

Mathematical Writing

Guideline for students and teachers
Department of Mathematics, Utrecht University
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Contents

Tools

Outline form

Checklist for a draft

Instruction

1. Goal of the writing assignments in the mathematical curriculum	1
2. An effective approach to writing assignments	1
3. Rules for the use of sources	2
4. Rules for handing in texts	3
5. Writing effective emails	3
6. The assessment of writing assignments	3
7. Recommended books and websites.....	4

Outline form

name/names:.....

For whom do you write/what is your audience?

What type of text do you intend to write?

mainly prose
 theorems and proofs

Which writing techniques do you consider using to accommodate your reader?
(for example: using examples to explain a difficult point...)

Please state the working title

What is the problem you will address in the text, or the main question you intend to answer?

Which sources do you intend to use / where do you think you will find adequate sources?

Please outline the argument, or inner logic, preferably using a scheme; in doing so indicate the following:

- a. Which subproblems do you intend to address, and in what order?
- b. As far as this can be indicated at this stage: how will you approach each subproblem?

In the scheme above, please indicate what part will be covered in which chapter. Add an estimation of the length (number of pages) of the various parts of the text.

When you cooperate on an assignment: indicate how the tasks will be divided

In case of an extensive assignment: indicate the principal deadlines

Checklist for a draft

name/names

Before handing in your draft, check it using the questions beneath. If some aspect still needs work, or needs to be discussed, put a mark in the appropriate box. Explain at the bottom of the page: What, in your view, is the textual problem for each of the items you ticked? (How) Are you considering to fix it? Do you have specific questions for your teacher or supervisor, about possible textual solutions?

General

- Is this text a result of your own thinking?
- If you used them, did you incorporate ideas of other people in your argument in a logical way? Did you state these ideas in your own words?
- Is the text adapted to your audience? Do you attend to the needs of your reader (concerning content, structure and style)?

Structure and cues to structure

- Organisation of the text: logical and balanced?
- Titles and subtitles: well chosen?
- Introduction(s) and conclusion(s): clear and functional?
- Paragraphs: well chosen and well constructed?

Style

- Is this text understandable and concise?
- Is the language precise? (definitions, concepts and the way they are used in the text, ...)

Symbols and equations

- Symbols and equations: Appropriate choice between using words or symbols? Appropriate choice between equations in-line or displayed? Equations adequately explained in the text?
- Notation: adequate and consistent?

Figures

- Figures and tables: well chosen? (neither too few nor too many)
- Figures and tables: well made up?

Final editing

- Layout: clear?
- Language: correct? Did you check the text with the spelling checker?
- Citations and reference list: in accordance with the rules?
- In case of a draft: did you use double spacing?

Other

- If applicable: did you hand in a former version, along with the feedback given at the time?

Space for remarks and explanations

1. Goals of the writing assignments in the mathematical curriculum

An important quality of mathematicians is their ability to analyse and approach complex problems systematically. Based on a systematic analysis, a mathematician is able to pinpoint the essential aspects of a problem, the different ways of approaching it and the consequences of each approach. In order for other people to understand and appreciate the analysis, the mathematician should be able to clearly communicate his findings.

The goals of the writing assignments in the mathematical curriculum are based on this view. In every writing assignment, firstly we expect you to investigate the subject: What is it about? What are the topics and subtopics? Which assumptions, methods and findings are important? Secondly we expect you to put your own insights into words, as clearly as you can. You may use ideas from other people (literature), but only if they are embedded into your argument in a logical way. Finally we expect you to take your audience into consideration: tailor the text to the needs of the intended reader.

2. An effective approach to writing assignments

Laying the ground: critical thinking

As indicated above, good thinking is of primary importance for good writing. In order to be able to write clearly, you have to think through your subject and master it. Mastery of a subject tends to come gradually. You attain it by activities like immersing yourself into the subject, talking to other people, performing tentative calculations and stepping back once in a while. Writing for yourself, or writing-to-think, can be helpful in this stage. Writing a summary, making a scheme, keeping a log of your questions and findings, or trying out parts of a proof: these activities may help you gain insight. Do not hesitate to ask your supervisor or teacher to analyse such preliminary writing-to-think texts with you.

Making an outline

A frequently used but ill-advised method for writing a draft is 'trial and error': starting to write, and, while writing, figuring out what the text will be about, what topics need to be addressed and how they should be organised. In most cases this strategy leads to a slow and cumbersome process of writing, a text that lacks clarity and structure, and that is difficult to understand. Start by structuring your argument, thinking about the needs of your audience and making an outline. When preparing a mathematical text you have to choose between two ways of writing: mainly prose or mainly theorems and proofs. Whichever you choose, always organise your text by introducing a mathematical problem in the introduction, addressing subproblems in the main body of the text and discussing the findings in the conclusion. Sometimes with a writing assignment you are handed a list of questions to be answered in your text. In these cases you should nevertheless make an outline before you start to write; an outline based on a central problem or question, that is tackled in the text in several subsequent steps. Do not compose your text by merely answering the questions that were handed out successively; such a text will lack an overall structure. For more details about composition refer to *Ten Simple Rules for Mathematical Writing* (Bertsekas, 2002) or use the outline form at the beginning of this guideline.

