

6 The Literature Review

The literature review is important because:

- It describes how the proposed research is related to prior research in statistics.
- It shows the originality and relevance of your research problem. Specifically, your research is different from other statisticians.
- It justifies your proposed methodology.
- It demonstrates your preparedness to complete the research.

6.1 What is a literature review and why is it necessary?

- Your dissertation is a substantial and lengthy piece of professional work that must satisfy a number of academic requirements. The literature review is one of these important academic requirements.
- The literature review is a critical discussion and summary of statistical literature that is of ‘general’ and ‘specialized’ relevance to the particular area and topic of the research problem in statistics.
- You should spend a lot of time on your literature review because if you do it well, you can use most of it in your dissertation.
- In a weak literature review, the Ph.D. student did a poor job of reviewing the relevant literature. It can be poor because there are too few references or the student does not adequately summarize the important results in the cited references. Keeping organized notes will help prevent a weak literature review.
- Every statement in a literature review must be supported either by a reference to published statistical literature.
- In a literature review, you do not present all of the details found in the references. For example, you can state a theorem, but you do not have to present a proof of the theorem. That is, you can (in general) assume the results in the published statistical literature are established facts. By providing the source of the reference, your advisor and committee can go to the original reference for all of the details.
- In your literature search you will:
 - discover what statistical knowledge exists related to your research topic
 - increase your statistical knowledge in your research area
 - find gaps (and possibly errors) in published research
 - generate new original ideas
 - avoid duplicating results of other statisticians
 - justify the relevance of your proposed research

- A literature review in a proposal is usually ≥ 20 pages. It should be long enough to convince your committee that you have thoroughly explored the research topic.

Why is a literature review necessary? The literature review performs a number of important functions:

- It demonstrates to a Ph.D. committee that the student has read a large amount of statistical literature to prove that the student is *aware of* the wide range of research in theory and methodology related to the proposed research topic.
- It provides proof to a Ph.D. committee that the student has an *deep understanding* of the published statistical research related to the topic of the dissertation.
- It should convince the Ph.D. committee that the student can *communicate* this understanding of the statistical literature and its relationship to the proposed research.
- It should support the originality and relevance for the Ph.D. research problem.
 - This is done by identifying specific gaps in the statistical literature. That is, the student identifies statistical questions that have not been answered and problems that have not been solved.
 - By identifying gaps in the statistical literature, the student can justify the originality of the proposed dissertation research. The originality can be an *extension* of research that has been published or a *modification* of existing methodology or theory that can be used to perform the Ph.D. research.
- In the proposal you will **emphasize** or **stress** the originality of the dissertation. Without a good literature review, you cannot convince your committee that that the proposed research is original.
- A dissertation may be unacceptable because the Ph.D. student does not clearly show that the research problem is original due to a poor literature review.
- Remember: the Literature Review is more than a summary of publications. It provides evidence that your research will be an original and relevant contribution to statistics.

Recommendations:

- Writing the Literature Review is not a simple task. It requires good organization. Specifically, you need to develop efficient time management and note-taking skills.
- You also need to be focused on assessing what is relevant to your proposed research, and what is not relevant (irrelevant). You do not want to include anything in the Literature Review that is not related to the proposed research.
- You should write notes regarding what you are reading *as you read it*. Do not wait, because if you do wait, you will almost certainly have to read it again.
- While reading, keep notes about the assumptions made and the important results. This will save you time later.
- In journal articles, the important results are briefly summarized in the Abstract. This gives you information about what to look for as you read the paper.

6.2 An Outline for Preparing a Literature Review.

1. *Generate a list of references:*

- Make a preliminary list of statistical literature that is relevant to your research topic. Your advisor can help you with this.
- Now you have to ‘procure’ (get copies of) the literature on the list. How much time this takes can vary greatly. Some books and journals may be available from your library or advisor.
- Other references, may take time to get. For example, you may also have to get a copy of a dissertation from another university or articles from conference proceedings. These take longer to procure.
- Make sure you keep notes of all details needed for the Bibliography that will appear at the end of your proposal and dissertation.
- Keeping detailed notes will save you a lot of time. References that appear in the Bibliography have a specific format. This process can be automated using BiBTeX within LaTeX.

