

A guide for scientific writing

Bachelor Earth Sciences

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Preface

Scientific writing is an art and skill that must be learned by repetitive practice of reading, writing and revising. Throughout the bachelor's programme of Earth Sciences, there are various moments during which you train your writing skills. These skills are not only necessary to successfully complete the final course of the bachelor programme, the bachelor thesis, but are also a prerequisite for effective communication with colleagues or the general public in your academic or professional career.

This document aims to provide concise guidelines and instructions for content, structure and style of scientific reports with examples of do's (in green) and don'ts (in red). Scientific reports can take the form of a fieldwork report, a literature review or a research paper, which all share a similar basic structure. Students are encouraged to use this document to structure and evaluate their text before submission. For teachers, this document may be useful to give consistent instructions, feedback and grades. Note that all instructions should be interpreted as guidelines and not as absolute laws; there may be good reasons to deviate from them. In such cases, it is advised to consult your supervisor.

This guide has been largely based on a previous version developed by the *Centrum voor Onderwijs en Leren* at Utrecht University (COLUU) and input and feedback from colleague lecturers and professors of the bachelor's programme of Earth Science at Utrecht University.

Dr Marcel van der Perk
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1 Introduction

1.1 Why scientific writing?

Scientists write to communicate their research results and findings with other scientists or experts. In this way, information is shared in a systematic manner, so that researchers can build upon the work of others. Although there are different ways to share information amongst the scientific community, such as oral or poster presentations on scientific conferences, science blogs, or data warehouses, written reports, especially those reviewed by peer scientists and published in international journals, are still the most effective way to add your research outcomes to the body of scientific knowledge.

1.2 Plagiarism and scientific misconduct

Plagiarism encompasses copying of someone else's work or ideas without proper reference and present it as an own piece of work. It is considered as academic misconduct. To avoid plagiarism, do not literally copy any phrases from source materials (article, book, or report) and always give a proper reference to the original source from which you borrow insights and knowledge.

Scientific misconduct is broader defined as "Intention or gross negligence leading to fabrication of the scientific message or a false credit or emphasis given to a scientist" (Danish definition) and includes, besides plagiarism, data manipulation and fabrication. It should be obvious that in the academic community, any form of scientific misconduct is considered to be a very serious offense and will be treated as such. More information, further explanation, and examples of fraud and plagiarism can be found on the university's website¹ or the plagiarism.org website².

DO's	DON'T's
<ul style="list-style-type: none">• Write in your own words and refer adequately to the literature	<ul style="list-style-type: none">• Do not copy entire phrases/paragraphs from existing texts

¹ <http://students.uu.nl/en/practical-information/academic-policies-and-procedures/fraud-and-plagiarism>

² <http://www.plagiarism.org/>

2 Structure and content

2.1 Reporting according to the IMRAD structure

Scientific writing has a long tradition and since the first half of the 20th century, the IMRAD structure has become the dominant structure for scientific reports reporting original research (most journal articles, congress papers, bachelor and master theses, etc.). IMRAD is an acronym for introduction, methods, results, and discussion. These four elements are the main ingredients for a scientific report and are preceded by an abstract and followed by conclusions. They also usually form the main headings for the successive sections of a scientific report or paper.

The IMRAD structure reflects in a way the process of scientific discovery through the empirical cycle. Although the empirical cycle is often complex and involves many iterative feedback loops (Fig. 1), the IMRAD structure seems to reduce it to an oversimplified, linear, and stepwise process. This is also why the IMRAD structure has been criticised in the past for being too rigid and too simplistic (e.g. Medawar, 1964). Nevertheless, the IMRAD method has been adopted by the majority of journals across a wide range of disciplines.

