Chapter 16

Writing the conclusion

> (I)n order to refute a conclusion, you have to put forth the best possible argument for it
>
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> *Plato at the Googleplex: Why Philosophy Won't Go Away, 2014*

The *Conclusion (*or *Conclusions)* is the last major section of your report or thesis. This section is sometimes called *Discussion, Discussion and Conclusion(s)*, or *Summary and Conclusions*. Instead of writing a *Conclusion* section, some researchers incorporate it into the *Results and Discussion* section in journal papers (Bunton, 2005, p. 212). Whether you use the term *Conclusion* or another term is really a matter of individual preference and style. Whichever term is used for this final section or chapter, the writing conventions reflect common features.

The general function of the *Conclusion* is to bring closure to the research questions stated in the *Introduction*. In the *Conclusion* the writer essentially contrasts pre-contribution with post-contribution so that 'what was unproven, unverified, unexplained, unknown, partial or limited is now proven, verified, explained, known, complete or general' (Lebrun, 2007, p. 199).

FUNCTIONS OF A CONCLUSION SECTION

The *Conclusion* section typically performs the following functions (Bunton, 2005, p. 213):

1. To remind the reader of the aims of your study (e.g. research questions/hypotheses) and key methodological features of your study
2. To summarise the most important findings and conclusions of your study
3. To evaluate the importance and significance of your study with commentary on its contribution to the development of theory and research

4. To point out the practical applications of your findings
5. To point out any limitations (if any) of your study
6. To recommend areas for further research

COMPONENTS OF THE CONCLUSION SECTION

Weisberg and Buker (1990) has pointed out that the *Conclusion* section in research reports typically has four basic components, shown in Table 16.1. They perform the functions of the *Conclusion* section identified earlier in the chapter.

ILLUSTRATION OF A CONCLUSION SECTION IN A RESEARCH PAPER

Writing Guidelines 16.1 illustrates how the components are reflected in a research paper. The language features used to perform the various functions are highlighted.

LANGUAGE FEATURES OF THE CONCLUSION

In this part of the chapter, we examine the language conventions used to present the information in the different components of the *Conclusion*. The language features discussed here are verb tenses and modal verbs.

Table 16.1 Components of *Conclusion*

Components	*Steps*
1. Restatement of aims and methodological approach of study	A. Restate aims of study (research questions/hypotheses) B. Restate key features of research methodology & methods
2. Summary of findings/conclusions	A. Review key findings B. Explain or compare
3. Evaluation of study's contribution	A. Point out significance of findings (for theory & research development and for practical applications) B. Point out practical applications of your study C. Identify limitations (if any)
4. Recommendations for future research	A. Recommend areas for further research

Writing Guidelines 16.1 Content analysis of a sample *Conclusion*

Component 1: Restatement of aims	A. Restate research aim/focus	*In this study*, the use of photogrammetry to measure volume change of a triaxial specimen was evaluated.
Component 2: Summary of findings	A. Summarises key findings	*Key findings* from the current study include the need for (1) redundancy of images (to ensure greater overlap of the images), (2) texturing of rubber membrane (to ensure better 'stitching' of the images), (3) high camera resolution (to obtain better image quality), (4) allowance for operator's error (in obtaining the images), and (5) allowance for compliance error of the digital pressure volume controller.
Component 3: Evaluation of study's contribution	A. Indicate significance of study (for research development)	An *innovative set-up* was designed to allow the camera to rotate and take all-around photos of the specimen at a constant height and distance. The applicability of this technique was investigated through two separate consolidation tests on kaolin and Changi sand. By comparing the image processing results to DPVC readings, a quantitative evaluation was generated.
	B. Point out practical applications & make recommendations	The *applicability of this technique to measure volume change* was investigated through two separate consolidation tests on kaolin and Changi sand and comparing the volume estimation of image processing results with the DPVC readings. The comparison shows that photogrammetry *can be employed for unsaturated triaxial soil tests if the volume change is greater than +/−100 mm³*. This translates to volumetric strains greater than +/−0.12, 0.05%, 0.02% and 0.01% for specimens of diameter 38, 50, 70 and 100 mm, respectively, and height to diameter ratio of 2.
	C. Identify limitations of study	However, several aspects with regard to the existing study and set-up *could be further improved* such as the use of soft, homogenous lighting as well as professional-grade cameras. Non-isotropic consolidation and loading on a soil specimen could be examined. Automation of both the rotation and image capturing process by the camera could be developed to reduce operator's error and increase efficiency in positioning of the camera.
Component 4: Recommendation for future research	A. Recommend area for further research	Compliance of the DPVC *should be further investigated* as it showed a very different volume change at low volume (and low pressure).

