



How to write scientific assignments

Recommendations for students in Industrial Engineering and Management

Modified by Lars Löfqvist, 2014-04-10

Writing a scientific assignment, such as a student thesis on basic (Bachelor) or advanced (Master) level, requires proper planning and structure. Spending some time on sorting out your thoughts and motives before you start will lead to time savings due to less rework and 'unnecessary' data collection. For a thesis this is normally done in a *Research proposal* of 1-2 pages that describes the topic, the study's purpose, the goal of the study, proposed methods, possible outcome and a brief plan for the research. Important in your research proposal is to focus your study. It is strongly advised to formulate clear and defined research questions, which will contribute to an increased focus. The purpose and research questions must be scientific even if you aim to do some practical problem solving in your thesis work. Scientific research questions normally aim at filling some kind of knowledge gap in the academic literature. The research proposal is a tool for you to focus your thoughts and to communicate your research to your supervisor and others.

Below you will find a suggestion for the sections required in a complete assignment (thesis). This structure is the most common in your research field and is sometimes called the IMRaD structure (Introduction, Methods, Results and Discussion). This structure is the recommended one, but you may deviate from this structure if you have good reasons to.

The headlines of the sections below are followed by a brief description of what each section should contain. In your assignments you can change the proposed headlines to others that may be more appropriate for your particular text. After the proposed structure you will find suggestions for how to cite reference sources.

The recommendation ends with a clarification of the different focus and requirements of assignments written at the basic or advanced levels.

Assignment (thesis) structure

Title page

The title page contains the title of the assignment, the date, and the name(s) and email address(es) of the authors. The date is the submission date or in revised versions the resubmission date. This makes it easy to identify the different versions of the assignment. The title page also includes the level of the assignment, the name of the course (or name of the study programme for a thesis), the supervisor, the examiner, the university and the department, which is Department of Industrial Development, IT and Land Management. There is a thesis cover page template to use that is specific for your department.

Summary/Abstract

The summary (often called an abstract) gives a short overview of the contents of the *whole* assignment, i.e. problem, purpose, method, results and conclusions. List relevant keywords that describe the study's content below the summary or abstract.

Contents page

The contents page provides an overview of the contents of the assignment. All headlines from introduction to conclusion are numbered. Only headlines at a maximum of three levels are included in the contents page. In general, try to avoid more than three levels of headings in theses. The

summary/abstract, table of contents and appendix (if needed) should be included but *not* numbered. Also include page numbers for each heading; the page numbering starts from the introduction/background section.

Introduction/Background

In the introduction section, the reader gets an overview of the research problem and a justification for a study about the particular subject. Introduce, therefore, the reader to the subject and the overall context and present arguments that motivate the study. Convince the reader that your text is relevant and worth reading. In order to motivate your study and highlight your contribution to the subject you can also provide a quick review of some previous studies. Write this section so that the purpose of the assignment will follow naturally after the introduction/background.

Purpose

The purpose statement should be short, clear and precise. The purpose is to explore and investigate the research problem that is the subject of the assignment. Do *not* write that the purpose is to write an assignment in a specific course. The purpose should give such a clear picture that the reader understands the content of the assignment. The purpose is formulated in such way that it can be discussed and a conclusion can be drawn at the end of the assignment. It is usually helpful to also formulate *research questions* that specify the purpose. The research questions can also provide structure for your analysis and discussion.

Methodology

In the methodology section you outline the approach you used to fulfil your purpose and to answer your research questions in the study. This means that you need to give a rich and detailed description of how you performed the whole study. The reader wants to know how you reached your results and conclusions to be able to judge the quality and trustworthiness of your findings. To just present your results and conclusions without describing how you reached them is not trustworthy, and the reader will not believe in your results and conclusions. It is important to give detailed descriptions of events, with examples, to avoid being too superficial.

In the methods chapter you need to justify *what* you have done in the research process and *how* you did it. You must also explain *why* you have chosen your particular research approach and research methods. To do this you need to use references to suitable books and/or academic journal articles about research methodology and research methods when you discuss your chosen approach and methods. You need to demonstrate that you are aware of the reasons and the consequences of the method choices you have made. This means that you must describe and discuss the pros and cons of the chosen approach and methods, but also briefly discuss why you did not choose other methods. Be sure to also discuss how the chosen methods affect your results and conclusions. You need to do this for your chosen overall approach, i.e. qualitative, quantitative research, case study etc., as well as your methods used both to collect data (for example interviews, observations, survey, secondary data) and to analyse your data.