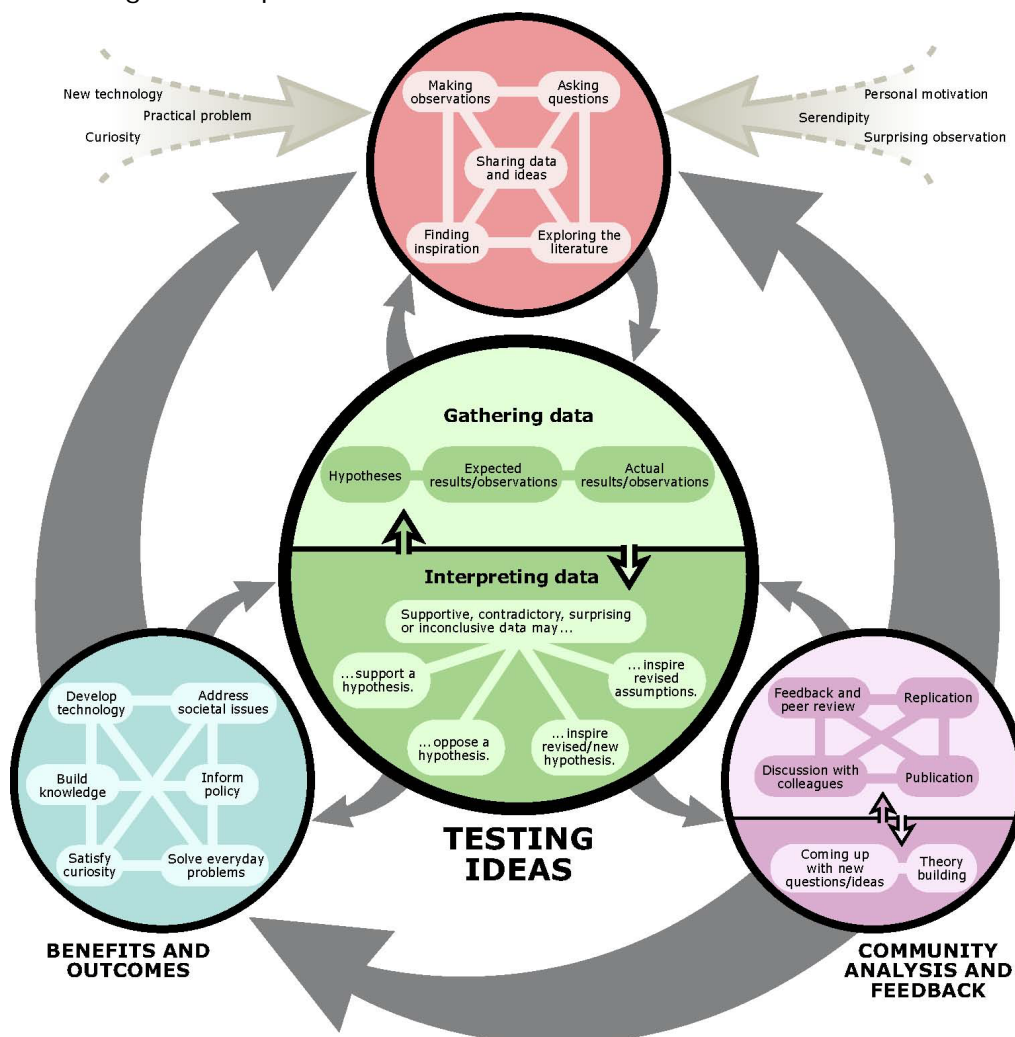


Figure 1 The empirical cycle (Understanding Science, 2015).

The reason for its wide use and acceptance is that the IMRAD method provides a clear and logical structure that helps the reader to browse through articles more quickly to find relevant information. Furthermore, papers and reports written according to the IMRAD method contain all required information to evaluate the quality of the research without unnecessary details.

DO's	DON'T's
<ul style="list-style-type: none"> Pursue the IMRAD structure for your report, thesis, or paper 	<ul style="list-style-type: none"> Do not deviate from the basic IMRAD structure without consulting your supervisor

The contents of each section will be further elucidated below.

Introduction

In the introduction section or chapter, you indicate what has been studied, why it has been studied, and, in general terms, how it has been studied. This section contains:

- The background of the study and problem statement;
- Research question, aim of the study, or hypothesis;
- An outline of the approach taken.

The background introduces the reader to the larger context for the specific study to understand why the topic is relevant, important, and thus why you have carried out your study. Thus, the background tells the story how you have come up with your research question (see red circle in Fig. 1). It includes a literature review to make clear to what extent the question has been addressed by others, but it should not summarise everything that is somehow related to your topic. If a research report requires a more comprehensive review or explanation of the theory, this could be included as a separate chapter after the introduction chapter.

The background usually ends with a conclusion or problem statement that sets the scene for your specific question. For example:

“The geology of an area has a profound effect on the physiology of the landscape and sets important boundary conditions for present-day morphodynamic processes”

or

“Insight in the geological structure and history of the area is therefore an essential prerequisite to understand the evolution of the present-day landscape”

or

“The geochronology of this formation is poorly understood”

In the next paragraph, you state the research question that will be answered in your report. This research question should be stated in the first sentence of this paragraph.

To formulate a good question, it is essential to consider the following:

- The question is important, relevant, and interesting: this should become apparent by a clear relation between the information provided in the background and your research question.
- The question is simple and sufficiently specific to be answered in your study: narrow down your question as much as possible, so that it is entirely clear what topic exactly you will be studying.

3. The question is measurable: the answer can be found by measurement. Usually that measurement is performed relative to something else (e.g. 'larger than') in the context of literature.
4. The question is feasible: you can find an answer within the given time frame with your resources and the facilities offered.

For example:

“What is the age of the Formation?”

The research question can also be formulated as a research aim or objective (e.g. “The aim/objective of this study is to determine the age of the Formation”) or as a hypothesis (“We hypothesise that the Formation is of Middle Jurassic age”). In earth science, stating a research aim is more common than stating a research question or a hypothesis.

In the final paragraph of the introduction section, the common thread of the report is explained by providing a brief description of the approach you pursued to answer the research question, for example what type of data you have collected (existing literature data, field data, laboratory analyses, experiments) and how you have processed these data. In a report, you may refer to the relevant chapters in which these steps are further elucidated. Note that this should not repeat the table of contents in your text (e.g. “After this introduction, Chapter 2 describes the study area. Chapter 3 describes the materials and methods....”).

DO's	DON'T's
<ul style="list-style-type: none"> • Formulate a relevant, simple, measurable, and feasible research question • Make clear to what extent the research question has been addressed by others • State the research question, research aim or hypothesis in the first sentence of a paragraph 	<ul style="list-style-type: none"> • Do not sum up everything that is somehow related to your topic • Do not repeat the table of contents in your text

Methods

The methods section or chapter, sometimes called "Materials and Methods", describes how the study was conducted. It describes the procedures that you have taken and which materials you used to find an answer to your research question and contains all necessary information to repeat the study. In the methods section, you show that the data were collected in a consistent, accurate, and accountable manner. This provides important information under which conditions your research outcomes have been established and, thus, in which context they can be interpreted. Although the methods section is primarily descriptive, it is also recommend to give reasons why you have chosen for the methods and materials used. The methods section may contain the following subsections (if relevant):

1. Study area: description of the study area (not based on own research results), for example location, topography, geology, geomorphology, climate, vegetation. In a fieldwork report, the description of the study area may also be presented as a

separate chapter (usually chapter 2 after the introduction, but before the methods chapter).

