Course Name: Technical Communication for Engineers

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Lecture 07- Results and discussion

Hello everyone and welcome to a new discussion which we are going to have on results and discussion under this technical communication for engineers. So, let us start with this. So, first we will see what are the topics which we have covered so far and now these two more topics which we are going to discuss in this lecture. and the remaining topics will come subsequently. So, first is result section and then we will also touch initially the discussion section and in detail we will go. So, how in a manuscript, project, report or paper a result section should be written. And that means that the result section of a research paper should objectively report that what was found. Objectively here means that whatever were the objectives which were laid down initially of the research, how those objectives have been achieved. So, we should write our result section in that manner. that saying that or mentioning that these objectives which were set initially have been achieved. And further important part here in the results section is that there should not be any speculation on why it is so or rather speculation on others work also. Because results section is purely a result of whatever the research which has been done. Whereas in the discussion section, what we do, We interpret the meaning of the results, the purpose of the results, how these results are important and not only interpretation, sometimes we also go for inferences, what are the meaning of these results and we try to put them in context and also try to explain the entire matter, entire topic which was of the paper or manuscript or your PhD thesis. So, let us go in the detail of result section and here we will be discussing different components of result section. So, first one is the result should answer main hypothesis or research questions or rather I would say all objectives which we have set. In case of a project, we propose that these are my objectives. In case of a PhD also, we put that these are my objectives or hypothesis and then after the data analysis methodology, how I could achieve those. So, one is try to answer or support those objective. The second thing is order of presenting result is arbitrary. This is another important thing that sometimes there is no particular sequence has to be followed. So, we can have the results we can present in arbitrary manner. But the best thing is that as per our objectives which we are laid down or hypothesis which we are there initially, if we write our result section accordingly in that sequence that is always preferable. Now another important thing is that results are sidelights, should not

receive equal weight. That means that along with other sections, one should not try to balance this thing. So, it is a sidelight means in the surrounding and it has got the weightage whatever is required to explain or to show that how that hypothesis has been achieved or those objectives have been achieved. So, while presenting the results for hypothesis, consider the following points. And this point has always been there that the things should be very clear, concise, focused and simple also. One should not make very complicated statements here which may not have a good meaning of that. And in one of the videos, I have showed that a person is speaking very good English but one is unable to understand for a small answer. So, it should be concise, clear and simple while presenting the results of these hypothesis or objectives. Further, that is enough detail presented to allow the reader to determine whether the effect of experimental treatment. versus like chance alone or not bias, sloppy techniques. So, here what we are trying that we should assess by ourselves that whatever the things which are being presented in the result section are sufficient. Or is there a lacuna or lacking something and we should suffice that one. And also we should bring some significant statistical value if these are there in the result section. If the data has been analysed in using say some statistical techniques that should also be highlighted. And further we should raise a question whether where adverse effects reported. Generally, one would not like to go through or read the negative results of any work or any thesis or hypothesis. So, in my opinion, this should be avoided. Paper or thesis should have most of the things which are positive as per the objectives or hypothesis which were laid down initially. And there are further more components of result section that do not state any differences where present between groups unless significant p-value is attached. And do not attach equal importance or even bother to include the entire statistical output. See, what you are doing in the result section, it is not a discussion section here. So, result section should only present the results which have come through the analysis of the data or whatever data has been generated in lab or field. And, select only those which are descriptive and inferential statistics so that one would like to use, one would like to place, which are supporting your results. This is what is another thing is required. inferences are always should be put in the results or sometimes depending on the work one can also bring this inferences part in the discussion as well. Now, the how to present results section, many points we have already covered but anyway because results are presented using either tables or graphs. Graphs here, there is a general term which is being used here, graph that means plots also, maps also and you know graphs, different kind of graphs or plots are there. Now, here these tables and graphs must stand alone. That means that they all should be part of your study but individual graph should explain why these are there or individual table should be you know self-explanatory in that sense. Now, further whatever the figures or tables which are being used in your manuscript or paper that one should write a text within this real section so that we can show the importance or meaning of these figures and tables. What I am trying to say that these figures or tables should not lie in your text