Writing and revising

Writing down words and sentences, taking a critical look and making amends: many feel this is the heart of the writing process. Production and editing are, indeed, two important stages in the process. If your outline is well constructed, and you have mastered your subject well, writing a draft should be fairly easy. Next, you re-read and revise the text, paying attention to various aspects. Especially in mathematical texts, many aspects need attention: structure, cues for your reader (headings for example), words and ways of putting things, notations, figures and citations,... In the beginning of this guideline a checklist is enclosed which contains all the aspects you have to pay attention to. Specific issues and solutions for mathematical writers are explored in Higham (1998), Knuth (1989) and in Bertsekas (2002).

Order of the steps

The steps discussed above may help you find your way during the writing process. You do not have to perform every step, every time you write, in the exact same way and in the exact same

order. When working on an extensive writing assignment, try to be creative and practical. When you get stuck thinking about a proof for hours, revert to some other useful activity. Start working on your reference list, editing a figure or tackle another subproblem.

3. Rules for the use of sources

General guideline

As indicated above we think it is of the utmost importance that you try to put your own thoughts into words when working on a writing assignment. Of course you are allowed to integrate ideas of other people into your text and into your argument – in many cases your starting point will consist of the ideas or work of other mathematicians. It is important that you incorporate these ideas into your own line of thought in a logical way, and that you make it clear to your reader all the time what idea, concept or method has been taken from which source. For the sake of readability, make it a rule to explain the ideas or findings of other people in your own words: summarize or paraphrase them unless it is absolutely necessary to quote literally.

Quotes

Sometimes it is necessary or useful to quote: to literally copy a passage from a source. When quoting pertain to the following rules:

- Copy the text word for word; it should be the exact same as in the original source.
- Short quotes should be placed in-line between quotation marks (“...”).
- Longer quotes should be displayed: visually separate them from the main text using a white space above and below and/or use indentation.
- Indicate any changes you made in the quote between square brackets in the quote (common changes: where you leave something out put ‘[...]’ in the quote; when you change the typeface to accentuate something put ‘[italics mine]’ in the quote)
- Whenever possible quote from the original source and in the original language.

Citations

Whether you are quoting, summarising or paraphrasing, it should always be clear from which source the ideas or findings you describe were taken. You can choose from two main styles of citation (extensively explained in Higham, 1998, pp. 94-96).

First there is the style by number. When citing by number you put a number between square brackets in the appropriate place in your text whenever you want to cite a source. The number corresponds to an item in the reference list at the end of your text, where detailed bibliographical information for each source is presented. Usually, the references in the reference list are listed alphabetically by author’s name. In some cases the references are listed in the order in which they are cited in the text. When using the style by number, consider incorporating the author’s name in your text the first time you cite the reference. An example: ‘Jones [1] proved this theorem using ...’. After that you may cite the source using the number only.

The second style of citation is by name and year. In this style, used in this guideline, you insert the name of the author and the year of publication in the appropriate place in your text, whenever you want to cite a source. The year of publication should be placed in brackets. The name of the author may either be incorporated into the sentence or placed in brackets. A (fictitious) example: ‘This theorem has first been proved by Smith (2002)’, or ‘This theorem has already been proved (Smith, 2002)’. The reference list is ordered alphabetically by author. Different sources by the same author are ordered chronologically in the reference list, with the most recent source coming first. If you have more than one source from the same year by one author append a letter to the year, for example: (Gray, 2001b).

Reference list

In the reference list, for each source that is cited in the text, detailed bibliographical information is presented in a specific format. The format states which bibliographical details should be presented (title, initials and names of the authors, year of publication...), in what order and in what typeface. The precise format varies according to the type of source (book, journal article, ...) and varies among publishers and journals.

In the Department of Mathematics, for writing assignments we solve this problem as follows: for every writing assignment, choose a specific journal and use the format of that journal consistently in your reference list.

Below is a standard format for publications that are available online only. This format is further explained in Nederhoed (2004). An alternative format is explained in Higham (1998, pp. 99-100). If the journal whose format you have decided to follow does not give guidelines for citing online publications, use either the standard format described below, or follow Higham.

Referencing format for publication available online only (note the bibliographical details to be included, note the typefaces used, and note the commas, dots and brackets that are used):

Name(s) and initials of author(s). (When available: year of publication or last revision; in other cases year of visiting). *Title of the document*. Date of visiting the website, in case of a site of a large organisation: include here the name of the organisation and the department in question, complete http-address/ftp-address/name database

You may break off the address before a dot or after a slash. Do not put a dot at the end of the address.

