the results of your work. Since you describe the work you did in the past, the text should be written in past tense. Be concise and clear.

Discussion

In this section, you put your research into context with other, previously published work. Here you can extensively reference to other work.

4.5 Suggested order for planning and writing the sections of a scientific manuscript

- Figures and tables ⇒ The data
- Figure legends ⇒ Provide essential details on the data
- Results ⇒ What did I do and what did I find out?
- Discussion ⇒ What does it mean?
- Introduction ⇒ What is my theme and why am I interested in it?
- Abstract, summary or synopsis ⇒ Take-home message
- Title page ⇒ Title, affiliations and keywords
- Materials and methods, experimental procedures ⇒ How
- List and sort the references ⇒ Whose work is my research based on?
- Acknowledgements ⇒ Who provided advice and materials, who paid for the work?
- Title page ⇒ Abbreviations

An excellent summary on how to structure the writing of a research paper are summarized by Mensh and Kording (2017), which is summarized in Figure 1. It shows that an hourglass is a useful metaphor for the general structure and line of arguments of a paper. Start with a broad phenomenon and problem in the introduction which leads to the specific research questions, then after describing materials and methods as well as the results, begin the discussion with some specific aspects of your research, and then expand it towards the end to the broader implications of your research. Note that in principle, the same structure can be applied to your Master thesis.

5 Summary

- The writing of scientific publications is one of the most important outcomes of scientific research.
- Publications are important for disseminating the research (i.e., announcing the results of research), but also provide sufficient information that makes the research reproducible and therefore fulfills a key criterion of the scientific method.
- Peer review is considered to be the highest standard of quality control in scientific research. However, even peer review has some problems such as conflicts of interest that need to be transparently discussed and addressed.

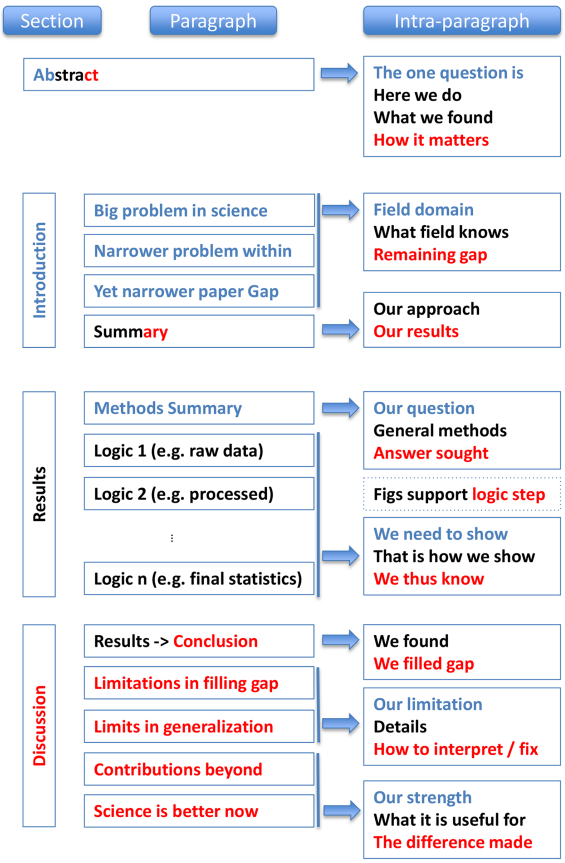

Figure 1 – *Outline of the structure of a research paper at three levels. Source: Mensh and Kording (2017). Licensed under CC BY 4.0*

- With the advance of internet-based publishing the central role of the (printed) research paper has somewhat diminished and many other ways of dissemination such as blogging or podcasting are being used.
- Preprint servers are becoming increasingly important to publish scientific studies fast and early.
- The actual process of writing can be exhausting and is better done with some kind of routines to be more efficient.

6 Key concepts

- ☐ Peer review
- ☐ Preprint
- ☐ Open access publication

7 Further reading

There are many excellent books about scientific writing. Here is a small selection of recommended ones.

- Tim Skern: *Writing Scientific English - A Workbook*. Facultas.wuv (2009)
- Steven Pinker: *The Sense of Style - The Thinking Person's Guide to Writing in the 21st Century*. Allen Lane (2014)

- Stephen B. Heard: *The Scientist's Guide To Writing - How to write more easily and effectively throughout your scientific career*. Princeton University Press (2016)
- Scott L. Montgomery: *The Chicago guide to communicating science*. Chicago University Press (2003)

8 Study questions

1. Why is the scientific paper a better means of communication and publication of original research in the natural sciences than large books (monographies)?
2. What are potential advantages of archiving manuscripts on public sites before they are accepted by peer review journals?
3. What are potential advantages and disadvantages of paper-based versus internet-based scientific publications?
4. How do you define the role of a laboratory notebook versus a scientific publication in your research?

9 In class exercises

9.1 Why write scientific publications?

Please discuss the following questions in groups:

1. Which types of scientific publication do you know?
2. What is the advantage of writing a scientific publication in form of a paper as opposed to other means of distributing the results of scientific research?
3. Can you name direct and indirect positive effects of publishing scientific papers? Think about the researchers, the scientific domain and the society in general.
4. What should be written into scientific paper as opposed to a laboratory notebook?

9.2 Peter Medawar: Is the scientific paper a fraud?

The essay can be downloaded from here: PDF.

1. What is the key problem (fraud) of a scientific paper according to Medawar?
2. Why does this problem arise from an incorrect understanding of the scientific process?
3. Medawar mentions 'Mass Observation': Is there a more modern term for this approach to science?
4. Why is Mass Observation a problem according to Medawar?
5. Which argument does Medawar make to support his claim that the theory of inductive reasoning is wrong?
6. What is wrong with the traditional form of scientific papers?
7. How should a scientific paper structured according to Medawar?

9.3 The scientific publication system

1. Assume that your master thesis will be published. What steps does it involve to publish a scientific publication?
2. What parts of your scientific work should be part of a scientific publication?
3. By what criteria are your scientific publication and its quality assessed?
4. Do you see any points of criticism with the current system of scientific publication?

9.4 Mensh and Kording: Ten simple rules for structuring scientific papers :noexport:

Mensh, B., and Kording, K. (2017). Ten simple rules for structuring papers. PLOS Computational Biology 13, e1005619.

1. What is the key approach to structure a scientific paper according to Mensh and Kording?
2. What are the key characteristics of a good scientific paper?
3. How does the C-C-C rule apply to Medawars's proposed structure of a scientific paper?

References

Mensh B, Kording K. 2017. Ten simple rules for structuring papers. *PLOS Computational Biology* **13**:e1005619. doi:10.1371/journal.pcbi.1005619