Academic writing: structure of a scientific text

Scientific texts have a well-defined structure where each chapter has a distinct function. The structuring helps the **reader** to find what they are looking for easily and it helps the **author** to develop their story in a logical way.

This instruction focuses on writing at the level of the text as a whole. For instruction on structure within sections, consult the handout Sentences and paragraphs.

Description

All scientific text intend to tell the story of a scientific question being answered or hypothesis being tested. However, unlike literary texts, all scientific texts are constructed in a similar way. This structuring is based on main chapters, where each chapter contains specific information (note: in a paper these chapters would be called 'sections'). The core consists of **Introduction, Methods, Results** and **Discussion** (IMRaD for short). There should be a clear line of reasoning throughout these section: the Methods, Results, and Discussion should focus on the research question(s) stated in the Introduction. Scientific texts may have additional parts: a cover page, a title page, an abstract, table of contents, recommendations, references (see also handout Citation) and appendices. Consult the author guidelines of your course about the exact requirements.

Guidelines

Here we discuss the function and contents of the core of the **IMRaD** structure. Box 1 discusses additional chapters and alternative orderings within the IMRaD structure.

1. Introduction
a. Function: to specify **what** you have investigated and how this is linked to what is already known about the subject. After reading the introduction, readers should know exactly which **question your study intends to answer** and why.
b. Structure: the Introduction is written as a **funnel**. It starts with the context and narrows down to the subject of the study. The funnel includes the following steps, in this order:
   - broader context and problem description;
   - prior studies and theory (see Box 1);
   - identification of the knowledge gap;
   - aim / research questions / hypothesis (see Box 2)

   The Introduction often ends with a short overview of the organisation of the report.
c. Size: roughly 10% of the total report.

Box 1 – Variants of IMRaD structure and contents

There may be good reasons to deviate from the strict IMRaD ordering. Examples are:
- A separate **Theory** chapter can be placed between Introduction and the Method (ITMRaD). Reasons for this can be:
  - the required theory exceeds the background information of the research questions;
  - development of a new theoretical framework is part of the study.
- The Methods can be split in 'Data' and 'Methods' (IDMRaD) if extensive details about the data (location, observation methods or conditions) are relevant.
- Contents of the Discussion can be moved elsewhere:
  a. Interpretation and explanation of results can be moved to the **Results**. This makes it easier for the reader to follow the discussion as the presented results are close by;
  b. The answers to the research questions can be moved to a separate **Conclusion** (after the Discussion: IMRaDC). This highlights the answers to the research questions in the Conclusion;
  c. Do both (a) and (b): the Discussion then only contains the critical evaluation of the study.
  d. Recommendations are sometimes put in a separate chapter.
- Grouping of certain chapters (M and R, or R and D) by task, topic or research question (e.g. separate chapters for research question 1 and 2; with each its own sections on Method and Results).

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2. Methods
a. Function: to specify **how** you have set up your study. After reading the methods section, the reader should be convinced that your data and method **can answer the research question**, and they should be able to **reproduce your study** exactly.
b. Structure: generally, there are two aspects of this specifying the set up: the **data** that you used, and the **methods** you used to transform and analyse the data in order to answer the research question (the actual methods). Start the chapter with an overview of its contents.
c. To characterize the **data**, the following aspects can be relevant (the order may vary):
   - **methods and equipment** used to collect the data (including some indication of precision);

- available **variables**;
- **location**(s) where data have been collected;
- **spatial** extent (total sampled space) and spatial resolution (spatial separation of samples);
- **temporal** extent and temporal resolution;
- number of **replicates**;
- if you use existing data, specify the **source** (including a reference if possible).
- If you use data that are the output of a **model**, specify the model (with references), and pay attention to e.g. resolution in space and time.

d. To characterize the **method** pay attention to:
- **Transformations** of the original (raw) data, such as filtering (e.g. to reduce outliers), averaging, categorizing (e.g. grouping of data by occurrence of a certain condition), or combining multiple variables into a new variable. If you use a **model** to transform your data (data in → modelled data out), describe that model.
- **Analysis** of the data. Clarify how you compared / judged / assessed your (transformed) data to answer your research question. Use the same order as in your Results section.

e. Order: usually data → method. But if the data part can only be explained using knowledge from the method part, you can reverse the order: method → data.

f. Size: 20-30% of the total report.

g. Tense: past simple.