A common way to motivate your chosen approach and methods is to use your research questions. Your research questions firstly show if qualitative or quantitative research is more suitable. If you want to measure something or look at how several aspects correlate with each other, quantitative research with the data collection method of survey is probably suitable. If you have more exploratory and/or explanatory research questions, such as why and how questions, qualitative research probably suits your study. If your research question studies something complex in a complex, real-world context, qualitative case studies, with data collection methods such as interviews and/or observation, may be suitable. For student theses in the research area of Industrial engineering and management, the qualitative case study with one or a few case companies is the most common research approach. Data collection methods commonly used within these case studies are often a mix of interviews, studies of secondary data (for example, websites, brochures, reports of the company) and sometimes observation. Other data collection methods are also possible. You often use a mix of different data collection methods (a technique called triangulation) in case studies, which is beneficial because you can cross-

check findings, which strengthen your study and increase the validity (see the next paragraph). If you do case studies, you also need to motivate your choice of case companies. Explain and discuss why your chosen case companies are suitable for helping you answering your research questions. Describe in detail how you did your data collection. For example, if you chose to do interviews, you must describe how you chose people to interview, motivate your type of interview (for example, unstructured, semi-structured or structured) and describe the interview situation and themes covered and questions asked. You must also describe how you summarized and analysed your collected data.

You must include a section about research quality when you discuss the quality of your study in terms of reliability, validity and generalizability. This discussion about research quality is usually put last in your methods chapter. *Reliability* is about the possibility of doing the exact same study again. For example, in qualitative case studies full reliability cannot be achieved, but it can be increased by carefully documenting the study. *Validity* is about how well the construct to measure or concept to study is studied. For example, in qualitative case studies the validity can be increased by using different data collection methods which allow for comparing findings by different methods. *Generalizability* is about whether the findings and conclusions are valid outside the actual study. Generalizability in a statistical manner is possible in survey research with answers from many respondents but is normally not possible in qualitative studies. For example, qualitative case studies have limited generalizability, but this can be increased by studying several cases. You must discuss the limitations of the study. Where and when are the findings and conclusions valid?

Last but not least, you must bring up and discuss possible bias and ethical and societal aspects of your study. Explain how the study can be biased and how that bias may affect the findings and conclusions. If you have investigated something controversial with ethical dimensions, it must also be described and discussed. For example, for interviews you may discuss if the interviewees have been treated in an ethical way. Discuss what possible impacts the study has on society as a whole.

Theoretical Framework

In this section you describe the theories, concepts, philosophies and definitions you use in the study. You may also present an analytical model that explains the terminology you have chosen and/or relationships between your core concepts. In addition to defining concepts the theoretical framework should include a presentation and analysis of relevant previous research within the field. In other words, what have other researchers done, and where are the research frontiers and the research gaps? Only include theory that is relevant for the study's topic and for the understanding of the study. Use literature of high academic quality such as academic journal articles, and use a variety of literature so as to avoid overusing certain sources.

Results/Findings

In this section you present your collected data. In empirical investigations, you will present your findings from for example, interviews, observations, surveys and such secondary data as reports and websites. In theoretical investigations (based on literature only), it means explaining the views of different authors. It is important not to do any analysis in this section. This means that you should avoid all types of evaluations and judgements when presenting your data.

Analysis and Discussion

In the analysis and discussion section you will analyse and discuss the data you presented in the previous section according to your stated purpose, as well as in relation to the research questions you may have presented. You must also relate your data with the theory you brought up in the theoretical framework section. You should specify if and how your results contribute to or contradict previous studies. When your findings say something different or something more than existing theory, it can be new knowledge that is worth highlighting. In case you have presented an analytical model, include it in this section. It can also work well to structure the analysis and discussion chapter according to the research questions. You must not present any new data in this chapter, but only use the data that were already reported in the results/findings section. Furthermore, do not introduce any new theory (except for own developed theory) that was not already introduced in the theoretical framework section.

