Writing a Postgraduate or Doctoral Thesis: A Step-by-Step Approach

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Abstract

A key characteristic looked after by postgraduate or doctoral students is how they communicate and defend their knowledge. Many candidates believe that there is insufficient instruction on constructing strong arguments. The thesis writing procedure must be meticulously followed to achieve outstanding results. It should be well organized, simple to read, and provide detailed explanations of the core research concepts. Each section in a thesis should be carefully written to make sure that it transitions logically from one to the next in a smooth way and is free of any unclear, cluttered, or redundant elements that make it difficult for the reader to understand what is being tried to convey. In this regard, students must acquire the information and skills to successfully create a strong and effective thesis. A step-by-step description of the thesis/dissertation writing process is provided in this chapter.

Keywords

Thesis · Dissertation · Postgraduate · Doctoral · Hypothesis · SMART objectives

48.1 Introduction

The foundation of the entire postgraduate or doctoral research program is disciplinary knowledge. At most universities, one of the main requirements is that the research introduces or expands a novelty that contributes to the advancement of the subject [1]. Even though the writing is a clear component of higher-level coursework and is frequently acknowledged as a source of significant concern for students, it is commonly undervalued. Gaining proficiency in academic writing is necessary for earning a Master or Doctor of Philosophy (Ph.D.) degree and improving the employability of Master or doctoral graduates, who must demonstrate this competency during their professional career. Universities, corporations, Non-government Organizations (NGOs), and government agencies demand efficient writing skills from research job candidates, making this talent increasingly crucial in the global job market. While research degree

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programs frequently emphasize subject-specific information, academic writing development is usually underestimated [2]. University's success is increasingly being measured by quality publications, which are also considered one of the requirements for 'academic promotion and funding competitions. Lack of journal publications reduces prospects for knowledge expansion. As a result, producing a strong thesis for doctorate candidates is essential that is good in writing, with structural format, original research, with proper analyses of data and interpretation.

The thesis should be an independent work written entirely by the research candidate, supported by the supervisor or guide in all aspects. It outlines a specific issue that the candidate has tackled, sometimes as part of a larger team and with the support and guidance of academic mentors. It motivates and describes the problem, identifies a clear gap for a potential novel academic contribution through critical analysis, evaluates existing solutions, and lays out a hypothesis, a suggested cause for the issue, or a proposed solution. The work done to choose the theory is also sufficiently explained and justified by the thesis [3]. An idea of the thesis must meet all Master or Ph.D. requirements, adhere to disciplinary standards and expectations, and exhibit advanced writing skills. It must demonstrate critical thinking and uphold a high level of formal literacy, having both accuracy and persistence. Writing for a doctoral degree thesis puts candidates through emotional endurance tests, prompts identity changes, and reassigns them to modern social and scholarly networks [1]. These factors make writing a thesis challenging and call for academic, interpersonal, and emotional guidance. It is also essential that the ability to explain ideas and analyse the data is more critical for a Ph. D. than the amount of writing a student can produce [4]. Through the various writing experiences obtained while pursuing the degree, the candidate will acquire knowledge on how to articulate their ideas, how to arrange their work so that readers of all types may connect with it, and how to develop the best layout so that it is evident to fit all the data together. They also learn what is proper, expected, and helpful in writing contexts. The list of writing abilities that can be applied outside of the academic environment is extensive and is a take-home learning gained through the Ph.D. degree. Time management is another significant point worth highlighting. The need for a routine and the willpower to follow it seems to be the first requirement for time management. The effectiveness of patterns and habits varies markedly from person to person. Without a schedule to finish the writing, imperatives like promises and deadlines may not be enough [5]. Thus, it becomes essential to set a timeline.

The students who seem to be writing frequently for journals or newsletters admit with disappointment that they remain engaged in the same chapter they worked on the week before. Many become overconfident about how soon they can complete specific aspects of their thesis. It appears that there is a connection between writing habits and time management, as well as an awareness of the scope of each writing assignment. Therefore, success in doctorate writing involves figuring out what works for each individual or adjusting to what one's life permits [1]. In this chapter, we will explain how to write a Ph.D. thesis, so that postgraduate or doctoral students can be appropriately guided.

