Research Methodology
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Lecture - 61
Scientific Writing: PhD Thesis

In the last couple of classes we have learnt how to write a good paper, what are the techniques of writing a good paper, what are the sections and we have come to the conclusions.

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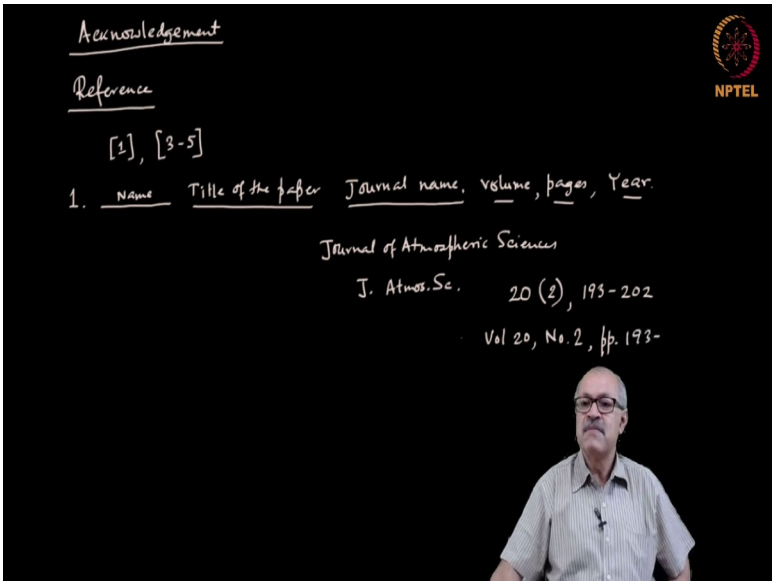

After the conclusions, normally we write the acknowledgement. It is a very important section, because anybody who has contributed in any way to the paper should not be left out. That includes anybody you have discussed with, whose discussion has in some way enriched your views that went into making this paper. That has to be properly acknowledged.

You may have had email communication with other scientists which helped in the work. You may have obtained a sample from somebody which may have helped. All these have to be duly acknowledged.

There are a couple of things that we sometimes forget. One is the funding agencies that, in some way or other, funded the project. If a project is funded by a funding agency and

the work is a result of a funded project, then we do acknowledge. We normally do not forget that.

But the fellowship of a student working on the particular problem – that is also a financial support for the particular paper. So, if a student has worked on a paper and he or she has been supported financially, his or her fellowship has been supported by the UGC or the CSIR or the Institute itself, then that has to be acknowledged. In the form that, if there are four authors, out of that one is supported by CSIR.

That person's name's abbreviation, say SB (abbreviation of my name), SB was supported by CSIR. So, that way we have to specifically acknowledge. If an instrument that has been used has been procured with a funding support from some funding agency, that has to be acknowledged.

If some technical staff has rendered a service that is more than the routine service that is to be acknowledged. Routine service means something for which he earns the salary. If he goes beyond that, something he does out of his own interest, builds a experimental apparatus, all that where some intellectual input went even from a technical staff, that has to be duly acknowledged.

But do not acknowledge the anonymous reviewers because they are anonymous. You have to mention the names of the persons who you are acknowledging.

So, that is the part of acknowledgement. Do not miss to acknowledge whoever provided your Junior Research Fellowship or the Senior Research Fellowship, whichever be the case.

After the acknowledgement comes the reference. References are cited as square bracket [1], [3–5] in the text. But, when you actually put the references, say 1, then you have to write first the name, then the title of the paper, then the journal name, then you have to state the volume, the pages and the year. These are the essential information that must go.

Now, different journals have different formats in which this information is put. For example, sometimes the names would be the surname comma the initial, sometimes the full name. The title of the paper is sometimes written just like that; sometimes it is within

inverted commas. In some formats the title of the paper is absent, for example, in the Physical Review format they do not put the title of the paper at all.

Sometimes the journals put the full journal names. Sometimes it is abbreviated. Journal name, for example, say Journal of Atmospheric Sciences. Sometimes you would have to abbreviate Journal as ‘J’. That is it. Then ‘Atmos Sc’. Just ‘Atm’ may not be right. So, some cases they prefer this kind of abbreviated journal names.

Sometimes the volume is written in bold face, sometimes not in bold face. Sometimes the issue in the volume, say, volume 20. In some cases volume 20 is sufficient because the page number is within the volume and if the page number is specified, then you can specify. In some cases you also put the issue number like this, and the page numbers are written as, say, something like this. In some journals you will find that this is written as volume.

