

How to write a research paper

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Abstract

Writing a good research paper is exceedingly difficult. In this report, we propose guidelines in order to make students' life easier. **The abstract allows you to elaborate upon each major aspect of the paper and helps readers decide whether they want to read the rest of the paper.** Therefore, enough key information [e.g., summary results, observations, trends, etc.] must be included to make the abstract useful to someone who may want to examine your work. How do you know when you have enough information in your abstract? A simple rule-of-thumb is to imagine that you are another researcher doing a similar study. Then ask yourself: if your abstract was the only part of the paper you could access, would you be happy with the amount of information presented there? Does it tell the whole story about your study? If the answer is "no" then the abstract likely needs to be revised. You should write the abstract as the last part of the project and it should not exceed 200 words. Generally, use the simple past (or for a concise introductory phrase the present perfect); for general statements and facts use the present tense.

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1. Introduction

This section of your report is where you will document all the painstaking research into the background of your experiment [1]. The main thing to bear in mind, when writing the introduction, is that a scientist who is unfamiliar with your exact subject matter may be reading the article. It is important, therefore, to try and give a quick and condensed history of the research leading to your experiment, with correct citations. You should also give a little background on why you chose to do this particular experiment and what you expect to find. It is a little 'old-fashioned' to hypothesis statement at the beginning of the report but the reader should be aware of exactly what you are trying to prove [2].

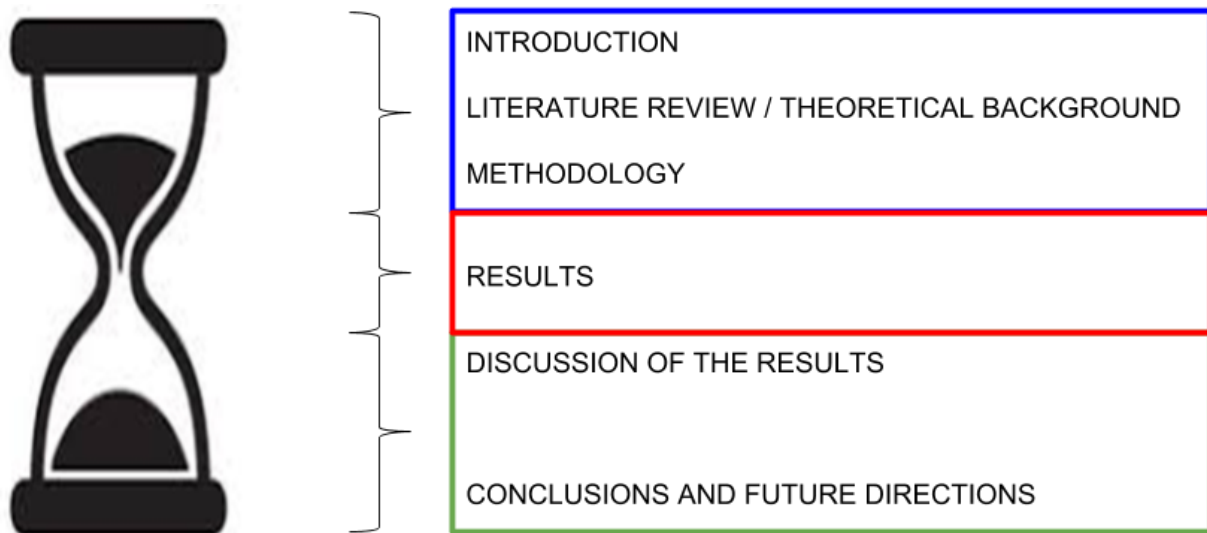


Figure 1 A scientific paper can be simplified by means of an hourglass

A scientific paper or a scientific report or a thesis (referred as paper in this guide) basically comprises the parts: title page, table of contents, abstract/summary, introduction, literature review/theoretical approach, methodology, results, discussion/conclusion, bibliography. The structure of the work can be simplified by means of an hourglass as shown in Figure 1: The

introduction first puts the topic into an overall context. Based on the state of research and gaps in the thematic environment, it formulates the research goal of the work. The theoretical approach leads to the "eye of the needle, through which the sand flows": to the questions or hypotheses. The following is the description of the scientific methods by which these questions should be answered. The results contain the core of the work: the presentation of the test results. In the discussion, the questions or hypotheses are taken up, answered and in turn placed in a wider context with the literature. Finally, in the conclusion, the key messages are briefly summarized and consequences shown. At the end of logical sections, the (intermediate) results should be summarized very briefly in order to clarify the line of argumentation, the "red thread".