48.2 Steps in Constructing and Structuring a Thesis

Ph.D. students are not likely to have produced numerous theses at the time of writing up; typically, they would have written one in a final undergraduate year and potentially another during post-graduation. However, the work is substantially longer in duration and covers a broader range of topics, necessitating greater attention to detail than any predoctoral studies/work. Most Universities demand that the entire dissertation or its component sections be "publishable" quality. This serves as the yardstick for choosing the information to be included in the thesis. Candidates should consider concepts of quality, credible and novel ideas for thesis writing and should consider the questions like; Are the stated experiments accurate? Is the data acceptable to

the scientific community? Would the entire framework hold up to peer review [3]? The most effective method for creating a strong thesis is likely to be thinking through writing. However, frequently the student cannot adequately explain the significance of the study's findings until the study is completed and the results are analysed and interpreted.

A thesis should be as specific and unambiguous as possible; it should not be just a list of questions and answers. Thus, it is always preferable to develop a thesis writing structure before beginning to write. When comparing the thesis with research papers, it is suggested that the main distinction between the two is the amount of meta-discourse used in the thesis. Since a thesis is a longer document than a research article, it is essential to include sections that inform the reader of what is to come and that make connections to other sections related to the topic the author is covering at that time [6]. A typical thesis comprises different chapters, Introduction, Literature Review, Material and Methods, Results, Discussion, Summary and Conclusion, each of which will be covered in more detail in the following sections. It is crucial to understand that a doctoral thesis is not constrained to any one chapter or part. Institutional standards and guidelines, supervisor and researcher preferences all play a role in determining how many chapters a thesis should include. Ideally, the thesis is organised primarily like a scientific research report, with discrete chapters for the introduction, methodology, results, and discussion; this is known as the IMRaD (Introduction—Method—Results—and—Discussion) model. The standard thesis often begins with an introductory chapter, a literature review, and a series of chapters that follow the IMRaD structure and concludes with a general summation chapter. While it is unsurprising that the IMRaD structure has managed to capture the interest of researchers because it is a frequently used format, many researchers have recently emphasised the attention towards alternative writing styles, particularly to research that uses a qualitative approach [6].

The main accomplishment of the candidate is to strike a balance between their points of view and the standards of their discipline. The goal of this book chapter is to assist Ph.D. students in having a visualisation of what and how the thesis should look like, as well as to provide ways of defining common frameworks. The use of frameworks like IMRaD indicates that the written work reflects authentic research contextualised inside the discussion and that the epistemology is based on legitimate methodologies. Students can use IMRaD as a checklist to identify the sections of their thesis that require development and to make sure that the anticipated aims and objectives are clearly visible. Although the initial structure plans are frequently not final, the basic framework of IMRaD remains the same. Students may need to rearrange their strategy as they gradually get a better understanding of their subject. Still, they must be careful to avoid concluding that doctoral writing is a compromised negotiation [1]. Editing the thesis and thoroughly checking for grammatical and typographical errors come as the final steps. In the following sections, a detailed step-by-step explanation is given on writing the different chapters in a doctoral thesis.

48.2.1 Thesis Introduction Chapter

The introduction is the action of introducing something or initiating by presenting the essential details before in-depth discussion, writing, and delving into it. It is an elementary act, part, or portion which would be in use of every spare of our routine life and also in scientific research, such as thesis and paper writing of various types of Graduate, Postgraduate, M.Phil, and Ph.D. It is a fundamental and unseparated part of any kind of thesis. An introduction starts with a statement grabbing the interest and curiosity of the readers. It introduces the central problem and highlights the importance of the investigation. It specifies the research question along with the approach that will be taken to address it. Citing verified evidence emphasises how serious the research issue is [7]. In the introductory part, "Create a Research Space" (CaRS) strategy proposed by Swales is frequently used to explain the presence of an

introductory section. It focuses on three characteristics or general strategies that should be presented in the introduction: (1) why it matters, (2) identifying a research topic's gap, and (3) outlining the uniqueness it will bring. These techniques are excellent for seizing readers' attention and highlighting the significance of the research [1].