or body of text in isolation. There has to be link and when linking these things the importance of figures and tables should also be shown there. And then it becomes useful and you know one can really understand the entire work or the paper. Both tables and figures carry a necessary part of message. And therefore, one should not avoid, if it is required, necessary, definitely use both types of presentation of result. And we can raise a question to ourselves while writing this section that are the results of statistical analysis presented sufficiently or not. If not, then we should add few more figures or graph or table if it is required. Because, once a paper is submitted for review or a thesis is submitted for evaluation and the reader or evaluator or examiner if he goes through and finds that sufficient analysis or statistical analysis has not been presented, then there will be lot of questions and that goes really in a negative sense for a work. Now, one can determine what statistical test produce the results. So, whatever the results have been produced that which method or how these have been produced that should have a link in the methodology section. Now, in this we should also consider question like are baseline values for group similar, means that whatever we are doing all whether they are having the same baseline value? That means whenever we want to compare things, have a relative understanding or study then we should have the same baseline. Baseline means year, can be year. So, if I am analysing say rainfall data and same time I am also analysing the temperature values, then the baseline year in those two comparisons should be same. Otherwise, there will not be any comparison and results will not have any value whatsoever. So, this is what the baseline values means here. Is the degree of variability reported? That means, standard deviation or other variables whether they have been sufficiently reported in the result section. Now, are these tables or graphs are clearly labled and appropriately scaled that is very very important. The scale part for the graphs, tables for the levels that or even figures or maps are labeled. This is a very common observation. And, in my own teaching experience, I have been seeing whenever the students are presenting their reports or making Power Point presentations, then they do not label things very clearly. They will not put legend. If they are presenting a map, they might not put a scale. And then, the audience or whoever is going through that presentation or a paper has to raise a question that what is the scale, what is this thing is. So, these things are very very important while presenting the results. They should be complete by itself. There should not be anything lacking in terms of information. And similarly, for graphs, plots, charts or maps, everything should be complete. And, we will have a complete discussion rather two lectures on this part also that how these things should be presented. We will be also discussing what are the bad examples of tables and graphs and what are the good examples. Further results of statistical analysis presented. Are the results have been presented? We must include if that analysis has been done in a particular study then all these should be presented. And, you know the whatever the results which have been produced through statistical analysis that also. Now, choosing figure types for result section. This sometimes it is up to individual. So, compare

different types of figures which you can prepare and see that which is more bringing or highlighting your results better. For example, one may like to have a pie chart. But when we will discuss graphs or these pie charts or plots, then I would be explaining to you that why pie charts are not preferred. instead of you know line graphs or other graphs. So, that is one thing. But nonetheless, it depends on the data, what kind of data you had and what kind of presentation or results section you would like to present these things. So, there may be horizontal bar chart or a table. But always if a data can be presented through a figure chart, it should be done all the time. The things or details or information you would like to present which cannot be done through a figure, then table should be used. In a same manuscript, same paper, the same data which is in table should not be presented in form of figures also because it is unnecessary. So, always it is preferable that if the data can be presented in form of graphs, figures, that facility should be availed. Now, whenever we would like to show the changes over time, then the trend analysis that is also done and that can also be presented either through column chart or line graph. and likewise. So, suppose you are having like this line graph and you are showing the trend of increasing a trend of certain phenomena or may be decreasing trend of certain phenomena. So, that is all possible. To show what typical or exceptional particularly how two groups compare to same dimension or variables. And for which we can use either histogram, cumulative percentage chart, a box plot or a scatter plot also. So, as I have said that the purpose of the figure and appropriate figure should be chosen for that. So, what we are discussing is general thing. But as per the data or the requirement, you should choose the appropriate figure or table. Whenever we would like as I have just touched this point that if you would like to show the correlations then a scatter plot. or multi plot chart can also be presented. Correlation, generally in graphs, figures we can show the correlation between two variables. Sometimes in a 3D, you can show correlation in three variables. But, if you go for this kind of thing, things should be very clear, the figures should be very clear when you are going for more than two variables correlation. Now, this results and discussion, both formats can be separate or can have combined. This is up to the length of the paper requirement as per your write-up or manuscript or work. What I am trying to say that the results and discussion as heading here. you can put everything in one. So, first para you can have on results, next para paragraphs you can have on discussion or you can have separate headings for result and discussion.Second thing is that this combined approach if we go for results and discussion as one section in the paper, then combined approach discusses results immediately as I have just mentioned that first you have to present the results, and then you can have discussion on that. One should not really switch between result and discussion section because that may create you know little confusion among the readers. But if it is as per the work requirement, if it is very necessary, one can also do that thing. There is no hard and fast rule for this but preferably first result should be presented and then discussion should be presented in that manner. So, when the two sections are