Source: Lim, B. J. M., & Leong, E. C. *Unsaturated Soils: Research & Applications, 2014.*

Verb tenses

As Weisberg and Buker (1990) observed, verb tenses in the *Conclusion* vary depending on the type of information being presented (p. 170). The verb tense most commonly used in the first two components when referring to purpose, hypothesis and findings is the *simple past tense*. In the third component when commenting on the significance and limitations of the study, the simple present tense is usually used. When indicating areas for future research in the final component, the simple present tense and modal verbs are normally used (see Table 16.2).

Modal verbs

This section deals with a complex language area which is important in the *Conclusion* (and also the *Results and Discussion*) section: modal verbs. Glasman-Deal (2010, pp. 150–166) identified modal verbs that are commonly used in scientific and technical writing and listed as most common are *may, might, could, can, should, ought to, need to* and *must*.

Modal verbs are used to indicate the degree of certainty with which a statement is made or to modify the 'truth value' of a statement. Compare the two sentences below:

1. The drop in acceleration pressure *was* due to density change in the fluid.
2. The drop in acceleration pressure *may have been* due to density change in the fluid.

Table 16.2 Correspondence between verb tenses and functions

Function	*Verb tense*	*Example*
Restating aim *(Component 1A)*	Simple past	This research *attempted* to assess two methods for air purification.
Restating hypothesis *(Component 1A)*	Simple past	It *was* originally *assumed* that …
Summarise findings *(Component 2A)*	Simple past	It *was found* that … The test *showed* that …
Explain/compare findings *(Component 2B)*	Simple present	The results *are* consistent with … The findings *differ* from those of …
Evaluate study's contributions *(Component 3A & B)*	Simple present	This research *adds* to the body of knowledge … These findings *provide* evidence/*lend* support to the assumption that…
Identify limitations of study *(Component 3C)*	Simple present	The small sample size *is* a limitation of the research.
Recommend future research *(Component 4A)*	Simple present	The small sample size *is* an opportunity for future research.

There is no modal verb in sentence 1 as the writer is stating with *absolute certainty* that the drop in pressure was caused by the density change in the fluid. In sentence 2, however, the modal verb *may* indicates that the writer considers the density change in the fluid as a *possible* cause for the drop in pressure.

Modal verbs are commonly used when making recommendations for practical applications and for further research. In the excerpt below taken from a journal paper, design suggestions and recommendations are presented with the modal *should*.

> Architects, engineers, and landscape architects *should take into account* the safety of installers and future maintenance workers in the design of the built environment and rooftop vegetation. Green-building certification organisations *should use* these design suggestions and include the safe design of vegetated roofs as a precondition for credit allowance.
>
> Behm, M. (2010). Safe design suggestions for vegetated roofs. *Journal of advanced concrete technology* 8(2): 258.

DO'S AND DON'TS IN WRITING THE CONCLUSION SECTION

Table 16.3 identifies the common mistakes (the *Don'ts*) in writing the *Conclusion* section and how to avoid them (*the Do's*).

Table 16.3 Do's and don'ts of writing the *Conclusion*

Do's	*Don'ts*
Include only findings presented previously in the document.	Do not include new findings in this section.
Base each conclusion soundly on material/ evidence previously stated in the document.	Do not neglect to ensure that each conclusion is related to specific material presented previously.
Make specific statements.	Avoid vague and generalised statements.
Interpret results or observations.	Do not merely repeat findings from the *Results and Discussion* section without interpretation.
Be modest in stating the significance of your study.	Do not exaggerate the significance of your findings.
State the limitations of your research and recommend areas of future research.	Do not treat your research findings as the final word on the topic.
Make sure the contents in the *Introduction* match those in the *Conclusion*	Do not neglect to make sure that the *Introduction* and *Conclusion* are logically linked.

The *Conclusion* section of the report or thesis is mainly concerned with reporting and interpreting the results and conclusions of your study in relation to the objectives and scope stated in the *Introduction* section. As in the *Introduction*, researchers in the *Conclusion* section indicate where and how their work fits into the research 'map' of their field. As Weisberg and Buker (1990, p. 160) points out, in the *Conclusion* 'you step back and take a broad look at your findings and your study as a whole'.

Finally, remember to check that the contents of the *Conclusion* match those in the *Introduction*. The *Conclusion* should address the objectives and scope stated in the *Introduction*. Read the *Conclusion* and the *Introduction* together to check that there is no contradiction.

CHECKLIST FOR WRITING THE CONCLUSION

- ☐ Is the *Conclusion* chapter well structured?
- ☐ Is there a logical link between the *Introduction* and the *Conclusion* chapters?
- ☐ Have you stated your *most important* results?
- ☐ Have you given an interpretation of these results, rather than just restating them?
- ☐ Is each conclusion drawn based on evidence presented previously in the report?
- ☐ Have you pointed out the importance, significance, and contribution of your work?
- ☐ Have you indicated the limitations (if any) of your work?
- ☐ Have you avoided stating limitations of your work in negative language?
- ☐ Have you indicated areas for future research that are the logical extension of your work?
- ☐ If appropriate, have you included possible practical applications of your findings?