This is a highly important chapter in the thesis equally as methodology, results and discussion, etc., mainly because of its position placed in the thesis. This has been always named Introduction chapter presented at the beginning. Since it comes in as Chap. 1, author must present the research topic in a diligent manner which should create interest in the reader. The author should provide clarity on the topic and the elements associated with it by defining it, describing the elements and their interaction, relationship, and differences. The systematic organization of background or summary of the existing research in the respective field must be presented. This chapter is also the place where the author has to provide a detailed account of the specific research problem, problem statement, hypothesis, objectives, scientific rationale, and clarify his or her position on the topic and the approach. Finally, the overview of the thesis and related aspects would be accommodated here. For the sake of easy understanding and the widely accepted structure, Chap. 1 of the thesis could be taken as a funnel or inverse triangle. It begins with a broad and general subject related to the research topic or title of the thesis, then narrows down to research questions, hypothesis, objectives, variables and the problems that are going to be solved in the research (see Chap. 1). It can also be said as the travel from divergent to convergent or details to micro details.

In simple terms, the author must explain what exactly a reader is going to read about the research topic, its importance, relevance, how it is going to contribute to society's welfare, and what are the policy implications.

The general structure of the introduction chapter is shown below (Box 48.1).

Box 48.1 The general structure of the introduction chapter is as follows, but not limited to:

- Introduction to the Problem
- Statement of the Problem
- Review of Literature
- Research Gap
- Purpose of the Study
- Research Questions
- Research Hypothesis
- Objectives of the Study
- The Significance/Rationale of the Study
- Definition of the Keywords (respective topic)
- Limitations and Delimitations

48.2.1.1 Introduction to the Problem

The author must establish his/her research territory by defining, explaining and describing the topic chosen for the study or research. It must provide a wider and clearer understanding of the topic to the reader and must be presented from a broader to the specific of the research. Broader may be in terms of geography, population, etc., to specific means to the specified population of geography. This is not the summary of the thesis or a brief version of each chapter. It is a place for introducing the research and its topic and the thesis. The statements, quotes, or definitions from other authors can be placed in the section, which will provide the stronghold, understanding, importance, and relevance of the study topic.

48.2.1.2 Statement of the Problem

The statement of the problem is the central or focal point of the whole research or the thesis because everything further in the thesis goes around this and tries to address issues of multiple concerns and features. A statement of the problem is highly specific to the study usually written in six to eight paragraphs with a strong aim for each one. This section can be identified and written

with Topic, Gap, evidence, Deficiencies, and Audiences:

- Topic: need to state the specific problem both from theoretical and practical points of view.
- Gap: Clearly mention that of not solving or not attempting this specific problem in previous research works.
- The evidence: must be written that the researchers indicate the problem prevails by referring to the earlier studies.
- Deficiencies: must be demonstrated how you as an author solved the problem and how the identified gap was filled.
- Audience: whom your study is directed to, and where it would be useful.

Note:

- There is no need of providing resources or references for every single statement made here except for the evidence section.
- The mention of a research gap in two places; the introduction and statement of the problem must not be confused. In the introduction section, it is a border gap but in the statement of the problem, it is a specific one where the author needs to clearly define and provide details.

48.2.1.3 Review of Literature

The process of reviewing literature will help the author to understand the various aspects of the research topic including what, where, how and among whom the studies were conducted. This will give an idea of methodological applications, study implications and an overview of the respective research area. At the same time, this process will provide opportunities to identify the research density (overworked) and the gaps, which further leads the researcher to consider those aspects of the research.

48.2.1.4 Research Gap (Niche)

The author must clearly state the research gaps identified from the literature review and cite pertinent references. Here one must include methodological gaps, research topic gaps, theoretical gaps, etc., which in turn help in constructing a strong background to conduct research.

48.2.1.5 Purpose of the Study

Indicate what you want to learn, what you try to find, and what you want to reveal from this research.