2. Field methods: description of the type of data (e.g. distance, height, thickness, direction, electrical conductivity) or samples (e.g. rock, soil, sediment, water samples) you collected in the field and how they were collected, e.g. corings, use measurement devices (e.g. GPS device, ruler, compass, EC meter; provide manufacturer and device type if relevant). In the case of mapping, also describe which parameters were mapped and which system was used (e.g. classification system). Details of the sampling or observation strategy (e.g. transect sampling, observations of outcrops, random sampling, stratified sampling) should also be given here.
3. Laboratory methods: description of the laboratory procedures or experiments: which parameters were measured using which method?
4. Data processing: description of the statistical methods you used to analyse the measurement data.

If available, also include information about the accuracy and precision of the acquired data as long this is based on independent, existing information (e.g. literature, device manuals etc.). If you have examined the accuracy and precision of the data yourself as part of your study (for example as part of a quality control), you should report only the methods here. The results of this examination should then be reported in the results section.

DO's	DON'T's
<ul style="list-style-type: none"> • Only describe methods that you have used to answer your research question 	<ul style="list-style-type: none"> • Do not report results from your own study (for example, results with respect to your study area or precision of your data)

Results

In the results section or chapter you describe the main outcomes of your study obtained according to the methods section in a neutral (i.e. without interpretations that may be subject to discussion) and accessible manner. Limit yourself to only those results that are relevant to answer your research question. It is recommended to structure the description of the results, for example to describe the primary features first, and then the secondary and tertiary features. You may also order the description of your results geographically (e.g. from north to south) or chronologically (e.g. from old to young).

Present the relevant results in the form figures, tables, photographs, and maps. In the accompanying text, you elucidate the general patterns in the outcomes and give relevant quantitative information (e.g. "The upper layer is usually 2 m thicker than the approximately 30 cm thick lower layer" or "The grain size increases with depth from 2 mm near the surface to 5 cm at 1 m depth").

DO's	DON'T's
<ul style="list-style-type: none"> • Only describe relevant data • Structure your description (e.g. primary - secondary features; geographically) • Use figures, tables, photographs, and maps 	<ul style="list-style-type: none"> • Leave out irrelevant information (e.g. touristic information or subjective experiences about the fieldwork area) • Do not repeat a description of the methods how you obtained your results

Discussion

In the discussion section or chapter, you give interpretations of your results by relating and comparing them to each other (e.g. Do they support or contradict each other?) and put them in a broader context of the literature (e.g. what did others find that relate to your subject?). Alternative interpretations may also be given (e.g. "The results suggest ..., but could also imply"). You should also discuss the consequences of your findings for the aim/research question/hypothesis (e.g. do the outcome support or oppose the hypothesis? should you revise your assumptions? what information is still missing to definitely answer your research question?; see central green circle in Fig. 1). Furthermore, you identify and discuss the implications for science (e.g. what new questions arose from your work?; see lower right purple circle in Fig.1) and society (e.g. how can the new findings be used to solve societal issues or to develop new technology?; see lower left blue circle in Fig. 1).

A persistent misconception is that the discussion section is meant to provide an overview of all flaws and uncertainties related to your observations and findings, thereby proving that your study is actually useless. Instead, identify and discuss what can be inferred from your outcomes given the flaws and uncertainties.

DO's	DON'T's
<ul style="list-style-type: none"> • Discuss what can be inferred given the uncertainties 	<ul style="list-style-type: none"> • Do not give an overview of all flaws and uncertainties proving that your study is actually useless

Conclusions

In the conclusions section you summarize the main findings and provide answers to your research question. The conclusions should logically follow from your results and discussion. Do not present new facts or results that have not been discussed in a previous section. Finally, draw wider conclusions regarding the implications for new questions that arose from your study.

DO's	DON'T's
<ul style="list-style-type: none"> • Summarize your main findings • Provide answers to your research questions 	<ul style="list-style-type: none"> • Do not present new facts or results

2.2 Other necessary content

Title

The title of a paper or report reflects the content of the report and is informative and short (approximately 15 words at maximum). Omit any redundant phrases, such as “a study of..” or “a report of...”. For reports, a subtitle may be added. An example of an appropriate title is “Assessment of soil erosion in Africa using remote sensing”, because it informs the reader about 1) The subject (assessment of soil erosion), 2) the location (Africa), and 3) the research method (remote sensing).

In a paper, the title is placed on top of the first page, followed by a list of authors. In reports, the title is on the cover page. The cover page also includes the names of the authors (and student number, if applicable), date and location of publication, name and code of the course and supervisor (if applicable).

Preface

In a longer research report, you may include a preface in which you the framework in which you carried out the study (e.g. part of your study programme or larger research project), acknowledgements to persons and institutes who have contributed to your research (e.g. for assistance during fieldwork or laboratory analyses, for providing data, for providing of funding, or for feedback on an earlier draft of your report or paper). The preface is not a chapter, so it is not numbered.