In the IEEE format, you have to write page to page ‘193–202’. In some cases the volume is bold face, in some cases it is not, and so every journal has a format. You have to stick to that format. In some cases the year appears right after the title within bracket.

It becomes normally a bit troublesome if you have composed the paper for a journal and then you have to submit it to another journal. It is possible that you submitted to one journal; it was rejected and you are now trying to submit to another journal. Then you have to redo the whole work to recompose the reference section.

To avoid this unnecessary trouble, Latex has a solution. There we create a single ‘.bib’ file, a single dot bib file.

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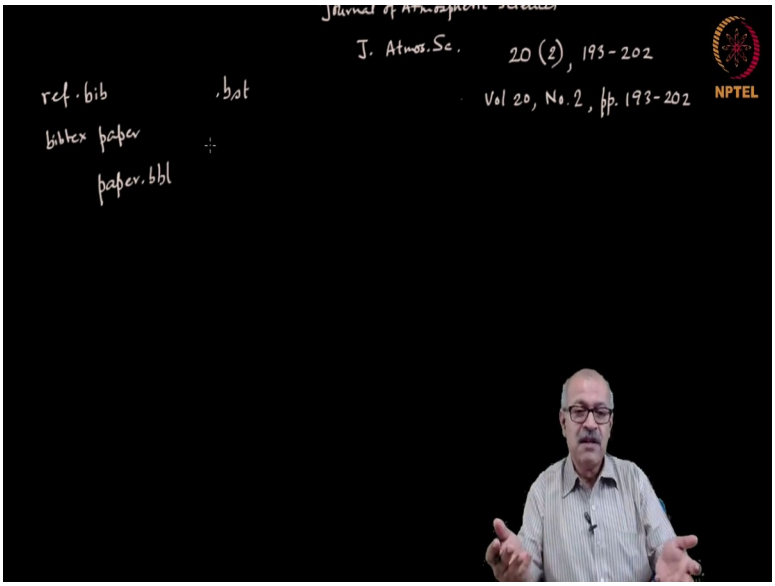

That contains all the information necessary in order to create an appropriate reference in a particular format. When the paper is composed, we run what is known as ‘bibtex’. This is a ref.bib file and then we run bibtex on the paper file.

If you do that then it produces the appropriate format for that particular journal. Every journal has a bibliography style file, ‘.bst’ file. You have to download that and then you have to declare that in the Latex file: this is the style that will have to be used. Then if you run bibtex on the paper, it automatically extracts that information from this file and put in a .bbl file.

If the paper name is paper.tex, then it will give the name paper.bbl and that file contains all the references in a particular format – the format that is recommended by that particular journal. And when the PDF file is produced, it will be automatically composed appropriately.

If you now have to submit it to another journal which uses a different format, all you need to do is to download the .bst file from that new journal’s website and just recompose it. It will automatically be composed that way. So, we no longer bother about this composing and recomposing depending on a journal’s specific requirement of the referencing.

This is about referencing. That is why we, at least the physicists, normally use Latex because that reduces a lot of unnecessary labor.

Whenever you have finished the first draft of the paper, then you have to ask yourself a few questions. For example, you have to ask: Have I included all the information necessary to convey my ideas? Have I eliminated all superfluous material? Because the paper has to be a condensed, filtered form of the material that you have, all superfluous material should be eliminated.

Have I given proper emphasis on the important ideas and subordinated those with relatively lesser importance? Because you cannot put everything at the same level of importance, so, deliberately you should choose what you should give importance to and what you should relatively subordinate.

Is the development of the subject matter complete and logical, so that there are no gaps and discontinuities? If you read the paper aloud, in many cases you can feel that there are gaps, there are discontinuities, certain jumps. Those need to be avoided. Have I been quantitative as far as possible in presenting the material? Because in science, you have to present things as quantitatively as possible.

Have I made the best use of the tables and figures? Are these very well designed they look good aesthetically pleasing, so that one has to worry about. Is the material I presented free from subjective judgment or preconceptions? If that has happened, then it has to be immediately plugged, because that is one of the prime reasons of rejection of papers.

Are the information provided sufficient for anybody to repeat the work, i.e., repeat the experiments or repeat the simulation? That means, have I provided all the information necessary? Have I provided all the parameter values and things like that? Are the facts I have presented adequate and sufficient to reach the conclusion that I have reached?

These are the questions you should ask yourself. And accordingly you should revisit. Normally I revisit and revise papers at least 10 times before I finally shoot it off to a journal, because that much revision and filtering is necessary in order to produce a finished product.