48.2.1.6 Research Questions

One of the key components of a thesis is the research question. It concentrates on the study, governs the approach, directs all of the phases of research and analysis, and then provides the solution to the problem. The research question needs to elaborate on and reflects a greater comprehension of the subject. As a researcher, demonstrate how the study will bridge a gap in the knowledge base. A Ph.D. thesis should concentrate on issues such as: (1) What, Where, and (2) Why is the subject important? (3) What is the issue and how can it be resolved? (4) If the problem is not resolved, will it continue to exist? (5) Who is negatively impacted by the problem? (6) Does this problem support or refute previously held beliefs? An effort should be made in the thesis (in the discussion section) to answer all such questions [7].

In a research question, you specify precisely what you want to learn from your work. Your research paper, dissertation, or thesis should be guided by a well-chosen research question. All research questions ought to be focused on a single problem or issue that can be researched using primary and secondary sources and can be answered within the time frame and practical constraints. Specific enough to answer in-depth and complex enough to develop the answer over the course of a paper or thesis. Relevant to your field of study and society as a whole.

48.2.1.7 Research Hypothesis

An unconfirmed theory is called a hypothesis. It makes it possible to estimate or forecast an outcome or relationship under particular circumstances. To evaluate its validity and dependability, it must undergo thorough testing after which, if proven, it turns into a scientific theory. A hypothesis does not have to be a component of a study; it merely aids the researcher in seeing the issue more clearly. The hypothesis is a

declaration and an educated guess that the student is not sure of and should be validated to see if it confirms the claim being made in the research or not. Therefore, the candidate should emphasise the proposed hypothesis and how it relates to the thesis topic [7].

The author must respond to the research questions posed in the preceding part of this section. For example, if one of the questions is "Is there any statistically significant relationship between parents' educational status and children's nutritional status in India?" then the hypothesis would be "There is no statistically significant relationship between children's nutritional status in India and their parents' educational status." Use only null hypotheses. It is a type of statistical hypothesis that makes the case that a given set of observations does not have any statistical significance.

48.2.1.8 Objectives

The objectives force us to be precise about methods and to define key terms of the research protocol/proposal. The objectives will specify what scientific questions the study is designed to answer. It is developed logically from the topic, research questions, and hypothesis. The statement of objectives is essential for selecting the factors to be investigated, the response variables to be measured, the data needed to describe the effects of the factors, and the kind of statistical analysis required. Thus, when the study is completed, the results will be compared to the objectives and research questions. Unless the objectives are defined, the project cannot be initiated. The thesis should compare the results to the objectives specified in the beginning.

The objectives should cover the entire breadth of the project. Take into consideration-contributing factors, and variables (drug treatment). Arrange them in a logical sequence. Group the objectives: they are sometimes organized into hierarchies: primary, secondary, and exploratory. Or General and specific. For additional details, see Chaps. 1 and 4.

48.2.1.9 Significance/Rationale of the Study

The author is expected to provide details in this section on how his or her research has a large impact on other studies, the area of study as a whole, and some other key individuals or the specific population. You can achieve this by asking yourself how and why this study would be essential. In the conclusion chapter of the theses, researchers frequently discuss any gaps in the literature that they discovered while conducting their research. They can serve as evidence of the importance of your research.

48.2.1.10 Definition of the Keywords

The author has to define the discipline specific keywords theoretically and operationally. The keywords are nothing but the different variables of the thesis. The theoretical definitions come from earlier publications in the respective area of research, where the author has to quote and cite definitions. This is also a process of placing the study in the research area. Then the task is to define the selected keywords, and what they mean in the present study. This can be called an operational or empirical definition. The whole study will be abiding by the operational definition, its meaning, and scope.

48.2.1.11 Limitation and Delimitation

Although they appear to be synonymous, limitation and delimitation are not. Particularly in research, their meanings, scope, and effects differ. They are essential components of any study that spans time. Some members of the scientific community have the incorrect idea that they would like to conceal it or not document it, which is an unacceptable practice. They are not as bad as people think they are. They are essential to record not only to demonstrate the study's shortcomings, but also to demonstrate the research's clear understanding, methodology, focus, and scope. The study's deficiencies are primarily the result of external factors or factors beyond the researcher's control. They could be the researcher's theoretical

and practical constraints. Delimitation is a factor that is entirely within the researcher's control and is used to define or focus on a specific research problem or incident. It mostly talks about the research question and the scope of the research aim.