Conclusions

Your conclusions should fulfil the purpose of the study and answer the research questions. The discussion of the research questions in the analysis and discussion section will help persuade the reader of the trustworthiness of your conclusions. Consider the generalizability of your conclusions. For example, if you have done a case study you cannot normally state that your conclusions are valid for all other cases. So be careful in how you write so you do not imply that the conclusions are valid in all cases. The conclusions section may also contain proposals for future studies based on the 'new' problems or questions that arose as result of your study. A managerial implications section can also be included if you wish to describe and discuss the possible practical implications of your study.

References

All written sources you have used as references in the text should be provided in a reference list. References in the reference list shall be put in alphabetic order by the authors' surnames. Do not make separate lists for different kind of literature. Make sure that all references used in the text also are present in the reference list and that all references in the reference list are used in the text. Be very careful, consistent and avoid formal errors in the use of references, because these errors are very easy to see and will lower the trustworthiness of your study.

References can be cited in many different ways, we recommend the following Harvard format of in-text citations and references.

Citation in text:

Reference is written (*Author, year*) or *Author (year)*, e.g. (Brown, 1998) or Brown (1998). The reference is located in the text.

Example: There are many studies of how outsourcing influences companies' productivity (Heshmati, 2000). According to Nutek (2000, p. 15) no effects have been revealed.

Page numbers are essential if you use direct quotations of another author. In other cases it is not required but may be advisable.

Book:

Author (last name, initials) (year). *Title* (italics). Location of publisher (not printer): Publisher.

Example: Utterback, J.M. (1994). *Mastering the Dynamics of Innovation*. Boston, Massachusetts: Harvard Business School Press.

Book in another language:

Author (last name, initials) (year). *Title* (italics) [Title in English]. Location of publisher (not printer): Publisher.

Example: Alasuutari, P. (1994). *Laadullinen Tutkimus* [Qualitative Research], Tampere: Vastapaino.

Book chapter:

Author (last name, initials) (year). Title of Chapter. Name of editors of the book if any (eds.). *Title of the Book* (italics), Location of publisher: Publisher, page range of the chapter.

Example: Elkjaer, B. (2005). Social Learning Theory: Learning as Participation in Social Processes. Easterby-Smith, M. and Lyles M.A. (eds.). *Handbook of Organizational Learning and Knowledge Management*, Oxford, UK: Blackwell Publishing, pp. 38-53.

Article in a journal:

Author (year). Title, *Name of Journal* (italics), Vol. xx, No. yy, page numbers.

Example: Berggren, C. and Bengtsson, L. (2004). Rethinking outsourcing in manufacturing: A tale of two telecom firms. *European Management Journal*, Vol. 22, No. 2, pp. 211-223.

Reports are referenced in the same manner as books.

Internet:

Author if applicable (year). *Title*, www.domain.com, access date.

Example: Accenture (2007). *The forgotten supply chain*, www.accenture.com, Access 2007-08-22.

Additional advice on writing scientific assignments

The key to an easy-to-read, fluent and good scientific text in an assignment lies in rewriting the text many times. By looking at the text many times you see new things to improve and redundant text to remove. It is also good to let others read your text to propose improvements, because their view on different things can be very valuable. It is common to get different advice from different teachers when you ask how to write. This is normal, because there is not only one best way to write scientific assignments. It is up to you to make the most of the different suggestions.

Other more practical advice is to be consistent in what you call different things through the whole thesis and do not mix different names or terms for the same thing. It only confuses the reader. Think of the inexperienced reader when you write and do not presuppose that this reader know all concepts you use or automatically understands complex connections. Always define or explain tricky concepts the first time you use them in the text. Introduce figures and tables from the text, before they are shown.

Put a lot of effort to get the references formally correct. Use the Harvard reference style. Do not mix them up with footnotes; use footnotes to provide additional or explanatory content, not reference citations.

What is the difference between basic and advanced level?

It is useful to know the difference between basic level and advanced level assignments. This will be explained in this section.