INTERESTING FACTS

After the *Abstract*, the *Introduction* and *Conclusion* are the most important chapters in a report or thesis. According to Brabazon (2010), short introductions indicate 'start of deeper problem' and short conclusions indicate that students are unable to grasp the significance of their research or that they are too tired to write a good conclusion.

The length of the *Conclusion* section depends on the length of the report or thesis. The length of reports and theses depends on a number of factors: field of research, research method, research topic and sometimes page limit

imposed by your institution. Marcus W. Beck plotted the length of master's theses and PhD dissertations from the University of Minnesota as shown in Figure 16.1. The master's thesis data are from 2009 to 2014 and contain 930 records. The PhD dissertation data are from 2006 to 2014 and contain 3,037 records. Figure 16.1 shows at the University of Minnesota, the typical lengths of master's theses and PhD dissertations range from 50 to 150 pages and from 50 to 350 pages, respectively. A reasonable guide on the length of the various sections of a report or thesis in comparison to the whole is: *Introduction* (10%–20%), *Literature Review* (10%–20%), *Materials and Methods* (10%–20%), *Results and Discussion* (20%–40%) and Conclusion (5%–10%). Using this guide, the conclusion for a 50-page report or thesis should be about 2–5 pages, for a 150-page report or thesis it should be about 7–15 pages and for a 350-page report or thesis it should be 17–35 pages.

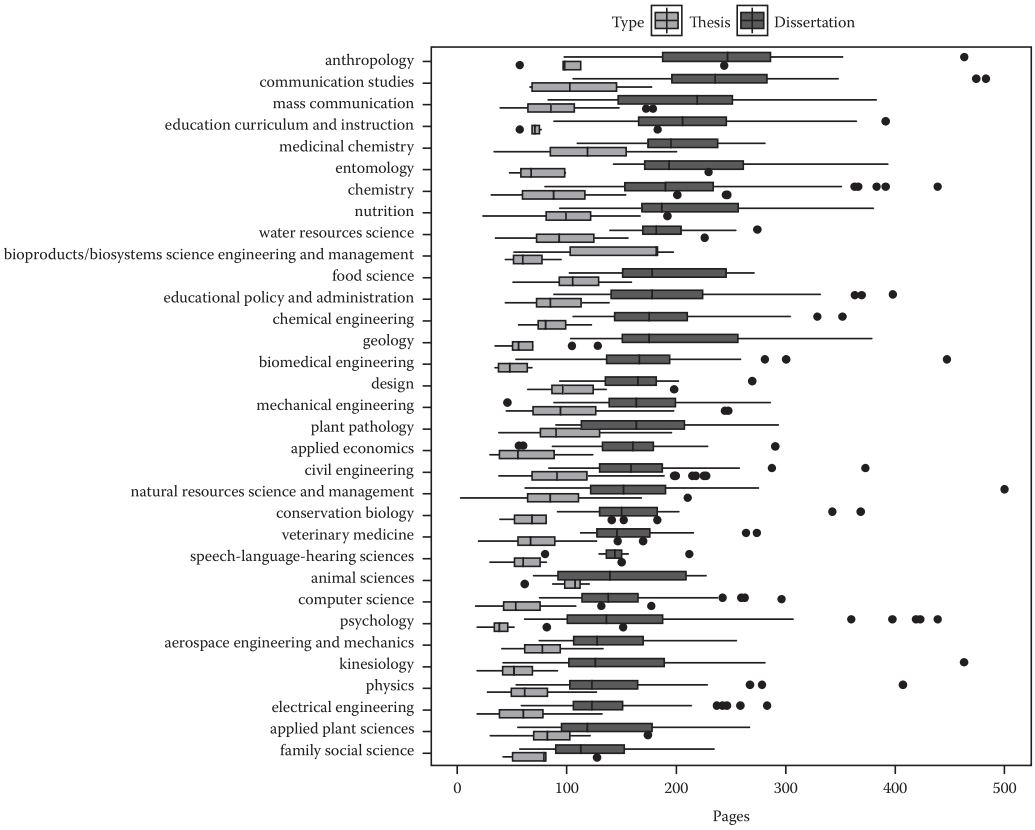

Figure 16.1 Comparison of dissertation and thesis page lengths for majors having both degree programs in the University of Minnesota database (boxes represent the median, 25th and 75th percentiles, the whiskers represent 1.5 times the interquartile range, and outliers are beyond the whiskers). (From https://beckmw.wordpress.com/2014/07/15/average-dissertation-and-thesislength-take-two/. Reproduced with permission from Marcus W. Beck.)

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