The author is obligated to document all factors beyond their control, such as the duration of the study, access to funding, equipment, participants, and so on under the limitation section and the consideration of the limitations with a clear comprehension of the study's requirements as outlined in the delimitation section.

48.2.2 Literature Review

All literature cannot be covered in the introduction chapter. Usually, a separate chapter with a detailed literature search on the problem statement, and existing literature related to the proposed work and methodology will be included. The students become more familiar with the ideas and works of others through the literature review process. It is, therefore, imperative to read relevant literature from reliable sources as much as possible. It is a segment that is present in a Ph.D. programme from the start to the finish, and thus it becomes vital to compile literature and information as and when it is gathered from the standard databases. Furthermore, it is crucial to understand that every claim will have a counterargument. Therefore, preparing for it will aid in effectively shaping the thesis. The next point that ought to cross the student's mind is HOW am I going to approach my study so that I can find a solution? It is important to consider WHY you want to conduct the study. What is the theoretical foundation of the research problem's investigation? To conduct the study scientifically, students must establish a research or experimental design [8]. If the student wants to use any figures and tables in the literature section of their thesis, permission from the publisher is required.

48.2.3 Aims and Objectives

The literature review is followed by defining the problem statement and arriving at the objective (s) of the study. The possible solutions for the unanswered questions are to be discussed to derive a hypothesis.

One of the most crucial components of the thesis is how the research aim and objectives are developed. This is so because the purpose and goals of the research dictate its depth and scope [9]. The goals would then be focused on how to accomplish the proposed study's goals [10]. Aims are declarations of intention. They are typically expressed in broad terms. They outline the results you anticipate getting from the endeavour. Contrarily, objectives should be clear statements that outline measurable consequences, such as the procedures that will be followed to bring about the intended result.

Aims and objectives usually describe the main focus of any research project. Basically, objectives are the action that the researcher will undertake to achieve the specified aspect of the research or project. In other words; the outcome researcher wants to achieve by conducting research is called the research objective. Objectives are the guiding force for any research or project. There may be multiple objectives in a research or project. The author must write clearly and specifically what the study answer or give the solution for a problem as an aim of the study and the specific mention how those answers or solutions were achieved as objectives. It means breaking up the most important ideas or aspects of your research aim into several smaller parts that together represent the whole.

Objectives may be designed based on the SMART approach; Specific, Measurable, Achievable, Realistic, Time constrained [11].

- Specific: Does the action you plan to take have any ambiguity, or is it focused and clear?
- Measurable: How will you track your progress and determine when the action has been completed?

- Achievable: do you have the help, assets and offices expected to do the activity?
- Relevant: Is the action crucial to achieving your research objective?
- Time-bound: Are you able to finish the action in the time you have available while still working on other research projects?

It is also a best practice of using verbs at the beginning of the objective writing that help convey your intent, in addition to following SMART. For example;

- In the case of Understanding and organising information verbs can be used Review, Identify, Explore, Discover, Discuss, Summarise, and Describe.
- In the case of solving problems using information verbs can be used Interpret, Apply, Demonstrate, Establish, Determine, Estimate, Calculate and Relate.
- Reaching conclusion from evidence verbs can be used Analyse, Compare, Inspect, Examine, Verify, Select, Test, Arrange.

48.2.4 Materials and Methods

The methodology is the most crucial part of the research design. Knowing the difference between methodology and method is important for researchers. While method relates to the systematic organisation and measurement of your research, methodology describes the theoretical interpretation of the research. The approaches used for various studies vary depending on the subject [8].

The methods used for data collection and analysis must be discussed and explained in your research methodology in the past tense. The methodology chapter or section is an essential component of your thesis, dissertation, or research paper. It explains what you did and how you did it, allowing readers to assess the reliability and validity of your research and the topic of your dissertation. This provides the opportunity for sharing how you directed your examination and why you picked the tools, methods, and techniques you picked. It is also where you should demonstrate that your research was rigorously carried out and that it can be replicated.