3. Results

a. Function: the results chapter presents your findings in an objective way. After reading the results section, the reader should be able to **answer the research questions by themselves**.

b. Structure: present the results in a **logical order**. This logic may follow from (1) the order in which the *methods* have been discussed, (2) order of the *research questions* (3) ordering in *space* or *time* (small-to-large or large-to-small), (4) *major* results to *minor* results. Start the chapter with an overview of its contents so that the reader knows and understands your ordering. To clarify the structure, you can use subheadings (maximum 3 levels) to split the results.

c. Develop a **story line** that leads the reader to the answers to the research questions. For that story line the order discussed under b. is essential. Do not sum up all results.

d. Use **tables and figures** rather than large amounts of text (see handout Figures and Tables). The text should provide a summary of what is shown in the table or figure. It should not repeat the contents.

e. Select the **minimum** number of tables and figures that you need to tell your story. Do not replicate the same data in a figure and a table.

f. Do not introduce new methods.

Box 2 – Aim, objective and research question

To clarify confusion about terms often used in the Introduction:

- **Aim**: a usually broad statement about you want to achieve with the study;
- **Objectives**: the specific steps that you intend to take to reach the aim;
- **Research question**: the question you intend to answer with the study. The main question should be aligned with your **aim**, whereas sub-questions will generally follow the **objectives**;
- **Hypothesis**: a statement (supported by arguments) about the expected answer to the research question (the study should lead to confirmation or refutation of the hypothesis).

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g. In the text, the results should be discussed to the extent that you make clear to the reader which results they should pay most attention to (unexpected, important, main trends, supporting your story line, or not). However, interpretation and explanation of the results is (in principle) part of the Discussion. However, deviation from this guideline is possible, see Box 1, third bullet).

h. Size: 40-50% of the total report.

i. Tense: presentation of data in past simple, presentation of the results in present simple.

4. Discussion

a. Function: the discussion chapter provides the link between results and research questions: by interpreting the results, the answer to the questions is constructed. After reading the discussion the reader should know **your answer to the research question** as well as the remaining **open issues**.

b. Structure: (1) discussion of the results (interpretation and explanation, may also be part of Results, see Box 1), (2) answers to the research questions (may also be a separate Conclusion chapter, see Box 1), (3) critical evaluation of the study.

c. In the **discussion** (1) of the results you *interpret* the results in connection with literature and the research question. This may also include *explanation* of the results (what is the mechanism behind the results).

d. When **answering the research questions** (2):
- keep the same order as used in the introduction (it may help to briefly repeat the research questions);
- provide a clear link between the results and the answer;
- if you introduced a hypothesis in the introduction it should be confirmed or refuted.

e. The **critical evaluation** (3) can contain a discussion of e.g. (after Schultz, 2009):
   - alternative interpretations;
   - unresolved issues;
   - exceptions and outliers;
   - assessment of both the limitations and the strengths of your data and method;
   - (dis-) agreement with prior work (literature).
   - recommendations for further research (can also be a separate chapter, see Box 1).
f. The discussion is *not* meant to discuss what could have gone wrong in the study, or what you would do differently in a future study.
g. Size: 10-15% of the total report
h. Tense: present simple when presenting facts, past simple or present perfect when referring to your own results.

References

Schultz D.M. (2009) The Structure of a Scientific Paper. In: Eloquent Science. American Meteorological Society, Boston, MA (https://doi.org/10.1007/978-1-935704-03-4_4).

Further reading

Wallwork A. (2016) English for Writing Research Papers. English for Academic Research (chapters 14-19) Springer, Cham (https://doi.org/10.1007/978-3-319-26094-5).