separated, I can give you the examples or benefits or you know drawbacks like this. If they are combined, then you are having freedom of switching between the different paragraphs. But, if you are having complete separate sections, then you do not have that chance anyway. So, if when the two sections are separated, There is a continuity in the discussion and the reader can view and analyse the complete study in one go as opposed to the reading results between a combined section. And that is the advantage of having two different headings for results and discussion. Because, we have to think all the time whenever such paper or manuscript or thesis are being presented or being prepared that how the reader will feel. While writing, we have to also think from reader point of view all the time. So, that the reader would have to go back the results section to correlate the discussion. And that sometimes combined section will not require such thing. But if it is a separate section, then he might be going back and reading the results and then switching on, switching off kind of situation. Now, as earlier mentioned that both approaches, both methods are acceptable. Both methods means results and discussion as one section, results and discussion two separate sections, both are acceptable but the choice is yours. If it is a lengthy paper, long, for example, a PhD thesis, my suggestion would be to have a separate sections. But, if it is small paper, small manuscript, then my suggestion would be go for a combined sections that results and discussion as one. And, basically there is no right or wrong, everything depends on your requirements. So, here we have discussed the effective separation of two sections also.

Now, how to effectively separate the results and discussion? If at all one go and choose this thing is that the important points to be kept when we are doing this separate sections for report or a manuscript or a paper for result and discussion section then the first is the stick to presenting data in the result section. So, whatever the results have come, one should stick to that when you are presenting in a separate mode. And also explain results in discussion section. Because, you are in the results section, you are only presenting the results whereas, the explanation of results or interpretation or inferences of the results or data should be presented in the discussion section. Now, information given in the result section should not be repeated in the discussion. In fact, any part of your thesis or manuscript should not repeat the same thing again and again in different sections. So, here also that whatever which has been mentioned in result section should be completely avoided in other section including discussion section. Now, how to communicate your results effectively. So, results section is the focus of the research work. See, I tell you through my own experience that whenever we evaluate any say project proposal or a paper or a thesis, what we do generally, this is what people do normally that first they see what were the objectives or hypothesis which one has taken initially. Second thing that how these objectives have been achieved. and how nicely this thing has been presented. And therefore, the results section is the focus of the research paper. that if results are not sufficient, results are not significant, results are not important, then there is no use of such

