Tips for successful theses

To all people who want to (or have to) write a bachelor's report a master's report or a diploma thesis

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Preface:

For a professor at the university, assessing and supervising theses is part of the day-to-day business - unfortunately not always the most enjoyable part of the work. For students, writing a thesis is part of studying - unfortunately not the most enjoyable part either.

Why is it that many students struggle through their final thesis and that the examiners sometimes have to unhappily fight their way through the work, too? To a large extent, this is because it is the first time that students are being asked to do real academic work, and they have never really learned how to do it before. But it's not that difficult, and a few tips can help make life much easier for students and teachers. If you take these tips to heart, you will write better papers. This leads to better grades (good for the students) and more readable exciting papers (good for the teachers). Of course, it is not possible to cover the entire theory of science in a short guide. That's why we're leaving it out. Nevertheless, anyone interested in more should do some research and find out more.[1]

1. The Topic

What should you write a thesis about? What can you write a thesis about? In principle, anything that a professor supervises can be suitable for a thesis. But what are good topics? As a rule, a thesis should be a scientific paper. That means it should have something to do with a research topic and the approach should be scientific. It is not necessary that the work presents completely new inventions, earns Nobel Prizes or solves the great problems of humanity. You can also work scientifically on small questions. But the central point is: you need a question.

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[1] Recommended for further reading:
Chalmers, A. F., Bergemann, N., & Altstötter-Gleich, C. (2007). Wege der Wissenschaft : Einführung in die Wissenschaftstheorie (6. Aufl.). Berlin [u.a.]: Springer.
Oder in Englisch zum wissenschaftlichen Arbeiten: O'Leary, Z. (2004): The Essential Guide to Doing Research. London: Sage

This question should be clearly formulated. And it should have a clear focus. It is usually better to have a narrower focus than a too broad one. Important criteria for the topic are[2]:

- clear and limited focus of the work
- motivation and enthusiasm for the topic by the student

2. Scientific Work

Scientific work is actually not difficult at all. For most theses in our field, the recipe is quite simple:

- Take a clear **question**
- **Research** the state of the art for this question
- For this question, one or more **solutions** are investigated.
- **Verify or falsify** the solutions and show that and to what extent they answer the question
- In each step, examine **possible alternatives** and justify your own path
- Finally, **reflect** on the entire procedure.

Something has already been said above about the **research question**. If you are not sure whether a research question is really good, then you can consider, for example, whether you could publish a paper on the research question at a scientific conference or in a scientific journal. You can discuss this with your supervisor, for example. Research also helps to find out whether the research question is relevant.

When **doing research**, you should find out as much as possible what has already been published in the field of your research question. Of course, libraries and supervisors can help

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[2] O`Leary suggests the following list of questions:
• Is the question right for me?
o Will the question hold my interest?
o Can I manage any potential biases/subjectivities I may have?
• Is the question right for the field?
o Will the findings be considered significant?
o Will it make a contribution?
• Is the question well articulated?
o Are the terms well-defined?
o Are there any unchecked assumptions?
• Is the question doable?
o Can information be collected in an attempt to answer the question?
o Do I have the skills and expertise necessary to access this information? If not, can the skills be developed?
o Will I be able to get it all done within my time constraints?
o Are costs likely to exceed my budget?
o Are there any potential ethics problems?
• Does the question get the tick of approval from those in the know?
o Does my supervisor think I am on the right track?
o Do 'experts' in the field think my question is relevant/ important/ doable?

with this. The simplest tool, and the minimum requirement, is to enter a few keywords about the thesis on Google Scholar (http://scholar.google.de). Other good sources are:

- CiteSeer or CiteSeerX: http://citeseer.ist.psu.edu/, http://citeseerx.ist.psu.edu/
- Sciencedirect http://www.sciencedirect.com/

Almost all documents are available online as HTML or PDF (from your university account or via VPN access from home).

- ACM http://portal.acm.org/

Almost all documents are available online as HTML or PDF (from your university account or via VPN access from home).

- There is very good access to eBooks, DFG national licenses, etc. via the university's electronic library (http://elib.suub.uni-bremen.de/).

With a little cleverness with the keywords, you can quickly find works that fit the topic. Important are also the available references in BibTeX or EndNote format. Very nice is also the free use of RefWorks (There are also training courses of the SuUB). With it you can build up your bibliography automatically and then import it into LaTeX, OpenOffice or a Word document.

