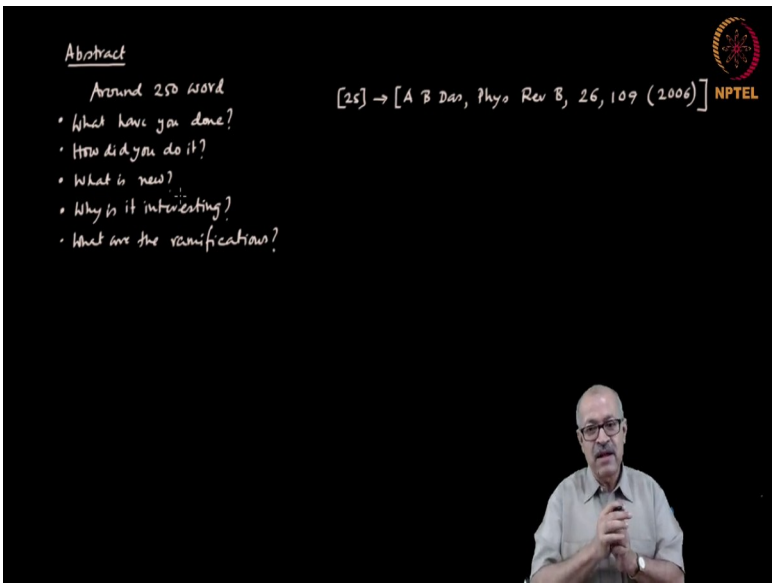
Research Methodology
Prof. Soumitro Banerjee
Department of Physical Sciences
Indian Institute of Science Education and Research, Kolkata

Lecture - 58
Scientific Writing: Journal Papers, Part 2

(Refer Slide Time: 00:19)



After the title, the most important part is the abstract. It is important because, after the title, what appears is the abstract and the abstract is available to everybody. So, when a prospective reader tries to find a paper, locates it through Google search, clicks it, he or she gets a page in which the title is there, the author names are there, and the abstract is there. The abstract is normally not behind the paywall. You do not have to pay in order to look at the abstract. So, people read the abstract to figure out whether to read the paper or not.

So, people would download the paper, people would ask the libraries to get the paper, only if the abstract arouses their attention. So, the abstract is our gateway into the mind of the reader, our scope to arouse interest of the reader, and anybody working in the field should get from the abstract what is the content of the paper.

An abstract is normally around 250 words or as advised by the journal. Some journals allow relatively longer abstracts; some journals expect shorter. But 250 words is sort of a ballpark figure. How do you write the material in such a short span?

You have to remember that the abstract has to convey to the reader the following questions. The reader will expect to know from the abstract what have you done? How did you do it? Is it the result of an experiment, is it result of a simulation, is the result of a theoretical work—derivation of a formula or something like that? And then he would like to know what is new that is so far not known? Why is it interesting? I have done something; that does not mean it has to be interesting. So, why is it interesting? If the result is true, then what are the ramifications?

More or less these are the things that a prospective reader will expect to know after having read the abstract. So, the way you have to present the abstract is in a very short way. Every sentence is the shortest possible sentence, but do not write that in the telegraphic way by avoiding ‘a’, ‘an’, ‘the’. It has to be correctly written with proper sentences, but you have to include the answers to these questions.

You have to remember that the person who will read the abstract may not read the full paper. Therefore, do not consider the abstract as a part of the paper. The abstract has to stand alone. A person may read the abstract and nothing else in the paper. By reading the abstract he or she might understand that it is not of my interest and therefore, will not read the paper. So, it has to stand on its own.

What does it mean? First, it would mean that in the abstract you cannot refer to some part of the paper. ‘In section 3 I show that’: no you cannot say that because the person who is reading the abstract might not read section 3. You will not be allowed to refer to some equation that comes later in the paper. ‘Equation 25 in the paper shows that’: no you cannot say that. You cannot even cite a paper. That means, in the main body of the paper there will be citations, you will refer to other peoples’ work, but in the abstract you cannot do that.

You can do that in somewhat rare cases, where the reference to some earlier work is crucial to understand what you are doing. Say, you are performing an experiment in order to test a hypothesis and the hypothesis is in that paper. So, in this kind of a situation you might have to write a citation. But in that case you cannot simply write like this: [25] because this is completely stated in the rest of the paper, but the reader is not reading that.