An example:

Bertsekas, D. (2002). *Ten Simple Rules for Mathematical Writing*. February 8, 2006, Massachusetts Institute of Technology: http://web.mit.edu/dimitrib/www/Ten_Rules.html

When referencing an item in a newsgroup or discussion group you may use the following format in the reference list.

Name(s) and initials of author(s). (Date of item). Title of item. Name of the newsgroup, archiving address

4. Rules for handing in texts

- In case of a draft version: use double spacing.
- If you received feedback on an earlier version of this text, hand in that version as well, along with the feedback you received at the time. In this way teachers may see how you improved your text on the basis of the feedback.
- Make sure there are no spelling errors: use the spelling checker.
- When English is a foreign language it is impossible to correct all other errors, in style, vocabulary and sentence construction on your own (without the assistance of a native speaker). Do perform the following checks. Before handing in your assignment read it carefully to make sure all sentences are complete. Look up words you hesitate about in a dictionary. Read mathematical texts to check common constructions and idioms used in writing a proof.

5. Writing effective emails

Most professionals, including the teachers in the department, have a tight schedule. Some guidelines for writing effective business emails are stated below:

- Only send an email when other methods (making a phone call or dropping by someone's office during the workday) are not possible or appropriate.
- Write a clear and concise topic in the topic line of the email.
- Start the email with a proper salutation.
- Use precise and concise language and avoid informal language.
- Indicate clearly what you ask or expect from the person who receives the email.
- Add attachments only when necessary. If possible, put the text in the email itself. Opening the attachments takes time and attachments may contain viruses and harm the receiver's computer.

6. The assessment of writing assignments

In the assessment of writing assignments five categories are taken into account.

Scientific quality

This considers the (complexity of) the main question, the approach taken, the execution, the amount of work done and the results of these efforts. Specific aspects are: the applicability of the approach that was chosen, the accuracy and the completeness of the literature search, the justification of choices that were made, understanding of the limitations of the approach, acknowledgement of limitations of the results attained, sufficient degree of abstraction, quality and persuasiveness of argumentation, proof or statistical analysis.

Working process

This considers independent work and initiative; capability to anticipate questions and developments en to place one's own activity in a larger context; competence in time-management and dealing with deadlines (finishing project in time).

Creativity

This concerns the contribution of the student and the originality of his/her ideas.

Structure and coherence

This concerns the capacity to formulate the research question clearly, to briefly summarize the results, to compare them with previous studies and with the field's current understanding of the subject and to explain implications for further research.

Style and language

The text should be divided into elements and these elements should be ordered in a logical way, from the most general level to the level of single sentences. The language used should be adequate, for example with respect to tenses used and the person in which the text is written. The punctuation should be functional and the spelling should be correct.

7. Recommended books and websites

Mathematical writing

Higham, N.J. (1998). *Handbook of Writing for the Mathematical Sciences*. Philadelphia: SIAM. This we consider a standard reference. It is a comprehensive guide to mathematical writing covering subjects like writing a proof, writing in English (as a foreign language), writing and revising several types of scientific texts, preparing a talk and using aids and resources.

Knuth, D.E., Larrabee, T. & Roberts, P.M. (1989). *Mathematical Writing*. Washington: The Mathematical Association of America. A version with figures omitted can be downloaded (February 2006) through Stanford University at <http://www-cs-faculty.stanford.edu/~knuth/klr.html> (look under 'Errata').

This classic book consists of a series of transcripts from a lecture course on mathematical writing by Knuth and his guest lecturers. It contains many anecdotes and examples and many useful advices.

Bertsekas, D. *Ten Simple Rules for Mathematical Writing*. February 8, 2006, through Massachusetts Institute of Technology: http://web.mit.edu/dimitrib/www/Ten_Rules.html
This is a slide presentation on mathematical writing. Clear, concise and specific.

Writing in English

Strunk, W. & White, E.B. (2000). *The Elements of Style*. New York etc: Longman.

This is a classic book, written by Strunk in 1918 and revised by White in 1979. It covers rules for punctuation, sentence construction, composition and style. The main objective of the book is to give advice on writing a clear and readable text.

Soanes, C. & Stevenson, A. (2004). *Concise Oxford English Dictionary*. Oxford: Oxford University Press.

In this monolingual English dictionary you may look up the exact meaning of English words. Although the dictionary is British, American spellings and usages are included.¹

Writing reports

Nederhoed, P. (2004). *Helder rapporteren. Een handleiding voor het schrijven van rapporten, scripties, nota's en artikelen in wetenschap en techniek*. Deventer: Van Loghum Slaterus.

This book is in Dutch. Written in a clear style, it covers all the steps in writing a report. Some topics are for example: systematically searching literature, typical sections in a report and their functions, advices on scientific style and rules for citation.

¹ As an alternative you may use one of the, American, Webster's dictionaries. These are specifically suited for American use.