In experimental research, chemicals, equipment, biosamples, and other materials are used as materials and methods. You describe the study in detail in this section. If it's a plant or animal, include its scientific name. For a better understanding, you can look at previous theses or publications that are closely related to your research. The following are some examples: Specify the location from where the chemicals/samples were purchased, obtained, or harvested. Include information about the age, sex, group size, treatment and control groups. For reproducibility, this information will provide precise recommendations. Chemicals require information such as brand and manufacturing location, food or chemical/analytical grade, the molarity of chemicals concentration and enzyme activity.

48.2.5 Results

It is always beneficial, to begin with, a brief abstract-style introduction outlining the goals of the chapter. A brief description would enable the reader in recalling the research topic, questions, and hypothesis so they could comprehend the findings more fully while reading this chapter. Write a summary paragraph that is comparable to the introduction at the end of the Results chapter [8]. Theoretically, everything must have been planned out from the beginning, but in practice, things may not have turned out as intended, and a student may need to embellish their work with a narrative [3].

The output of the experiments is to be disseminated to the reader with good clarity. Three to four years of efforts of the candidates can be recognized by the way of representing the results obtained in the experiments. Compiling the results after completing the entire duration of Ph.D., will be a tedious task and it may not be ideal. Candidate should be capable of analysing the experimental results as and when performed

and data collected. At the same time, the data is to be processed and interpreted and documented in written format. This will assist and show the way for the next experiments. The flow of writing the results may vary with the disciplines. However, the results should follow the methods mentioned in the previous section, ideally with the same titles and subtitles. This will help the reader to follow the stepwise process and link to the previous experiments. A systematic way of representing data is the beauty of writing skills.

The data presented should be clear, precise and concise. Usually while writing the results, a question may arise about whether or not to include negative results. The positive results are those which are in agreement with the hypothesis. If the results are not as per the hypothesis, then it may require further study. After reperforming the experiment, if the results are not good or relevant, they can be considered negative results. It is always preferred to include the negative results. This may be of marginal interest, however, it may help future scientists, so that such experiments need not be repeated by others. Hence always mention the limitations of the experiments in the Results and Discussion sections.

The results that can not be adequately presented in text form, can be represented either in table or graphics (figure) form. The tables are used to represent numerical data, and figures are used for comparing the meaningful relationships between the groups or to study the trend. Figures are easy to understand and convey the message quickly. It is always better to avoid duplicating the results in tables and figures. Sometimes, due to unavoidable reasons, tables and figures may be required, especially when qualitative and quantitative/numerical comparison is involved in the results (for example, see Chap. 45). While representing the values in a table, restrict it to two decimal points and maintain uniformity throughout. The tables and figures must be simple and self-explanatory. Figures may be a line graph, scattered plot, bar chart, histogram or pie chart (see Chaps. 29 and 44). Special emphasis is to be given to the table title, subtitles, units, figure axis titles and magnification. Also, the abbreviations used in tables and figures are to be defined. User friendly colour codes are to be used in the figures. More importantly, cite the tables and figures at appropriate text locations.

The statistical comparison of all the results (see Chaps. 29 and 30) is a must to include in a thesis. The number of repeated trials, statistical terminologies (mean, standard deviation, standard error of the mean, measure of variability, p value, F-value), symbols, colour codes if any, are to be given as footnotes in the table and the figure legends.

48.2.6 Discussion

Writing the discussion in a thesis is a very crucial and difficult part. The discussion section is the most significant part of the thesis. The thesis's central argument and the culmination of results can be found here. Here the student will discuss why the issue raised is important, what people have done to address it, where opportunities exist, and what novelty was chosen about contributing to this area. Here candidates will discuss their ideas, criticisms, comprehension, experimental strategy, data analysis and summary, visualisations, insights, and conclusions.

The discussion of the results includes the explanation for the practical experimentations or interpretations of the results, such as their usefulness and relevance to the current situation. The results are linked to the hypothesis. The discussion should address whether the results are fully or partially related to the hypothesis. Do not repeat the results, instead highlight the significant aspects. The discussion part should give information on the findings of the experiments and the reason for those results with supporting literature if any. Why the results are important and how

they may affect the outcome of the research, is there any added value for the existing knowledge to be discussed? The scientific basis/evidence from the experiment is to be provided while discussing every aspect of the results. If there is no supporting literature, it should be clarified that the results obtained are unique and/or different from the existing ones.