The abstract has to stand alone and therefore, this has to be written as: in the square bracket you have to write the whole thing. Suppose it is written by some A B Das, volume 26, page and year something like that. The name of the author, the journal name, the volume, the page number and the year—that completes the citation; gives complete information. So, in the abstract itself you have to give this complete thing. This kind of citation is allowed in the main body of the paper, not in the abstract.

In the abstract you cannot write a displayed equation. Even though you might think that this is the main result of the paper, you cannot write a displayed equation in the abstract. The abstract has to be a single paragraph, you cannot break the paragraph even.

So, it has to be a single paragraph about 250 words. You should answer these questions and it has to stand alone. You cannot include any displayed equation, you cannot include any citation, you cannot refer to a section or equation or a table or a chart or a figure in the main body of the paper, because you have to assume that the person who is reading the abstract might not read the whole paper.

So, it has to be a stand-alone material and it should be written that way. You have to avoid all superfluous expressions and words. What I do normally is that, after having written the abstract, I read it carefully, try to read each word and try to ask myself if that word is needed. If I find that, if I drop this word it does not diminish the substance of the abstract, then I drop that. Similarly, words or collection of words are dropped. That way, shorten it as much as possible.

The abstract should be the shortest possible expression of the paper that you are writing. It should be written in such a way, so that you cannot remove a single word from the abstract without diminishing its substance. That is why, writing the abstract is also a very difficult thing.

One has to practice again and again writing a paper. Normally, when I started writing papers, I would write an abstract, cut it, write an abstract, cut it, and that would go 25-26 times and only then I would be able to satisfy myself that this is an acceptable abstract. So, writing an abstract is a rather difficult, but very necessary pursuit.

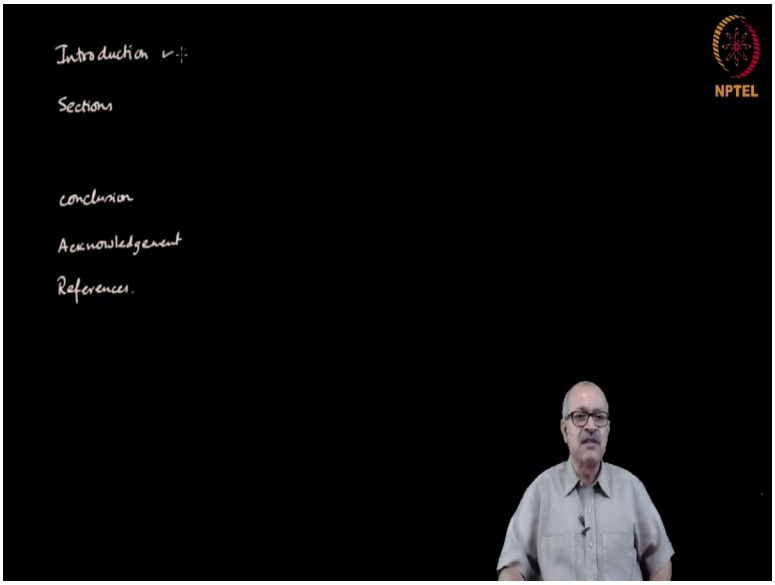
As I said, the main purpose of the abstract is to help the reader decide whether to read the paper or not. Therefore, it should be able to excite the readers imagination and

expectation from the paper. He or she should get a very clear idea of what this paper contains.

If you have obtain a result then do not be afraid of stating it. A very common mistake is to state the result only in the conclusion of the paper. No. Say it in the abstract itself. When I come to the introduction, I will say that the introduction also should state what the main result of the paper is. 'In this paper we show that' -- you should use a statement of that kind, so that the reader gets it very clear in his head, what ultimately the outcome of this paper is.

So, after you have written the abstract, comes the body of the paper. The body of the paper is normally divided into a few sections. Except for those papers that are called 'Letters', you need to break up into sections. Letters are short papers normally within 5 pages. In Letters, you do not need to sectionalize. It can be one continuous flow of narration. But a paper of a normal size (normal size means something like 8 to 12 pages) will be divided into sections.