Table of contents

In research reports or bachelor theses, a table of contents comes at the beginning of your report. It contains a list of all chapters and sections, and if applicable subsections. The chapter and section titles should be short and each title should cover the contents of the item concerned. The table of contents reflects the logical order of the chapters and section and for each item, the table of contents refers to the respective page in the report where this item starts.

Furthermore, a complete list of figures and tables and a list of appendices is included with reference to the pages they appear. Both tables and figures are numbered consecutively (do not use Roman numerals), but in research reports or bachelor theses it is also allowed to number the tables and figures consecutively per chapter (e.g. Figure 1.1, 1.2 or Table 3.1, 3.2, .3.3, 3.4).

Summary or abstract

For a fieldwork report or a bachelor thesis, a summary of about 1 page is provided at the end of your thesis. The summary briefly summarises the context, research aim or question, research approach (methods and materials), and main findings and conclusions (in this particular order). It should inform the reader about the highlights of your work.

In a research paper, a more concise abstract is provided at beginning of your paper before the introduction section. An abstracts contains the same ingredients (and, ideally, the same information) as a summary, but is more concise.

The summary or abstract is not a chapter, so it is not numbered. For both research reports and papers, include a list of 5 key words that are related to your study. These key words should be mentioned at the end of the abstract.

References

At the end of the report or paper (after the conclusions section or chapter), you include a reference list, in which you list all literature, to which you have referred to in your main text. Conversely, all references in the reference list should appear in the main text. The reference list is not a chapter, so it is not numbered. Just as the summary, the reference list is ordered in alphabetical order. For a correct formatting of the references in the main text and in the reference list, we refer to chapter 3.

Appendices

An appendix contains materials that would obscure the structure and message of the text if it is included in the main text. Examples include tables of all quantitative research results, examples of field observation forms, or computer code. All appendices should be given an appropriate title and numbered consecutively.

DO's	DON'T's
<ul style="list-style-type: none">• Give a short and informative title to your work• Include references in the main text in the reference list and vice versa• Include materials that would obscure the structure and message of the body text in appendices	<ul style="list-style-type: none">• Do not include redundant phrases in the title• Do not give a chapter number to the preface, table of contents, summary, and references

3 Style

3.1 General

Not only the structure and content of scientific texts are important, but it is also essential to choose the appropriate wording, syntax, and style in your text. After all, your text should be easy to read and comprehensible, especially for your target audience that mainly consists of colleagues and educated laymen. This chapter provides a number of useful tips and considerations with respect to style.

In the degree programmes of Earth Science, in general we follow the style manual by the American Society of Agronomy (ASA)¹. We refer to this document to find general information about the use of abbreviations, punctuation, and units in your text. For further information about the correct use of punctuation, see the Wikihow website² about this topic.

3.2 Structure and lay-out

3.2.1 Page numbering

You should always insert page numbers in your document.

- For the body text or the entire document, use consecutive page numbers in Arabic numerals at the bottom of the page.
- In reports, you may use a different style and page numbering for the front matter (i.e. title page, preface, table of contents) (often Roman numerals) and the body text (Arabic numerals).
- In reports, page numbers are not printed on blank pages (e.g., blank even pages preceding a new chapter).

DO's	DON'T's
<ul style="list-style-type: none">• Insert page numbers in your document	<ul style="list-style-type: none">• Do not insert page numbers on blank pages

3.2.2 Chapters and sections

The chapters and sections reflect the global structure of a text. They often have a standard title such as "Introduction" or "Methods", which allow readers to find information readily and quickly. All titles should have the same logical hierarchy. For example, if you describe the geological formations found in your study area, name the consecutive sections accordingly, but do not mix up the geological formations with chronostratigraphic units or geomorphologic units either in the titles or text.

Furthermore, the titles at the same hierarchical level should be formatted in the same manner (font type and size). These styles can be defined in your word processor (for

¹ <https://dl.sciencesocieties.org/publications/style>

² <http://www.wikihow.com/Use-English-Punctuation-Correctly>

example, in Word: in the Style ribbon in the Home tab, such as 'Heading1', 'Heading2', 'Heading3'), which results in a consistent numbering and lay-out.

- Chapters, sections, and subsections should be numbered using Arabic numerals (1, 2, 3.1, 3.2, 3.3, etc.).
- Numbering of subsections with more than three numerals (e.g. section 4.2.3.4) is unclear and should be avoided. Alternatively, use font effects such as *italics* for subsection titles to further structure your text. Non-numbered subsections should not appear in the table of contents.
- The preface, summary, list of references are not numbered
- Titles do not end with a full stop.

In research reports, each new chapter should start on a new page. If you print your document double-sided, each chapter should start on a right page (odd page number). If necessary add a blank page (even page number).

DO's	DON'T's
<ul style="list-style-type: none"> • Chapter and section titles have a consistent logical hierarchy • Use the same format for each hierarchical level • Chapters, sections, and subsections should be numbered using Arabic numerals • Start chapters at a new page 	<ul style="list-style-type: none"> • Do not make subdivide your text in too many sections and subsections that are only one paragraph in length

3.2.3 Paragraphs

Paragraphs are the smaller units of a text. For clarity, it is essential that each paragraph treats only one topic. The topic of the paragraph becomes manifest in the first or last sentence of a paragraph. This sentence is also called the topic sentence. To establish coherence within a paragraph, make sure that each sentence is related to this topic sentence. This can be achieved by repeating key words or phrases or using parallel structures or linking words. These techniques are further elucidated in section 3.4.1.