2. *Reading the literature:*

- Once you have a preliminary list of references, you now have to read this material. This process is ‘time-consuming’ (takes a lot of time) because you will have to read a large amount of statistical research.
- You must realize that not every reference will contain material that is relevant to your research problem. This is a necessary part of the process: Keep what is relevant and ignore what is irrelevant. It is better to read something that is not directly related to your dissertation than miss a reference that is important and relevant to the dissertation.
- While you are reading, keep notes about the assumptions made and the important results. Good notes help when you begin to write the literature review.
- Try to determine the methodology used by the author. This will be helpful when you want to describe how your research is related to prior research. For example, is your research an extension or modification of this author’s research?
- Remember that you are not just summarizing. For each reference you read, *think critically* about the content. That is, ask the following questions:
 - What is the author trying to say?
 - Is it relevant to my research? Is yes, then why is it relevant?
 - What is original about the methodology used by the author?
- Critical thinking is very important because it demonstrates to committee that you are doing more than just reading and summarizing statistical literature.

3. *Update your list of references*

- As you read the references in your initial list, you will find other references you will need to read. Most of these new references are part of the reference list of the article or book you are reading.

- Specifically, you will follow references from one publication to another publication until you have a thorough background knowledge on a topic or subtopic.
- Do not expect that your advisor or co-advisors will have all of the published research in their offices. You should expect to have to get copies of some of the publications by yourself.
- You should ask “Have I accessed the most recent and relevant literature?” throughout the proposal and dissertation process. Because the whole process takes more than one year, you should expect one or more new publications to be appear in a journal between the time you finish the proposal and the time you finish the dissertation.
- Therefore, expect the Literature Review in your dissertation to include several additional references that are not in the Literature Review of your proposal.
- Every time you get a new reference to read, repeat Step 2: Reading the Literature.

4. *Presentation*

- (a) As you continue to read, you will be generating more and more notes. At some point you must start writing the Literature Review. You should do this as soon as possible.
- (b) To organize the contents of your literature review, you should refer to the Outline of the Dissertation discussed in Section 5.5. At this point I am assuming you have this outline.
- (c) For each item, make a list of references that are related to that item. These references will be either ‘general’ or ‘specialized’. Recall:
 - **General references** (e.g., textbooks) can provide useful information on the research area (such as response surface methodology (RSM), survey sampling (SS), statistical quality control (SQC)) and on a more focused research area (such as optimal designs in RSM, adaptive cluster sampling is SS, accelerated testing in SQC).
 - General references, however, are not very useful or provide very little information on your research topic. For example, you will find very little, if any, information about space-filling designs in textbooks. That is why you need references that ‘specialize’ on that topic.
 - Some general references will be journal articles that are related to your research topic but have lower importance.
 - For example, suppose your research topic is in space-filling designs. One class of space-filling designs are the class of uniform designs. To demonstrate the relevance of uniform designs, you may cite several publications containing industrial applications of uniform designs. You do not, however, have to describe the studies in detail. You can make a general statement like:

Borkowski and Piepel (2008) presented an application of uniform designs for a 16-component nuclear waste-glass mixture design containing single and multiple component constraints.

This example provides evidence of the relevance of space-filling designs in industry. It also shows that you are familiar with current research, and not just textbook summaries.

- You must realize that most textbooks only contain statistical information that is (at best) several years old. Therefore, it is necessary to find current published literature.
 - After you have collected the information from general texts, you must now provide detailed information that focuses on your research topic and research problem. This information will come from the **specialized references**.
 - The specialized references enable you to show that a gap exists in the statistical literature and that your research will fill the gap.
- Note: Referencing a publication in the literature review does not mean you will not mention it again later in your dissertation. You should expect to mention some references in the Discussion chapter because you want to relate your results to those specialized references and show that you actually filled the gap in the literature that you proposed.

6.3 Finding research materials

- Libraries provide guidance on accessing information from a large number of sources. Typically, the library at your university includes internet searching and access of databases for finding published statistical literature.
- I also recommend spending some time browsing (searching) the shelves in the library. After you have located a book in your preliminary list of references, look at the neighboring books on the shelf. You may find another good general reference.
- For example, you find Cochran's *Sampling Techniques* in the library. You may find other good sampling references around this book.
- Not every reference can be downloaded from the internet, and not every reference will be found in the Library at your university.
- Even though most of your references should be available to download from the internet through your library, there will be references (such as conference proceeding, articles from journals that no longer exist, articles published in languages other than English, technical reports) that you cannot get immediately.
- These references may require you to request an interlibrary loan or to contact the primary author using email.
- Not only will you produce a high-quality dissertation, you will also learn skills on how to access information that you will be able use in future research projects.