2. Literature Review

It could be also as a part of the introduction It may be useful to do a chronological format where you discuss from the earliest to the latest research, placing your research appropriately in the chronology [3], [4]. Alternately, you could write in a thematic way, outlining the various themes that you discovered in the research regarding the topic. Again, you will need to state where your research fits.

3. Methodology

Here you clearly outline what methodology you used in your research i.e. what you did and how you did it. It must be clearly written so that it would be easy for another researcher to duplicate your research if they wished to.

- It is usually written in a 'passive' voice (e.g. the participants were asked to fill in the questionnaire attached in Appendix 1) rather than an 'active' voice (e.g. I asked the participants to fill in the questionnaire attached in Appendix 1).
- Clearly reference any material you have used from other sources. Clearly label and number any diagrams, charts, and graphs. Ensure that they are relevant to the research and add substance to the text rather than just duplicating what you have said. You do not include or discuss the results here.

3.1. The Importance of a Structure

Writing an academic essay means fashioning a coherent set of ideas into an argument. Because essays are essentially linear—they offer one idea at a time—they must present their ideas in the order that makes most sense to a reader. Successfully structuring an essay means attending to a reader's logic. The focus of such an essay predicts its structure. It dictates the information readers need to know and the order in which they need to receive it. Thus your essay's structure is necessarily unique to the main claim you're making. Although there are guidelines for constructing certain classic essay types (e.g., comparative analysis), there are no set formula.

3.1.1. Answering Questions: The Parts of an Essay

A typical essay contains many different kinds of information, often located in specialized parts or sections. Even short essays perform several different operations: introducing the argument, analyzing data, raising counterarguments, concluding. Introductions and conclusions have fixed places, but other parts do not. Counterargument, for example, may appear within a paragraph, as a freestanding section, as part of the beginning, or before the ending. Background material (historical context or biographical information, a summary of relevant theory or criticism, the definition of a key term) often appears at the beginning of the essay, between the introduction and the first analytical section, but might also appear near the beginning of the specific section to which it's relevant.

It's helpful to think of the different essay sections as answering a series of questions your reader might ask when encountering your thesis. (Readers should have questions. If they do not, your thesis is most likely simply an observation of fact, not an arguable claim.)

- **"What?"** The first question to anticipate from a reader is "what": What evidence shows that the phenomenon described by your thesis is true? To answer the question you must examine your evidence, thus demonstrating the truth of your claim. This "what" or "demonstration" section comes early in the essay, often directly after the introduction. Since you are essentially reporting what you have observed, this is the part you might have most to say about when you first start writing. However, be forewarned: it should not take up much more than a third (often much less) of your finished essay. If it does, the essay will lack balance and may read as mere summary or description.

- **"How?"** A reader will also want to know whether the claims of the thesis are true in all cases. The corresponding question is "how": How does the thesis stand up to the challenge of a counterargument? How does the introduction of new material—a new way of looking at the evidence, another set of sources—affect the claims you are making? Typically, an essay will include at least one "how" section. (Call it "complication" since you are responding to a reader's complicating questions.) This section usually comes after the "what," but keep in mind that an essay may complicate its argument several times depending on its length, and that counterargument alone may appear just about anywhere in an essay.
- **"Why?"** Your reader will also want to know what is at stake in your claim: Why does your interpretation of a phenomenon matter to anyone beside you? This question addresses the larger implications of your thesis. It allows your readers to understand your essay within a larger context. In answering "why", your essay explains its own significance. Although you might gesture at this question in your introduction, the fullest answer to it properly belongs at your essay's end. If you leave it out, your readers will experience your essay as unfinished—or, worse, as pointless or insular.

