

Lab Research Project

For this project, you will apply the statistical concepts and techniques that we learn about in class and in the lab to your own research project. You will start from a simple question, and will go through the normal process of preparing a proposal, doing the experiment (or collecting data from an online database), analyzing the data, writing a scientific paper, and presenting your study to the class. This process of scientific research is common to all areas of Biological research.

The following information is provided as a guide for this project. All components of the lab research project (proposal, manuscript, and presentation) will be done in teams of two.

Proposal (5 marks)

Obtaining research funding is an important aspect of any scientific career, and often depends on how efficiently you can write a research proposal. In a research proposal, you have to sell your ideas. You have to know what other people did before you and you have to decide on the methods you will use to answer your own question. Always remember that as scientists, we use the scientific method. This means that your proposal should be based on a question that leads to a hypothesis that will be tested.

Your proposal should include a title page that contains a clear and descriptive title and author information. A short introduction consisting of a literature review must be included. This literature review should build to a clear research question, study objective, and hypothesis. You must also include methodology describing the study, as well as expected results. The research proposal should not be more than 4 pages double-spaced.

Literature Review:

All proposals require a literature review. You have to know what has been done in the past on the subject, and you must summarize it clearly and concisely to put your own research question into context. In a proposal, this is generally a selective rather than exhaustive description of the literature, and should include significant and recent references that form the foundation of your study.

It is important in your literature review that you are very critical about sources. Scientific textbooks are usually acceptable sources of basic information. However, research papers and reviews in published refereed journals are the most valuable references and you should use these whenever possible. Make sure that you are using recent references whenever possible. Importantly, websites are generally not acceptable sources in science. These should be limited to highly reputable sources (e.g. NCBI, United Nations, WHO, etc.) and should be used only when absolutely necessary to reference data not found elsewhere. The Brock library website, Google scholar, PubMed, and Web of Science are excellent resources for obtaining literature for your review.

Research question, hypothesis, & expected results:

It is important that you have a clear research question in mind when writing your proposal. From this question you should develop a research hypothesis and should consider the expected results of your study. These important points should be incorporated into the proposal in a way that flows logically from the literature review, and must be clear to anyone who reads your research proposal.

Project methodology:

The description of your methods should provide a reviewer with a clear idea of your experimental design and how you will get the data. Describe the subjects of your study, the sampling method, and the overall experimental design (number of subjects, replicates, etc.). If an online database is being used, describe the data that will be used, and provide any information from the database on the nature of this data and how it was collected.

A description of the variables that will be measured (explanatory and response, and whether each is numerical or categorical, etc.) should be included in this section. In terms of statistical analyses, you will build this section during the term as we learn about various types of statistical testing, so it does not need to be described extensively in the proposal. However, you can get an idea of the tests that may apply to your data from Interleaf 7 ("Which test should I use?") on page 366 of your textbook

References cited:

The references that you use or cite within the text must be included in a separate section called "references cited". Make sure that you insert references as you write your proposal, rather than trying to go back and add them in later after it is written. Any information used to explain or support your ideas that is taken from other sources (journal articles, textbooks, etc.) must be clearly cited. For this project we will use the referencing format used by the journal PLOS Biology. See the detailed instructions for authors found at <http://www.plosbiology.org/static/guidelines>. Note that this journal uses the **citation sequence** method of referencing.

Research Paper (10 marks)

Before beginning your research paper, consult some journal articles on topics related to yours. Read the articles and familiarize yourself with how they are structured and laid out. Review how the methods are written, and how the results are presented. This exercise will give you an idea about how to best present your paper. The paper you are writing will have **five components**: An abstract, introduction, methods, results, and discussion. You must also include a complete list of the references cited in your paper.

Title and an abstract:

The title of your paper should be an informative description of your study. The abstract is a concise summary of your paper. The abstract should begin with a few sentences of background information that set up the question of your study. Briefly describe what you did to answer the

question (the methods). Then state the main results and conclusions. An abstract should be less than 300 words.

Introduction:

Your introduction will likely build upon the literature review included in your research proposal, beginning with a couple of paragraphs of general information on topics relevant to your experiment. It should contain sufficient background information to convey what is already known in this area and to put your experiment in context. Inclusion of more recent observations or findings may lead to a discussion of gaps in the current knowledge, which leads to your question of interest. Clearly state your question and briefly indicate how it will be addressed. Your hypothesis and prediction should be clearly stated. Try reading the introduction of a few different papers on related topics, to see how it builds in this way. A good introduction will have a logical flow that leads the reader to the same question and hypothesis as you are presenting.

Methods:

This section will also build upon the information included in your research proposal. Language used in the methods section is the same as the rest of the paper (i.e. nice prose). However, by convention, the methods must be written in past-tense impersonal (e.g. plant height *was* measured daily at 5pm). In general, be concise. Provide enough information so that a reader knows all of the key facts about how you conducted your study and analyzed your data, without including unnecessary details. Usually this section will be divided into a few subsections. For example, study species or study sites, experimental design, and statistical analyses.