To start a new paragraph, indent the first line of a paragraph by about 1 cm (and do not leave a blank line between the paragraphs), but do not do this to the first line of a chapter, section or subsection. This method is common in most British-English texts. Alternatively, you could start a new paragraph by leaving a blank line between the paragraphs.

3.2.4 Tables and figures

All tables, figures, photographs, and maps should be numbered consecutively in the order as they appear and referred to in your report or paper. In papers and short reports, number them sequentially. In longer reports, include the chapter number in the table/figure number (e.g. Table 4-1, Table 4-2, Table 6-1; Figure 1.1, Figure 1.2, Figure 3.1, etc.).

Furthermore, note the following:

- Provide a caption to your table or figure. This caption should be sufficiently informative to understand the table or figure without reading the main text.
- Place the table caption above the table and the figure caption below the figure.
- Each table and figure should be referred to in the text. Refer explicitly to the table/figure number. In word processors, it is advised to insert cross references, which update the table or figure numbers automatically when a new table/figure is inserted, moved or deleted. This tool is also useful for automatically generating lists of tables and figures.
- Place the table or figure closely and preferably after the reference to it.
- Explain the symbols used in the table/figure caption or figure legend.
- Give units to the symbols (in the caption, in the row and column headers of tables, in the figure legend, or in the axis titles of graphs)
- In tables, use the symbol '-' or "n/a" (not applicable) when a parameter was not determined
- If a table or figure is borrowed from the literature, provide appropriate references. For official publications, you may need permission from the publisher of the original table or figure.
- In tables, use only horizontal lines between the rows; do not use vertical lines to separate columns.
- In tables, align text and numbers to the right.
- Provide a scale bar and orientation to maps, cross sections, and field sketches.

3.3 Literature references

3.3.1 References in the body text

All works that have been consulted in the production of a scientific text should be included in the reference list and should also be cited in the text. The style of referencing and citation differs between fields of science and publishers. Nevertheless, the style is always consistent throughout the entire report or paper. Below you find the guidelines for composing citations according to the manual by the American Society of Agronomy (ASA):

Journal articles

- In-text citations include the surname of the author and date, either both inside parentheses or with the author names in running text and the date in parentheses. For example:
"Recently, Johnson (2014) has shown that" or
"This has recently been shown (Johnson, 2014)"
- If there are two authors, name both:
"This method was developed by Johnson and Smith (2012)"
- If there are more than two authors, use the et al. (*et alii*; "and others") convention:
"This was based on a method introduced by Smith et al. (2002)"
- If more than one references are cited at one location in the text, order them chronologically in the running text separated by a comma:

"this was discussed by Smith et al. (2002), Johnson and Smith (2012), and Johnson (2014)"

or order them between brackets separated using a semicolon:

"...has widely been recognised (Smith et al., 2002; Johnson and Smith, 2012; Johnson, 2014)"

- For citations of multiple works by the same authors in the same year, add lowercase letters (a, b, c, ...) after the year. The name or names of the authors do not need to be repeated, for example:

"This method has been extensively applied (e.g., Murphy and Wong, 2014a, 2014b; Wong, 2014)"

- In the unlikely case, it was impossible to trace the original publication, refer to both the original work and the work it was cited in, for example:

"According to Peterson (1873), cited by Vanderkeelen (1999)"

Books

For references to books, you should be aware of the difference between books, which have been written by one or more authors, and books, which have been edited by one or more editors and which contain chapters that each have been written by one or more authors. In both cases you should refer to the authors who have written the relevant chapter in the same way as the reference to journal articles.

Web pages

For references to websites, also refer to author and year of publication. If the author is unknown, you could refer to the publisher instead. If the date of the website publication is unknown, refer to n.d. (no date). For example:

"Lee (2010), ASA–CSSA–SSSA (2015), Easybib (n.d.)"

Do not refer directly to the URL in the running text, except in a footnote.

Quotations

Quotations (literal citations) should preferably be avoided and are only very sparingly used when it is important to know what an author has literally written. Short quotations (fewer than ~40 words) are enclosed within double quotation marks. Provide the author, year, and specific page citation in the text. For example:

"No Geologist worth anything is permanently bound to a desk or laboratory, but the charming notion that true science can only be based on unbiased observation of nature in the raw is mythology." (Gould, 1987, p.98)

Quotations longer than ~40 words are written in italics placed in an indented, freestanding block of text. Quotation marks are omitted. For example:

No Geologist worth anything is permanently bound to a desk or laboratory, but the charming notion that true science can only be based on unbiased observation of nature in the raw is mythology. Creative work, in geology and anywhere else, is interaction and synthesis: half-baked ideas from a bar room, rocks in the field, chains of thought from lonely walks, numbers squeezed from rocks in a laboratory, numbers from a calculator riveted to a desk, fancy equipment usually malfunctioning on expensive ships, cheap equipment in the human cranium, arguments before a road cut. (Gould, 1987, p.98)

3.3.2 Reference list

All works cited in the text should appear in the reference list. Consider the following guidelines:

- The references are alphabetically arranged according to the first author's surname. The first authors' name is inverted (surname first and then initials separated by full stops); the subsequent authors are not inverted (initials and then surname). All single-authored articles of a given person should precede multiple-author articles of which the person is first author. Alphabetise entries with the same first author according to surnames of succeeding coauthors and then chronologically, when the names are repeated exactly. Two or more articles by the same author (or authors) are listed chronologically and then by the first significant word of the title (not *A* or *The*). Articles by the same author or authors published within a single year are listed by adding lowercase letters (a, b, c, etc.) to the year. For example:
Johnson, C.B., and G.W. Smith. 2007.
Johnson, P.N. 2005.
Johnson, P.N., P.E. Garth, and T.E. Horton. 2004.
Johnson, P.N., T.E. Horton, and P.E. Garth. 2003a.
Johnson, P.N., T.E. Horton, and P.E. Garth. 2007.
Johnson, P.N., T.E. Horton, F.E. Vanderbilt, and P.E. Garth. 2003b.
Johnson, P.N., W.N. Kolowski, P.E. Garth, P.L. Lewis, and T.E. Horton. 2001.
Johnson, P.N., and D.E. Wester. 2012a.
Johnson, P.N., and D.E. Wester. 2012b.
- After the authors and year of publication, the title of the publication is provided in sentence case capitalisation¹; Titles are listed in the original language (for languages with non-western characters, use an English translation of the title between square brackets).
- For journal articles, provide the title, the name of the journal in which the article was published, the volume number, followed by a colon, the begin and end page separated by an en-dash (–) and a full stop. It is strongly recommended to also provide the so-called digital object identifier (DOI; an identifier used to uniquely identify an electronic document) at the end of the citation. You may write the full journal name or an abbreviation for the journal name (but use one system consistently throughout the reference list). See for journal title abbreviations the ASA Style Manual². For example:
Kleinhans, M.G., M.F.P. Bierkens, and M. van der Perk. 2010. HESS Opinions On the use of laboratory experimentation: "Hydrologists, bring out shovels and garden hoses and hit the dirt", *Hydrol. Earth Syst. Sci.* 14: 369–382. doi:10.5194/hess-14-369-2010.
- For books written by one or more authors, provide the author names, year, book title, name and location of the publisher. For example:
Hendriks, M.R., 2010. *Introduction to physical hydrology*. Oxford University Press, Oxford, UK.
- For chapters in edited books, provide author names, year, chapter title, followed by "In:", the editor name(s), "editor(s)", Book title, Name and location of the publisher, and page range. For example:

¹ See <http://blog.apastyle.org/apastyle/2012/03/title-case-and-sentence-case-capitalization-in-apa-style.html>

² See <https://dl.sciencesocieties.org/files/publications/style/appendix-a.pdf>

Casado, M.R., R. Corstanje, P. Bellamy, and B. Marchant. 2013. Issues of sampling design in wetlands. In: R.D. Delaune et al., editors, *Methods in biogeochemistry of wetlands*. SSSA Book Ser. 10. SSSA, Madison, WI. p. 1–19. doi: 10.2136/sssabookser10.c1.

- For PhD theses, provide author name, year, thesis title, followed by “PhD thesis”, the name and place of the university (separated by a comma). For example: Bierkens, M.F.P. 1994. *Complex confining layers. A stochastic analysis of hydraulic properties at various scales*. Ph.D.thesis. Utrecht University.
- For webpages, provide author name (if author is unknown, use organisation name), editor, year (i.e. year when web page was created, if known; if not, use n.d [no date]), title, publisher (if ascertainable or the organisation responsible for providing and maintaining the information), available URL (in the format: http://internet address/remote path) and the date the source was accessed in brackets. For example: USGS. 2015. *Mineral resources online spatial data*. US Geological Survey, <http://mrddata.usgs.gov/general/map.html> (accessed 10 April 2015).
- For further instructions about the style of the reference list, see the ASA Style Manual¹.

3.4 General writing style

3.4.1 Syntax

Assuming you master English grammar at an acceptable level, the readability of your written texts still heavily rely on a clear, attractive and coherent structure of the sentences. The readability of your text is enhanced by connecting your sentences and varying the structure and length of sentences. The next paragraphs discuss some hints and suggestions how to achieve this. Note, however, that some recommendations should be used sparingly and with care to preserve their impact.

Connect your sentences

Linking words

Linking words or phrases mostly consist of conjunctive adverbs and are used to link ideas from one sentence or paragraph to the next. They are also called sentence connectors if they are placed at the beginning of a sentence or transition words if they connect paragraphs. Linking words emphasize the connection between ideas, so they help readers follow your line of reasoning or see relations that might otherwise be misunderstood or missed. Useful linking words are:

- Illustration: *as shown by, e.g., especially, for example, for instance, in particular, namely, particularly, specifically, such as, that is, to illustrate.*
- Addition: *again, and, also, besides, equally important, first (second, etc.), further, furthermore, in addition, in the first place, moreover, next.*
- Comparison: *also, in the same manner, likewise, similarly.*

¹ <https://dl.sciencesocieties.org/files/publications/style/chapter-01.pdf>

- Contrast: although, and yet, at the same time, but, despite, even though, except, however, in contrast, in spite of, nevertheless, on the contrary, on the other hand, regardless, still, though, unlike, whereas, yet.
- Logical relation: accordingly, as a result, because, consequently, for this reason, hence, if, otherwise, since, so, then, therefore, thus.
- Temporal relation: after, afterward, as, as long as, as soon as, at last, before, during, earlier, finally, formerly, immediately, later, meanwhile, next, since, shortly, subsequently, then, thereafter, until, when, while.
- Spatial relation: adjacent to, above, below, beyond, close, elsewhere, here, nearby, opposite, to the right, left, north, east, south, west, etc.
- To summarize or conclude: in conclusion, in summary, on the whole, that is, therefore, to conclude, to sum up.