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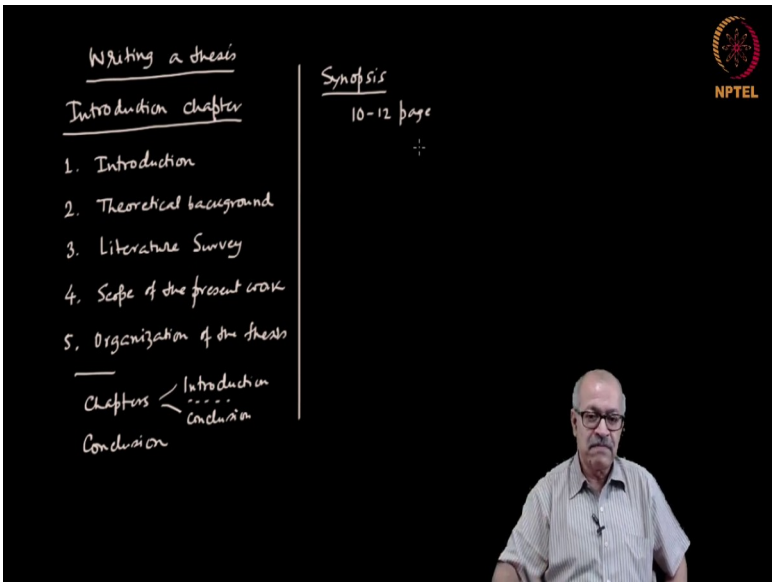

Now, after we have learned how to write a paper, let us come to writing a thesis. This can be master's thesis as well as PhD thesis.

Now, the style of writing a paper and the style of writing a thesis: the content, how to organize it – these are not very different. For example, a paper has the abstract, introduction, the sections, the conclusion, the acknowledgement, the references. It is the same in case of a thesis.

The only major difference is that, in a paper you are space constrained. It is limited by a number of pages. The shorter the paper, the larger the number of people who will read it. People do not want to read long papers. So, one has to be as brief as possible.

If I have produced a mass of data, we filter that out and we only present that much information, which is necessary in order to make my point. I am not talking about deliberate dropping of data points. I am saying that if you have repeated the experiment a large number of times or you have done for very many different parameter values, you might choose the parameter values for which you have a story to tell.

What I am trying to say is that, often we do much more work than we ultimately put in a paper. Now, a thesis is not constraint that way by the number of pages. So, there you might put as much information that you have generated, which might, in some way, contribute to the point that you are making. So, a larger amount of material can be put.

Secondly, in a paper, because of the space constraint, if you are putting a derivation, we often jump steps. Say, an integration is there. We write integral of this and then write the result, while in actually doing it you will put many more steps. We do not do that in a paper generally, and we expect the reader to actually work it out and to come to the final conclusion.

But, in a thesis, since we do not have space constraint, it is expected that you would put all the steps. That is why, simply copying and pasting from a paper into the chapters of a thesis is not a good idea. You have to add these material.

Moreover, the units of a paper are the sections while the units of a thesis are the chapters. Therefore, whereas a section can be a page long, a chapter cannot be a single page long. So, much more material has to be there in each chapter. The Abstract of a paper is just a paragraph. One paragraph of something like 250 words, while that in a thesis might be 2-3 pages long and that can be broken into paragraphs.

So, there are stylistic differences between a paper and a thesis. The most important chapter in a thesis is the Introduction. As I said, the most important section in a paper is the Introduction. In a similar way, the most important chapter in a thesis is the Introduction. In the thesis, the first chapter is normally the Introduction.

Within the Introduction chapter the following sections are expected. First is an Introduction. You might think what is happening? In the introduction there is another introduction? Yes, the Introduction is the chapter, but within that there will be a section called Introduction in which you will have to answer the same questions that I talked about: What is it all about? What is the area of this thesis? What is the problem to be attacked?

This is the content of the Introduction section in the Introduction chapter. There is a bit difference because we do not normally write the theoretical background in a paper. But, in a thesis you cannot assume that the reader has a complete command over the theoretical background. So, one normally provides the theoretical background in the thesis itself, in the Introduction section. Then you have to put the literature survey.

In the Introduction section of the Introduction chapter, you have said what are you trying to do, and then on that whatever is already known – that has to be narrated. The number

of papers to be cited in a thesis is normally much larger than the papers to be cited in a research paper, because you do not have the space constraint. So, the literature survey has to be much more extensive and normally one puts 200 to 300 references in a PhD thesis.

In the course of a PhD student's work, one expects a PhD student to have read that many papers. So, all that has to be there in the literature survey. And the literature survey actually has to be presented like a narrative of the present body of knowledge. How it developed? Who did what? Who added this? Who added that? That way, it has to develop in a very logical way.