Results:

The results section presents the data of a scientific paper. As with other sections, it may be helpful to review the results section of a few different scientific papers to get a sense of how this section is written. Be thorough in your descriptions, and clearly present the results in the form of tables or figures. Keep in mind the various principles we have discussed throughout the course on how to best present information in tables and figures, and make sure that your figures and tables are as clear as possible. All figures should include a title at the bottom of the figure, while all tables should have a title at the top of the table. These titles should be thorough, so that even if we were to take the figure or the table away from the rest of the article, someone who hasn't read your paper would know exactly what it was showing. Importantly, all tables and figures should be described and referenced within the text of your results. If the results are significant according to your statistical analysis, you should state so. If they are not significant, indicate that too. You may use multiple statistical tests with your data set, but make sure the tests you use are appropriate for the data.

You should not discuss the results in any detail at this point. You may point out some trends, but don't discuss what these trends might mean. You have to purely describe what you have found from your observations and the analyses.

Discussion:

This section is often the heart of a paper. It is where you can assess the meaning of your results. In

the discussion, you should always be considering two things: your questions and your results. Important results should be summarized, but not repeated in any detail. Instead, briefly summarize the results in the context of discussing and interpreting them. Include references from other research studies that support and help interpret your results. Discuss the implications of your results. A discussion of a scientific paper is usually heavily referenced. Draw from previously published data to support your conclusions and interpretations whenever possible. If your results differ from previous studies, an explanation rather than a refutation should be presented. The discussion should also indicate or discuss any problems with your study. Finally, at the end of the discussion you should present the larger implications of your results (“the big picture”), and should discuss possible directions for future research in this area.

References cited:

Every article that you cite within the text of your paper must be included in the references cited section. When reading a scientific article, you will often seek out some of the other papers that are cited. It is absolutely critical that the detailed citation of each is included in this section. Cite only the references that you have included in text, and not every paper that you have read. For this section of a scientific paper, the formatting always depends on the journal that is being targeted for publication. For your paper we will use the referencing format used by the journal PLOS Biology. See the detailed instructions for authors found at <http://www.plosbiology.org/static/guidelines>. Note that this journal uses the citation-sequence method of referencing.

Edit, rewrite, and format:

Once your first draft is written, read your paper from beginning to end. A scientific paper will always need alterations, and many scientists write and save many versions before they are satisfied with the final presentation. When reading your paper be critical of yourself, and seek out any logical flaws in your interpretation and reasoning. Re-examine the introduction to make sure it builds to your question and hypothesis. Check your results section to see that the data is presented in a way that highlights the important trends, and determine whether your results should be combined or simplified in some way. Re-examine your discussion to see that the results are being interpreted correctly, are being presented in the context of other findings, and the implications are discussed thoroughly. Finally, check to make sure all of the references are included. It is also important to polish your writing style. Your final paper should be logical, precise, clear, and direct.

Once you are satisfied with your final version, check the following formatting guidelines before printing. Your paper should be double-spaced, and should include page numbers at the bottom right of the page. Include tables and figures at the end of your results section (after all of the text of your results), before your discussion.

Oral Presentation (10 marks)

In the lab, you will present your paper in a 10 minute presentation, followed by a brief question and answer session. Both members of the team should speak during the presentation. You are

also expected to show interest in other presentations by being attentive and asking thoughtful questions.

Introduction:

Try to capture the full attention of the audience from the very beginning of your presentation. The introduction of your presentation should explain the context and motivation for the study. Introduce the topic sufficiently, providing enough background information and context that your presentation will be accessible to people who might not be familiar with that particular area of study. Whenever possible, make use of figures to help explain the background topics rather than text. The background information should lead the audience to understand why this study is important. Conclude your introduction by clearly stating the research question and hypothesis.

Methods:

Explain the methods clearly and simply, avoiding too many details that could be confusing. This should not take more than one slide.

Results & Discussion:

In this section, you should present the most important results from your paper. Figures and tables should be presented in a clear and simplified way, so the audience can quickly and easily see the trends. In a presentation, the meaning or interpretation of the results should be discussed along with the results themselves whenever appropriate, rather than in a separate section. For example, "This figure shows..., suggesting that..."

Conclusions:

End your presentation with concluding remarks that reemphasize the main findings, conclusions, and future implications. This section can also be used to discuss any weaknesses or shortcomings in the paper, and future directions in this research area. Consider the "take-home message" of your presentation, and make sure this is communicated to the audience.

Additional pointers for PowerPoint slides:

- Be careful not to use too much color or design in your PowerPoint template. In general, a simple template, with neutral colours and fonts, is better.
- Provide a title on each slide.
- Avoid cramming your slides with too many words and images.
- In general, images are more effective in a presentation than text. Try to use mostly images in your presentation, and ensure that your slides contain a minimal amount of text.
- If your slides have a background graphic, do not put text or images over the graphics. This creates a messy appearance to the audience.

Additional pointers for presentation delivery:

- Presenting is all about communication. You are exchanging information with the audience. It is important that you are able to convey knowledge and understanding of the subject **without reading** pre-written information. For this reason, you must not, under any

circumstances, read your presentation from a paper, cue card or tablet. Doing so will result in an automatic zero for the presentation delivery component of the mark.

- Preparation is key. Plan what you want to say with each slide, but do not read the slide. Practice your section of the presentation a few times on your own, and then practice with your partner. This will help you improve your timing, wording, and transitions between slides, and will help you feel less anxious.
- If needed, use a laser pointer to draw the audience's attention to a particular part of your slide, but be careful not to overuse it.
- Make eye contact with the audience.
- Be aware and try to limit any distracting behaviours while presenting.
- Take a deep breath and be positive. It is normal and healthy to feel some nervous tension before a presentation. Speak loudly and try to convey confidence, even if you are not feeling it.