If you use the linking words at the beginning of a clause, they should be followed by a comma. In the middle of a clause, a comma is usually placed both before and after the linking word. You may vary the above example linking words to increase the attractiveness of your work. However, be consistent in style in sequences, such as *first, second, third...* (or *firstly, secondly, thirdly...*).

Linking sentences

A linking sentence coherently connects the preceding sentence with the next sentence, for example: "This has four consequences. First," Or "This can be illustrated by the following example".

Pronouns

Pronouns (e.g. it, they, these, which, who etc.) are used to refer to a noun or one or more persons (the pronoun's antecedent). The use of pronouns may help to increase the relation between sentences if the antecedent is in the preceding sentence. The pronoun should however refer unambiguously to its pronoun. For example:

Ambiguous:

"The method was applied in an experiment. It consisted of three steps."

Unambiguous:

"The method was applied in an experiment that consisted of three steps."

Parallel structures

Parallel structures involve the repetition of sentences or phrases that conspicuously have the same grammatical pattern. The repeating pattern in a series of consecutive sentences helps the reader to see the connections between ideas. Parallel structures can be applied to the word, phrase, or clause level and are usually joined by the use of coordinating conjunctions such as "and" or "or." For example:

"In spring, summer, or winter"

or

"A slope failure results in transport of debris downhill by slumping, sliding, rolling, or falling"

or

"The sinking of deltas causes coasts to recede, water levels to rise, and salt water to intrude further landward"

Note that the sentence elements should be in the same grammatical form so that they are parallel. So, avoid faulty parallelisms, such as:

“In spring, summer, or in winter”

or

“A slope failure results in transport of debris downhill by slumping, sliding, rolling, or by rockfall”

or

“The sinking of deltas causes coasts to recede, water levels to rise, and landward intrusion of salt water”

Vary sentence length

Avoid long sentences and vary the length of consecutive sentences. An example of a fault, too long sentence is:

“Numerical models describe reality in terms of mathematical equations, usually at least partly based on laws of natural sciences, which allows the modeller full control over specified boundary conditions and laws, so that the physics-based model may be used to test whether a hypothesis does not conflict with the laws of physics.”

This sentence can be broken up into:

“Numerical models describe reality in terms of mathematical equations, usually at least partly based on laws of natural sciences. Modelling allows full control over specified boundary conditions and laws. Thus, a physics-based model may be used to test whether a hypothesis does not conflict with the laws of physics.”

Vary order of clauses

To increase the attractiveness of your text, vary the order of clauses in consecutive sentences. If a repetitive grammatical pattern has no function to connect ideas, a sequence of sentences with a similar pattern becomes boring. For example:

“Karst landscapes result to a significant degree from the dissolution of bedrock. They are most commonly underlain by limestone and dolostone bedrock. They contain surface karst landforms, such as sinkholes, caves, and large flow springs. Karst landscapes are characterised underground drainage networks that commonly bypass surface drainage divides.”

This sentences can be rephrased into:

“Karst landscapes result to a significant degree from the dissolution of bedrock. They are most commonly underlain by limestone and dolostone bedrock. Sinkholes, caves, and large flow springs are typical landforms that can be found in these landscapes. Another characteristic feature of these landscapes is the occurrence of underground drainage networks that commonly bypass surface drainage divides.”

DO's	DON'T's
<ul style="list-style-type: none">• Increase the attractiveness and readability of your text by connecting your sentences and varying the length of sentences and the order of clauses	<ul style="list-style-type: none">• Do not be inconsistent in style in sequences• Do not use different grammatical form in parallel structures

3.4.2 Word use

A scientific text is written in complete sentences, but it is not prose. Scientific language is a concise description of facts. Besides the use of a proper syntax, the use of lively, precise, clear, and simple words makes your text more comprehensible and readable.

Use key words consistently

Particularly in paragraphs in which you define or identify an important idea or theory, be consistent in how you refer to it. This consistency and repetition help the reader to understand your definition or description. Thus, avoid the use of synonyms for key words throughout your text. On the other hand, avoid the overuse of single expressions other than key words by using synonyms to represent equivalent meanings. To find appropriate synonyms, you can use a thesaurus (e.g. the online thesaurus.com¹).

Use formal words

Avoid informal or spoken language in scientific texts. Instead, use formal alternatives. Examples of informal words and their formal alternatives are:

Informal	Formal
<ul style="list-style-type: none">• a lot of• do (verb)• big• like• think• talk• look at• get• keep• climb• really• things	<ul style="list-style-type: none">• much, many• perform, carry out, conduct• large• such as• consider• discuss• examine• obtain• retain, preserve• ascend• ... (leave out)• ... (be precise)

In addition:

- Avoid contractions (“do not” instead of “don’t”)
- Avoid clichés (“this site is excellent for...” instead of “this site is the cream of the crop for”)
- Avoid “one” as pronoun, use passive voice instead
- Avoid subjective words, such as **gigantic**, **beautiful**, **nice**, **fantastic**, or **enormous**.