One very common mistake that that many PhD students make is to copy and paste from the abstracts of different papers. When they want to say what this paper did, they simply copy and paste from the abstract of that paper. That is very wrong: (A) because it is plagiarism; you cannot write from somebody else's paper and (B) you are supposed to be writing a narrative which flows like a river. The flow will be obstructed if you suddenly go into somebody else's language. Everybody has a linguistic style which is different from each other. If you simply copy and paste and the next again copy and paste, the examiner will be able to see that these have been copied and pasted.

So, do not do that. Rather, you understand what has been done, what is the contribution and in what way the contribution of that paper is relevant to your own work. That has to be narrated in your own language. That is how the literature survey has to be put. And the literature survey has to be extensive, something like say 8 to 10 pages, sometimes even more.

After you have presented the literature survey, i.e., you have told the reader what is already known, then you have to tell the reader the scope of the present work. Scope of the present work has to be another section heading that is based on the literature survey.

After the literature survey we say that this is known and therefore, this is unknown, and this is what we are trying to know from the work done in this thesis. This is the scope of the present work.

Finally, you have to state the organization of the thesis, that means, what goes in which chapter. So, these are the usual sections of the Introduction chapter of a thesis.

After that, there will be other chapters, and finally, there will be a Conclusion. Notice that each chapter will have an Introduction and a Conclusion. An Introduction, then the material for the chapter, and finally, a Conclusion.

So, every chapter will have an Introduction. In the Introduction of the chapter, you have to state what are you dealing with in that particular chapter. The conclusion has to state what are the conclusions from the work done that is reported in that chapter.

Now, there is a common mistake that people do. Normally 3-4 papers have been published out of a student's work. Often I find that one copies and pastes the paper as it is as a chapter of the thesis. This is not a good idea. It is not a good idea because, firstly, the paper has been published and copyright has been transferred to a publisher and therefore you do not have the right of directly copying and pasting from there. Secondly, as I said, the paper is a shortened, squeezed, filtered version of the work done and you need to put more in the thesis because you have scope of putting all the results that you have got. Thirdly, you need to put in all those missing things that were not there in the paper, for example, the intermediate steps in a derivation. All that has to be put in.

So, the style of writing a thesis chapter, and the style of writing a paper are different and so it is not a good idea to just copy and paste. But you can start from that and fill in the remaining material, so that the thesis chapter becomes a wholesome chapter.

Notice that there has to be Introduction, there has to be Conclusion and I said earlier that the Introduction chapter has to have the hint of the conclusions. That means, the organization of the thesis says what is done in this chapter, what is done in that chapter.

And there also we have to use languages like 'in this chapter we show that', which means that the conclusion out of that chapter is hinted on right at the Introduction chapter. So, the conclusion is written here, conclusions are written there, conclusions are again written here.

The conclusions out of the whole thesis are written in a separate chapter. Do not copy and paste. Each time it has to be written in a different form. Here you are writing organization of the thesis in which you are writing that this particular chapter 3 deals with this aspect, we perform an experiment or we propose a hypothesis or whatever it is.

And finally, you have to say that in this chapter we show that. And then in the conclusion of a chapter we go into much more detail because the whole work has been presented in that chapter. So, then we write the chapter conclusion in a relatively more detailed form.

When you go to the Conclusion chapter, you do not copy these ones. You will write it afresh, because this is the ultimate take home message that the reader gets from the whole thesis. So, this is how the a thesis is normally written.

In a thesis, normally you have another element that one has to write, called Synopsis. It is a 10 to 12 page summary of the thesis. The whole purpose is that, after you have submitted the thesis to a university or institution, the academic section will send it to prospective examiners. How to find the prospective examiners? They initially locate a few people who work in that area and their consent has to be taken. How you take the consent? They send this Synopsis to the prospective reviewer to take their consent. The reviewer reads the synopsis and figures out whether he or she would like to examine this thesis or not. So, the Synopsis has to be written in such a form which will catch the attention of the examiner. He or she would be interested to read the thesis.

It basically contains all that is contained in this Introduction chapter, more or less that way, in brief. You have to give more weightage to this organization of the thesis in the synopsis, because the examiner would like to know what are contained in each chapter. So, you have to briefly state what is the area of the work you do not have to talk very detail about the theoretical background and the literature survey.

But, you have to state the scope of the present work and then what is given. It is possible to put a couple of graphs or charts that are crucial to give the examiner a feeling of what is contained in the thesis, what is new in the thesis. So, this is how we write the Synopsis and the whole purpose is that to catch the attention of a prospective examiner.