4. Results

The results section is where you report the findings of your study based upon the methodology [or methodologies] you applied to gather information. The results section should state the findings of the research arranged in a logical sequence without bias or interpretation. A section describing results is particularly necessary if your paper includes data generated from your own research.

4.1. Importance of a Good Results Section

When formulating the results section, it's important to remember that the results of a study do not prove anything. Findings can only confirm or reject the hypothesis underpinning your study. However, the act of articulating the results helps you to understand the problem from within, to break it into pieces, and to view the research problem from various perspectives.

The page length of this section is set by the amount and types of data to be reported. Be concise, using non-textual elements appropriately, such as figures and tables, to present results more

effectively. In deciding what data to describe in your results section, you must clearly distinguish information that would normally be included in a research paper from any raw data or other content that could be included as an appendix. In general, raw data that has not been summarized should not be included in the main text of your paper unless requested to do so by your professor.

Avoid providing data that is not critical to answering the research question. The background information you described in the introduction section should provide the reader with any additional context or explanation needed to understand the results. A good strategy is to always re-read the background section of your paper after you have written up your results to ensure that the reader has enough context to understand the results [and, later, how you interpreted the results in the discussion section of your paper].

i.e. We report the distribution of exam grades at EPFL in Figure 2, where “No. students” are number of students who sat the exam, “No. students with marks” are the number of students who obtained a grade while “Pass rate” is the percentage of students who obtained a pass or better (≥ 4).