Use concise words

Avoid wordy or empty words and phrases in your report or paper. Instead use concise alternatives:

¹ <http://www.thesaurus.com>

Wordy	Concise
<ul style="list-style-type: none"> • In order to • As a matter of fact • At the present time • Due to the fact that • In spite of the fact that • Are dependent on 	<ul style="list-style-type: none"> • To • In fact • Now, currently • Because, since • Although, though • Depend on

Furthermore, avoid redundant phrases such as “It is interesting to note that” or “It can be remarked that”.

Use precise and concrete words

You can enhance the clarity of your writing by using concrete, specific words rather than abstract, general ones.

- Avoid vague phrases, such as “The layers are different in thickness”, but use concrete descriptions and quantify whenever possible, for example “The thickness of the lower layer is 2 m, whereas the upper layer is only 0.3 m thick”.
- Use words that express exaggerated certainty (“undoubtedly”, “obviously”) sparingly, but also use relativising words (“sometimes”, “possibly”, “somewhat”) with care
- Use specialist terms accurately, but avoid using technical terms that the readers will not understand. If you use such unfamiliar technical terms anyway, provide a definition.
- Avoid ambiguous words and phrases (see also section 3.2.1)

Give examples

Elucidate complex terms or concepts by providing examples to enliven your text.

3.4.3 Using tenses

In scientific writing, there are conventions about the correct use of verb tense. Beside the time frame (past, present, future), the verb tenses you use in your report or paper also reveal whose idea is presented (yours or someone else's) and how general or specific your description is. In brief, the following tenses are commonly used in scientific texts:

Simple present

Simple present tense is in general used to describe an action that that occurs now or on a regular basis. In scientific reports or papers, this tense is used to describe a generally accepted scientific fact or an own statement. Therefore, it is typically applied in the introduction section, in which you give a literature review or statements of main ideas.

For example:

“This thesis examines the first approach” / “In this thesis, the first approach is examined”

“Iron oxides frequently occur as secondary precipitates in both modern and ancient sediments”

Simple present is also used to refer to figures and tables in your text, for example:

“Figure 3 shows that...”

Past tense

Past tense emphasises the completed nature of a past activity or event. This tense is used to describe such past activities or events, for example:

“The drawdown of the Mediterranean water level caused erosion and deposition of non-marine sediments”.

More importantly, past tense is used to describe the methods, results, or conclusions of past research, including your own study that you are reporting on. For example:

“Vissers et al. (2013) found that the maximum extension in the eastern end of the Piemonte Ligurian Ocean was ~315 km”

or

“The measured piezometric levels were interpolated to a groundwater table for the entire study area”

or

“We demonstrated that nitrate concentrations differ strongly between the major flow routes”.

Present perfect tense

Present perfect tense is used to describe unfinished actions that started in the past and continue to the present. In scientific texts, the use of this tense is usually limited to the introduction section (literature review) to indicate that research in the area is still continuing or still has immediate relevance. For example:

“ Recently, there has been a strong debate about the melt rate of Himalayan glaciers”

or

“This method has been effectively used in snow cover mapping”

3.4.4 Passive/active voice

Passive voice emphasises what was done and is generally conceived to be more objective (and, thus, to be more “scientific”), but it is also considered to be impersonal, wordy, and often boring. On the contrary, active voice is considered to be more concise and unambiguous; it appropriately describes science, which is actively performed by scientists.

Traditionally, scientific texts relied on the use of passive voice, but nowadays most scientific style manuals support the use of active voice. Nevertheless, there is still an ongoing debate whether active voice is preferred over passive voice, also amongst the instructors of the earth science programmes at Utrecht University.

In general, use passive voice if you don't know who or what is responsible for the action, or if this is unimportant. For example:

“During the early Malm (Oxfordien) thick layers of dark marl were deposited”

Discuss with your supervisor which voice is preferred when writing about your own actions, for example:

“We measured the metal concentrations in the water samples by ICP-OES”

or

“The metal concentrations in the water samples were measured by ICP-OES”.

3.5 Spelling

Despite British English and American English are generally similar in many respects, there are a number of more or less well-known spelling differences you should be aware of. The main differences and examples of American English and British English can be found on the Oxfords dictionaries website¹. For your report or paper, choose either American English or British English and remain consistent in spelling throughout your text. Note that citations should always be cited exactly in the original spelling.

¹ <http://www.oxforddictionaries.com/words/british-and-american-spelling>

4 Checklist

Please check the following list before submitting your report to the supervisor:

- Is the structure consistent? (no results in the introduction or methods section; no methods in the results section)
- Are the tenses correctly used?
- Is the reference list complete? (all references in the reference list are referred to in the main text and all references in the main text are in the reference list)
- No informal language used
- Page numbers are included

It is recommended to check the relevant rubric to see how your work is evaluated.

References

Medawar, P (1964). "[Is the scientific paper fraudulent?](#)". *The Saturday Review* (August 1): 42–43.

Understanding Science (2015). University of California Museum of Paleontology. Available at: <http://www.understandingscience.org>. Accessed 1 April 2015

Useful web pages

<http://www.americanscientist.org/issues/pub/the-science-of-scientific-writing/99999>

<http://www.nature.com/scitable/ebooks/english-communication-for-scientists-14053993/contents>

<https://www.aacc.org/publications/clinical-chemistry/clinical-chemistry%C2%A0guide-to-scientific-writing>

<http://www.wikihow.com/Use-English-Punctuation-Correctly>