Depending on the question and the research, different **solutions** can be generated. These can be programs, user studies, drafts, etc.

It is important to show that these solutions also answer the question. Most of the time you cannot **verify** everything. Depending on the type of work, this also differs. If you have a new interface idea, the verification can be a user evaluation, if you propose a new method for processing large amounts of data, a performance test would be useful. In any case, question, solution and verification should fit together. If you cannot answer everything, you should preface the question.

In general, you should **check alternatives** at every point. Look left and right. What have others done? How else could the problem be solved? Why do I take variant A and not variant B? Often you will justify that you have to limit yourself to one variant within the scope of your work. But it is good to show that you know the alternatives.

The following applies to the entire work: accuracy is important. Conclusions must be justified. Literature has to be substantiated etc. But this should be obvious.

How scientific should the work be?

We do not expect Nobel Prizes. What is important is the procedure described here for solving a problem. So do not worry, a bachelor thesis can also have a less scientifically demanding topic. But still you should always have a **clear question**, **do research**, **check alternatives**, **verify/validate solutions** and **reflect** on the work. In addition, it must meet the formal requirements for citation. If in doubt, ask your supervisor.

3. Supervisor

Generally, the supervisor of the thesis is a professor. Sometimes it is also a research assistant or an external person. Each supervisor has his/her own style. Normally, however, they are all willing to give a lot of feedback.

At the university, it is often the case that, in addition to a professor, a research assistant also supervises. In many cases, students have more contact with the research assistant than with the professor. This can be very practical, because a professor's schedule is quite full and the research assistant can help much better with practical questions. Nevertheless, you should also talk to the professor if he is the reviewer.

Basically, the following applies to the supervision: it is the students' work and they are responsible for it. Many students turn out to be surprisingly resistant to supervision. This means that the supervisors hardly see the students, they hardly react to feedback and let themselves be seen far too rarely. It is always better to check in with the supervisor regularly (e.g. every 2 weeks) and report what is going on than to wait too long. It is better to talk to the supervisors more often. Otherwise you get into a negative spiral: You think, for example, that after four weeks you should already have done much more. Therefore, it is better to work another week and then really show the supervisor a lot. After five weeks, however, you think that there are too few results for five weeks ...

Most working groups offer a colloquium for final theses. There the essential aspects can be discussed and there will also be the chance to present the intermediate steps. Take advantage of this opportunity. The more often you have to explain to others what you are writing about, the better.

It is very important to give your supervisor a preliminary version of the written thesis to read. Give him enough time to read it (2 weeks). Then you will get feedback that you can use for corrections. This way you can easily improve your grade considerably.

For the midterm reports, long texts are often bad (supervisors do not have so much time to read a lot of text). Better make a few slides or show short demos.

Secondary Reviewer

Secondary reviewers are not given enough attention by many students. They decide 50% of the grade. This means that they are just as important for the grade as the first reviewer/supervisor of the thesis. Therefore, you should contact the second reviewer in time and also discuss the concept of the thesis with him/her. It is also important to ask what is particularly important to the second supervisor for the grade. If you do not know this, you cannot take it into account.

4. External Theses

Many students want to write their theses as external theses. From the university's point of view, there are actually no external theses. The reviewers and those who assign topics are professors. However, some students want to write theses in the environment of a company or external institution. This is often tempting, because you can get money there as a student assistant and perhaps also get a foot in the door with a future employer.

However, such external theses also bear a number of dangers:

- The topic that a company is interested in is sometimes not directly the field in which the university supervisor is an expert.
- There are conflicts of interest between the university, students and companies:
    - The university expects an examination performance and a thesis

    - Students want to earn money and a good grade
    - The companies want a task to be done
- Often, the questions defined in such theses are scientifically imprecise or not very exciting (e.g. development of a web-portal)
- On-site supervision is often poor, as company staff are not interested in in the performance of the examination
- The supervision by the university supervisors is poor, as the work has little relation to the research in the working group
- The processing times are often much longer than planned, as students get bogged down in the demands of the job and the thesis.

In principle, external work can be quite useful. However, it should be well weighed up. Experience shows that the quality of external work is significantly lower (approx. one whole grade) than that of internal work, and that the processing time is often significantly longer. So if it is only about earning money, then you are better advised to quickly do a thesis at the university and then work in a company after graduation.