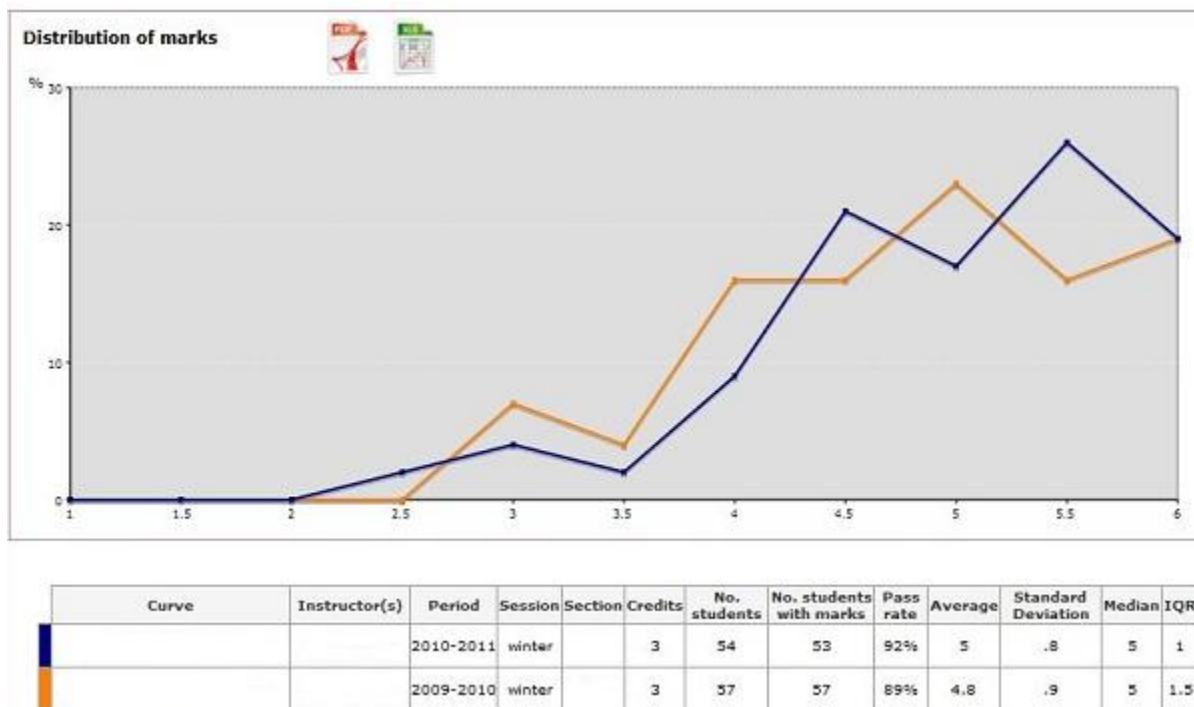


Figure 2. Distribution of the scores of the grades obtained by EPFL students during the Academic years 2009-2010 and 2010-2011 where we can observe an increasing of the pass rate and the average score (source <https://is-academia.epfl.ch/page-61934-en.html>).

5. Conclusions

So much is at stake in writing a conclusion. This is, after all, your last chance to persuade your readers to your point of view, to impress yourself upon them as a writer and thinker. And the impression you create in your conclusion will shape the impression that stays with your readers after they've finished the essay. The end of an essay should therefore convey a sense of completeness and closure as well as a sense of the lingering possibilities of the topic, its larger meaning, and its implications: the final paragraph should close the discussion without closing it off.

- ***To establish a sense of closure, you might do one or more of the following:*** Conclude by linking the last paragraph to the first, perhaps by reiterating a word or phrase you used at the beginning. Conclude with a sentence composed mainly of one-syllable words. Simple language can help create an effect of understated drama. Conclude with a sentence that's compound or parallel in structure; such sentences can establish a sense of balance or order that may feel just right at the end of a complex discussion.
- ***To close the discussion without closing it off, you might do one or more of the following:*** Conclude with a quotation from or reference to a primary or secondary source, one that amplifies your main point or puts it in a different perspective. A quotation from, say, the novel or poem you're writing about can add texture and specificity to your discussion; a critic or scholar can help confirm or complicate your final point. For example, you might conclude an essay on the idea of home in James Joyce's short story collection, *Dubliners*, with information about Joyce's own complex feelings towards Dublin, his home. Or you might end with a biographer's statement about Joyce's attitude toward Dublin, which could illuminate his characters' responses to the city. Just be cautious, especially about using secondary material: make sure that you get the last word.
- ***Finally, some advice on how not to end an essay:*** Don't simply summarize your essay. A brief summary of your argument may be useful, especially if your essay is long--more than ten pages or so. But shorter essays tend not to require a restatement of your main ideas. Avoid phrases like "in conclusion," "to conclude," "in summary," and "to sum up." These phrases can be useful--even welcome--in oral presentations. But readers can see, by the tell-tale compression of the pages, when an essay is about to end. You'll irritate

your audience if you belabour the obvious. Resist the urge to apologize. If you've immersed yourself in your subject, you now know a good deal more about it than you can possibly include in a five- or ten- or 20-page essay. As a result, by the time you've finished writing, you may be having some doubts about what you've produced. (And if you haven't immersed yourself in your subject, you may be feeling even more doubtful about your essay as you approach the conclusion.) Repress those doubts. Don't undercut your authority by saying things like, "this is just one approach to the subject; there may be other, better approaches. . ."

We believe that formatting as well as fonts, labelling and layout of this report represent the right way to present a research project. We therefore expect that the students will use this template using the appropriate styles, the right way of numbering and referring to papers and figures.

Bibliography¹

- [1] C. Andrade, “How to write a good abstract for a scientific paper or conference presentation,” *Indian J. Psychiatry*, vol. 53, no. 2, p. 172, 2011.
- [2] E. D. Kallestinova, “How to Write Your First Research Paper,” *Yale J. Biol. Med.*, vol. 84, no. 3, pp. 181–190, Sep. 2011.
- [3] Z. A. Doubleday and S. D. Connell, “Publishing with Objective Charisma: Breaking Science’s Paradox,” *Trends Ecol. Evol.*, vol. 32, no. 11, pp. 803–805, Nov. 2017.
- [4] V. Gewin, “How to write a first-class paper,” *Nature*, vol. 555, no. 7694, pp. 129–130, Mar. 2018.

¹ Zotero could be a useful tool: <https://www.zotero.org/>