It is very important to maintain research integrity while discussing the thoughts on the results. If the results are not according to the existing literature, in spite of repeated experiments, the researcher should have the courage to write the rebuttals to the literature in the thesis. Sometimes the published literature might not have been done under proper experimental conditions or authors might have missed the step(s) in the methodology section. Rebuttals will help to correct such errors. Occasionally, some of the candidates may tend to do falsification of data if the results are not according to the literature. Such kind of misconduct is an unethical practice and may ruin the future of the candidate (see Chaps. 58 and 59). Instead, write the limitations of the experiments and the possible reasons for obtaining different results [10]. Publishing the research work in the journals before thesis submission will also help in writing a good discussion for the thesis. The reviewers comments will help to improve the quality of the representing the results.

Statistical differentiation of data and discussion will enhance the confidence level of the thesis presentation. Further, the inclusion of scope for future studies or suggestions to improve the results will also encourage to take the study forward and corrections to be made in the method/procedure followed [12]. Future perspectives can also be a part of the conclusion of the study.

48.2.7 Summary and Conclusions

Writing the introduction and the conclusion sections is equally difficult. One significant distinction, though, is that in the conclusion chapter, questions raised in the introduction are addressed. Even if the "Conclusions" requires a paragraph that may describe the entire argument, it is crucial to keep in mind that it is not a synopsis of the Introduction. It could be helpful to quickly recapitulate the study questions and hypotheses in the conclusion chapter to connect them to the discussion of the results. In order for the scientific community to accept and acknowledge the thesis' contribution, the Conclusion part, like the other chapters, should be written in a scientific style. Instead of discussing the limitations, it is preferable to emphasise that the thesis has a valid and measurable result [8].

The conclusion section should also summarize the entire research including the problem statement, methodology, results and discussion in a concise manner. The conclusion should indicate whether objectives are fulfilled and the hypothesis is confirmed or refuted. Only the important research findings are mentioned without repeating the sentences. How the results are encouraging for the clinical settings is to be discussed. The conclusion should also include the future directions of the study. As readers usually prefer to see the abstract and conclusion, the outcome of the study must be conveyed in such a way that readers agree with the researcher's views.

48.2.8 Referencing Section in the Thesis

Studies in science are motivated by earlier work. Therefore, no one can claim that their research was carried out independently, without referencing the work of other scholars. The information sources that were used by researchers must be listed under the References chapter. They are the key components of research as they link various information sources and help the readers spot knowledge gaps and deepen their understanding of a particular subject. They also help in verifying the originality of the arguments presented in the thesis. As a result, every researcher needs to cite sources to support their findings [13].

Any research in the modern era begins with the earlier work, or there will be some reading material for their hypothesis, and they are called

references for the work [14]. The references can be anything that is referred to obtain the data for the thesis work. The primary source of references are journals or periodicals and sometimes books. Books are said to be a lesser priority as the change in knowledge is higher in journals and magazines than in textbooks. However, in recent days, the references can be a diary or a lab notebook of a scientist, photographs, figures, diagrams, or even videos. Every statement which brings forward the point of discussion should preferably have a reference. In the research communications, except the abstract, results (there could be an exception) and the conclusion will have references as they originated from the thesis work. Depending on the design of the thesis outline, generally, the references will be at the end. However, some universities accept the references chapter-wise. The chapter-wise referencing will make the references repeat and end up in extra pages in the thesis. Traditionally, the references come under the side heading of the bibliography. However, in recent days the most acceptable side-heading is 'References'. Whatever the outline format of a thesis, the critical aspect is citing those references in the right place, and keeping the references at the end of the thesis is challenging. Hence, the method of citing plays an essential role in being learned and interpreted before starting the thesis. There are several standards referencing styles to cite the works. However, it is ideal to follow the referencing style suggested by the respective Universities where the Ph.D. work is being done.

Citing references in research communication plays an important role. It validates the idea of the argument in the hypothesis, enables the readers or future researchers to follow the original work, provides credit to the original author or scientist, or inventor, avoids plagiarism to a certain extent, keep-up the academic honesty and the research integrity, and it proves the extent of reading and interpretation that has happened over time [15].