A basic level assignment, such as a bachelor's thesis, deals with basic knowledge of a subject, whereas advanced levels, such as a master's thesis, are more in-depth. Figure 1 illustrates the differences in focus between basic and advanced levels. A basic level assignment is primarily aimed at *solving a particular problem or task in its context*. Advanced level assignments have a stronger theoretical connection, *focussing on the literature base and the theoretical insights and contributions*.

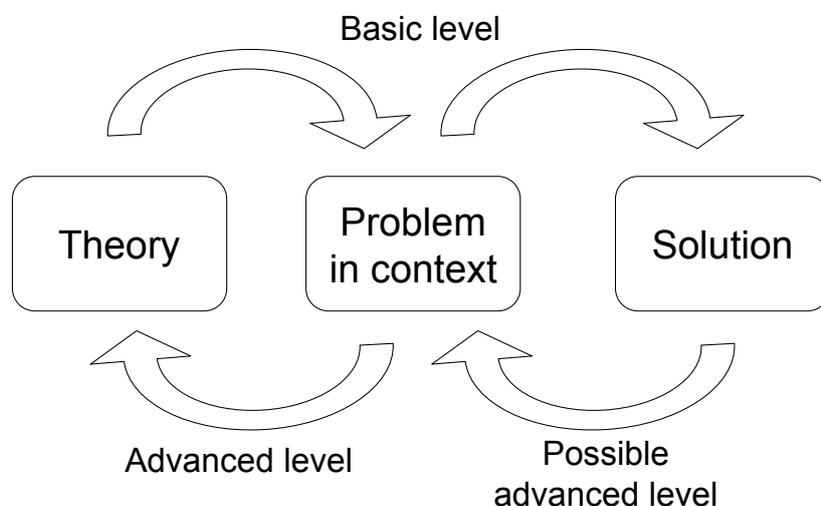


Figure 1. The difference between basic and advanced level writing assignments.

Another possibility, for an advanced level assignment, is to propose a solution and then link it to the context and the theory. As an example, compare the following two purposes:

1. *The purpose of this assignment is to provide suggestions for changes/improvements from a process-based view and justify how quality control can be improved and costs reduced.*
2. *The purpose of this assignment is to evaluate the impact of the process-based view on the profitability of a middle-sized enterprise.*

What is the difference between the two? In the first example you can detect a clear focus on solving a problem and proposing a solution, i.e. it is a basic level assignment. The second is aimed at evaluating the process-based perspective, i.e. there is no specific problem to be solved, but the result will be used to improve the theory within the field. It is thus an advanced level assignment.

Examples of typical subjects for advanced level assignments are:

- *Comparing* different theories/concepts/philosophies
- *Evaluating* different contexts by using theories/concepts/philosophies
- *Evaluating* different theories/concepts/philosophies in a specific context
- *Developing* new theories/concepts/philosophies

Examples from different subjects are:

Industrial environmental economics

- Basic level: *The purpose of the assignment is to explore drivers, opportunities and barriers for integration of management systems.*
- Advanced level: *The purpose of this assignment is to explore the development of GSCM in manufacturing industry in China based on the single-case study and to suggest changes for strengthening the relationship between GP and GSCM based on the analysis.*

Logistics

- Basic level: *The purpose of this assignment is to map, analyse and suggest improvements for the flow of information in two specific contexts: industrialisation (TTM) and mass production (TTC) in company AB.*
- Advanced level: *The purpose of this assignment is to investigate how the flow of information should be managed in two specific contexts: industrialisation (TTM) and mass production (TTC).*

Industrial organisation and management

- Basic level: *The purpose of this assignment is to evaluate and suggest improvements for the outsourcing strategy of company A.*
- Advanced level: *The purpose of this assignment is to evaluate the ability of a matrix organisation to handle the distribution of manager responsibility at different levels of customer focus.*

Quality management

- Basic level: *The purpose of this assignment is to suggest changes/ improvements from a process-based view and justify how quality management can be improved and costs reduced.*
- Advanced level: *The purpose of this assignment is to analyse the contents of APQP and evaluate its usefulness as a tool in pro-active quality management from a TQM perspective, with particular focus on continuous improvements and process management.*

Good luck with your future writing of assignments!

/The Teachers/Professors at Industrial Engineering and Management at University of Gävle