5. Written Thesis Document counts

For the grading of the work, the most important thing is the written thesis document. That is, the written and bound work, which is handed in at the end. There are numerous books and sources in which you can read a lot about the preparation of theses. Therefore, here are just a few important points, with which many students have their problems:

- **Structure of the thesis document:** The paper should follow the typical structure of scientific theses:
    - Introduction (What is the thesis about).
    - State of the art and research (What do you need to know, what has been researched?)
    - Proposed solutions (own approach, investigation, system)
    - Implementation (How did one implement the approach/system? What technologies, frameworks, programming languages, etc.?)
    - Evaluation/Validation (Why is one's own approach an answer to the problem)
    - Discussion (Did you achieve what you wanted to do, what could you have done differently, relation to the state of the art?)
    - Summary
- **No experience report.** The thesis document should not describe everything that has been done. Based on the results, you should specify the question again and then report stringently. It is best to orientate yourself on scientific papers.
- **No schoolbook.** In the case of state of the art, you should only present what is needed for your work in a clear and concise manner. Under no circumstances should you report everything you have read somewhere. Decisive for a good grade is **your own contribution**, not what you have from other sources.

- **Literature and references:** Literature must be carefully prepared. The citation style should be consistent. Proper publications (journals, conferences) are always better than web links. It is best to use a citation style where you can see what is being cited, i.e. (Malaka et al. 2006) instead of [23]. Use a literature management system, this makes life easier. There are many different tools, such as BibTeX, EndNote or Zotero. Each tool can export the data accordingly. For citation style, we advise "APA-like" or "Harvard style". These use the author and the year for referencing and make the text much more readable.
- **Language, style and comprehensibility:** The readability, care and comprehensibility of a thesis also reflect the scientific quality of the work. Here you can also make up at least one grade by
    - having the thesis proofread by yourself and by others,
    - using short precise sentences that have clear statements,
    - using spell checkers,
    - avoiding platitudes, filler words, and phrases.
- **How many pages?** Page numbers do not matter. What is important is the content. Good journal papers often have only 10 pages. The trick is often not to write a lot, but a little. Those who write less text with more content
    - not only writes better but
    - saves time, patience and the reviewers' nerves,
    - increases the chance that others will read and understand the thesis,
    - and saves the environment.
- **- Implementation and data:** Crucial to the thesis is essentially the scientific work found in the written version of the thesis. The implementation usually serves as a tool to achieve the scientific results. The description of an implementation should be based on software design methods (e.g. waterfall model, human-centered design). Also, the use of constructs of a modeling language for the analysis, design, and concrete implementation in a programming language cannot hurt and enhances the thesis accordingly. As well as research data and other material that may be relevant to the thesis, this should be included in appendices or, even better, on a CD with the thesis. Self-written programs, design, etc. must be submitted on a CD/DVD. The archiving of raw data (this also includes pictures, graphics, result tables, etc. in the thesis document) and auxiliary materials is even obligatory in some areas. Since these data and programs are the methodical tools of the trade, it is also looked at and is taken into account in the grading.
- **Methods:** It is important for every thesis to present and justify the chosen research methods. These can also be development methods. Frequently, however, the theses also include social science methods (such as questionnaires, interviews, case studies or observations). Here you should definitely consult a relevant book or the office hours of the supervisor or the study center. Not every conversation with a specialist is an "expert interview", not every social gathering is a "participant observation". Especially with questionnaires, you can get a lot wrong.
- **Abstract:** The thesis should contain a short abstract on an extra page. It helps readers to quickly learn what the thesis is about.

6. Software

Which software you use is relatively unimportant. You can also write good documents with OpenOffice or Word. A favorite is still LaTeX in combination with BibTeX. Here are some general hints:

If you do your thesis with Word or OpenOffice, you have to use the style sheets. So a heading has the style sheet "Heading 1" (example from an English OpenOffice). If you then want to change the appearance, you only need to adjust the style once and the whole document looks accordingly. If you are missing a style, create one and use it. Only if you strictly follow these rules you can e.g. automatically create a table of contents and then simply update it (right mouse button → Update).

LaTeX makes many things easier, but also has its problems. Here, however, the typesetting is great and if you use a lot of formulas, you will learn to love LaTeX.

Conclusion, choose the software according to your preferences and the task you want to do.