(Refer Slide Time: 12:21)



Out of them, the first section is the introduction. The introduction actually is the next most important part because, when a person has downloaded the paper, then the first thing he or she reads is the introduction. By reading the introduction, the person tries to figure out whether he or she will read the whole of the paper, because everybody's time is precious. So, the person might decide that only a particular section is of my interest

and I will read only that, or maybe a graph, maybe a chart is of my interest. So, I will only refer to that. The introduction should actually guide the reader. I will come to the details of the introduction in the next class, because it will take a little more time than I have remaining in today's class.

In the body of the paper, after the introduction, comes different sections. The first section is introduction, then other sections follow, and finally, it is the conclusion, and then the acknowledgement and then the references.

Now, the sectionalization. You have to decide how you break your material into various sections, so that each section has a story to tell and the whole paper has a wholesome story to tell. So, this is the way of writing the paper. You have to sectionalize, each section has a specific content and then you have to write in the conclusion.

Now, if you read newspapers—good newspapers—then you notice one important thing. Suppose a news item takes, say, 3 columns, and then maybe it is continued to the fourth page. But you would notice the first paragraph itself is such that you get more or less a complete idea of the whole story from the first paragraph. Only a few lines, and then they go on elaborating things. It is not that they start from the start and then, after having read the whole thing, you get full idea. The first paragraph gives a clear idea of what I am trying to tell.

The same applies to the introduction. The first paragraph of the introduction is the first thing that the reader reads and that should tell what is the area of work, what is the problem that you are attacking, etc. It should arouse the interest of the reader to go on, because, remember, everybody has shortage of time, and everybody is trying to optimize the amount they read. So, everybody is trying to find out whether what I am reading is worth reading or not. That information needs to be conveyed through the first paragraph of the introduction.

It should rouse the readers' interest. It has to be written in that way. In the introduction, the following things need to be covered. I will detail later. The introduction has to tell the reader what is it all about. The introduction has to tell the reader what is already known about that particular question and that is to be included in the literature survey. Then the introduction has to show that, after these are known, what remains unknown. What is the question being asked in this paper. That question has to be such that, after having read

the literature survey, the reader has it clear in his mind that this is the question that is yet unanswered. The introduction clearly spells out this is the question that I am addressing in this paper.

Then it has to say how you are trying to address that question. Are you doing an experiment? Are you doing some simulation? Have you developed some code and doing some simulation? Or, are you proving a theorem? What are you doing in order to get an answer to the question that you asked.

Finally, you have to say, again I am repeating this issue, that do not keep the main conclusion out of the paper to be stated in the Conclusion section. No. The main outcome of the paper should also be stated in the introduction itself and it has to be in a very concrete language. “In this paper we study the property of ...” that is not an exciting language. The proper language is “in this paper we show that”, “we prove that”, “we demonstrate that”. That means, you have demonstrated this and the reader would be interested to know what you have demonstrated, how you have demonstrated, and what is the result. But, if you vaguely say that in his paper we study the property of gallium arsenide, then the reader has no clue as to what ultimately it contains. So, avoid general statements. Make concrete statements like ‘we prove that ...’.

Finally, the last part of the introduction is where you tell the reader how you are presenting this paper; that means, the outline of the paper. Section 1 is the introduction. You have to say Section 2 contains this, Section 3 contains this. In Section 4 we proved that, in Section 5 we described the experimental apparatus. Section 6 we described the results of the experiment and so on and so forth.

So, how you have broken up the paper, how you have presented it, that needs to be the last paragraph of the introduction. In relatively shorter papers, the Letters as I said, this part, that means, describing how you have organized the rest of the paper, this part may be omitted because of brevity. You need to be brief in such papers.

So, that is the general outline of the introduction. Then comes the different sections in which you would either develop a model and then show what the model gives in terms of simulation and then what the experimentally testable outcomes are.

If you do an experiment, then describe it. If you are not an experimentalist, you expect others to do the experiment, then state exactly what can be experimentally tested. So, that way it carries on. Finally, you have to state the ultimate take home messages in the Conclusion section. Then you have to acknowledge those who are not among the authors, but who have, in some way or other, helped in the course of this research. So, that is how we organize a paper.

I will come to the details of each section in the next class, especially starting with the introduction section, because there are things in the Introduction section that need to be elaborated.