There are multiple ways of citing references in the text and the bibliography. For details, readers should read Chap. 39. There are many referencing styles, such as the Modern Language Association (MLA), the American Psychological Association (APA), the Chicago Manual of Style (CMS), the Vancouver system, the Harvard system, the American Medical Association (AMA) Style, the American Chemical Society (ACS) Style, the American Institute of Physics (AIP) Style, the American Political Science Association (APSA) Style, the Institute of Electrical and Electronics Engineers (IEEE) Style, the Turabian style, the Modern Humanities Research Association (MHRA) style, Oxford system, etc. [16]. The most common one is Vancouver and Harvard referencing method in biomedical sciences. However, American Psychological Association (APA) format is also followed in many instances. Both Harvard and Vancouver reference styles are parenthetical referencing in which the references in the text are inserted using parenthesis or brackets. The Harvard system is also called 'Author–Date system', the text citation uses using sir name followed by the year, and in the bibliography, references are sorted alphabetically and then chronologically. The Vancouver system uses numbers for citation in the text, and the references are sorted numerically in the bibliography [15].

To simplify the citing to reduce the ambiguities, a large group of publishers and societies came forward and introduced Digital Object Identifier (DoI) with the ISO standard (ISO 26324) by forming International DOI Foundation (IDF) (https://www.doi.org/) [17, 18]. The DoI connects digitally to the article of origin. Hence, DoI will play the most important role in the future referencing system. Before we understand the important components to be cited in the reference, we need to understand the fundamental need for references in the thesis or any research communication. To know the basic objectives of referencing one needs to know the different components to be cited in the references, following are a few important ones.

- Journal article: Authors name, the title of the article, year, volume, issue, page number/article number (for online journals), DoI (for digital archives).

- Textbook/book: Editors, book title, publisher, place and year of publication. DoI or ISBN (International Standard Book Number).
- Book-Chapter: Author names of the book chapter, followed by writing 'in' Title of the book, publisher, place and year of publication. DoI or ISBN (International Standard Book Number), page range.
- Websites/blogs/social media: Author name, year, page title. Available at: URL (Accessed: Day Month Year).
- Images/videos/ podcasts: Author/presenter name, year, title (video/podcast). Day/month/year. URL with accessed day month year.

Overall, managing references is the most crucial Herculean task. However, nowadays, computer tools make it easier. Hence, the researcher should have proper knowledge of these tools, and it is also essential to have the skills to manage them. Looking at the complexity of citing and managing references, scientists in informatics have developed electronic tools for managing references in the thesis and journal publications. These tools are highly versatile and convenient in modern-day science communication. Many such tools include EndNote, Mendeley, RefWorks, Zotero, and ReadCube [19–21]. Most Universities across the world used EndNote and Mendeley. EndNote is a product by Clarivate Analytics (formerly Thomson Reuters), currently a subscription-based product. However, EndNote is one of the best reference tools with high compatibility with almost all journals and publishers [22]. Currently, Mendeley is not just helping to manage references, but it also helps as social media for the researcher to share their findings or research updates.

48.3 Concluding remarks

Writing a thesis or dissertation is a scientific art, that involves the depiction of the research skills of a scholar. After performing detailed experiments for 1 to 3 years, it is extremely difficult to summarize the results in a crisp manner. It is obvious that the candidate might be struggling for the selection of required data to be included in the thesis. For a decision to be made, the candidate has to check the results against the objectives and hypotheses. Special attention must be paid to ethics as well. Most ethical issues have unique codes of conduct, such as how to handle human/animal or tissue samples or carry out clinical trials. If these regulations apply, they must be followed precisely within the thesis. Even without evidence of deceit, plagiarism can result in the revocation of a Ph.D. award years after it has been granted. Hence care must be taken while writing the thesis and including the reported literature. Special attention is to be given during the final checking of the thesis. The candidate should ask someone else to read the thesis who is not familiar with the current research problem, for readability and grammar check. Overall, the meticulous planning and execution of the research work may help in writing a good thesis.

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