work or no significance overall of that research which has been done or presented. So, this is the basically the focus of the research. You might have set certain objectives, you have got the methodology, but what are the results? If results are good, then your paper or manuscript or project will be accepted. So, result section is the focus of the research paper and this section that is result section represent the outcome of your work. This is what the output whatever the output analysis data whatever is has been done the result section should show that output. So, therefore, a well-written result is essential to generate, I would say, to keep interest of your findings of your paper or manuscript among the readers, audience. So, this section should be presented nicely. The research should be focused on this section also, you know, written part and it should be well-written. And well written we have already discussed that well written means it should be very clear, concise and focused thing that whatever the object is this is how we have been achieved these are the results. So, what are the things which should include in this result section that key outcomes of the study as per the objectives which were initially declared. Then statistical analysis represents the significance if a manuscript or a work has got that one. A visual representation of your data that we have also discussed that figures, tables, graphs, charts, maps as per the work and do not represent the same data twice. That means, one should not repeat the same thing again and again in different sections or even within one section. So, each section should have unique information and each section should be complete in that sense. Now, this part that table or figure, to represent data. Avoid using both. This also we have discussed that one should not keep the table and figure for the same. That means the data which is presented in the table is also presented through figures. No, always prefer to present figure. Always remember that a picture tells thousand words. And I can add one more part of this saying is that a picture tells 1000 words and a map tells 10,000 words. So, if it is possible, you have a map of some area, study area, one should always present that one.
So, now we come to the discussion section and how the discussion section should be presented in your write-up. Again, the same thing do not repeat results. Now, we are discussing when we are writing results and discussion as a separate sections and therefore, there is no need to repeat the results. And initially start with very simple discussion and may go to little complex one. So, it has to be building to conclusion because that is after discussion the next section which will be conclusion which we will discuss in the next lecture, how conclusion. So, very briefly the conclusion should be consist with study objectives. research equation and also we should explain the results, answers, the question under study. So, these are the things which we should put in the results section, in the discussion section. In discussion section as also mentioned earlier, the interpretation, inferences, meaning, significance of your data, of your results should be presented in the discussion section. So, result section sometimes might be relatively smaller in length as compared to discussion section. But, since result section is also having figures, charts and tables. So, you know from weightage point of view or length

point of view, it may be just opposite. The result section might be long, but discussion section is less. And, I would say that try to keep a balance between result section and discussion. Discussion is another very important section of your write up. very important because if you have not discussed that part just presented results then people or the audience will not be able to understand or will take home that what is the significance of such work and what are the importance of that work or inferences of that work. So, that is why it is necessary to have a balance. Also, in the discussion section, one should emphasize what is the new which has been noble, nobility which has been achieved, what is different which has been achieved and of course, what is the important about your results, why it is different from others, why it is so significant and your study why it is so significant that should be explained, discussed in the discussion section. Also, you can think of alternative explanations for the results. Sometimes results may have, so one can present that either because of this or not because of this. So, this kind of thing. Always, in all sections including in discussion section, always try to avoid speculations.

Do not guess, do not try to guess and write things in that manner. Because, then people will ask what are the proofs and then you do not have the proofs. So, better to restrict ourselves in this section only based on our results as per our laid down objectives. So, this should be completely avoided the speculations. Further, avoid biased language or biased citation of previous work. The bias here is that you know the previous work might have been presented in a different way or different thing and you are not honestly presenting that work. And you are trying to make a bias of that, that is not a good practice while preparing a write-up, and again do not confuse non-significance or no difference especially with small sample sizes. When the sample size is or in the field or data when you are having very limited data then you know one should not confuse the audience or reader with no significance. And do not confuse statistical significance with clinical importance. Clinical importance means here that very small significances are there and you are trying to put lot of emphasis on that whereas data and result does not show like that. So, never give incidental observations, the weight you attach to the conclusions.

You know these are, incidentally you have found that one, but can you repeat that experiment, can you repeat that thing, can you substantiate that thing and that is why such observations should not be presented here in the discussion section. So, whenever you are writing or written the discussion section, try to look back. Look back what that answer whether results make sense in terms of your expectation as expressed in the hypothesis. So, results or the objectives which have been laid down, have you answered those questions? Have you achieved those objectives? Or could you prove that hypothesis? This is what you should answer. So, always try to look back and try to see whether those things have been handled nicely here or not.

And what you read before beginning, the text or research articles that also is important in the review section which you have done. Clinical practice is again depending on the work you know what you should do to avoid these things. And theoretical considerations again that look back section will cover. So, before finishing or while writing one should try to look back for what purpose this entire work is started, are we doing justice to that or not. Another thing is that limitations, sample size of course, what else? So, we might be having limitations of carrying out or limited methods available for analysis, limited instrumentation available for analysis, limited field work was done. as originally planned. So, those limitations should be mentioned but not with big importance. Otherwise, people will feel that this study is having very limited significance. So, this is important that one should look back and try to see that how things started, what were the objectives and what I am achieving. So, any unsettled points in the results.

And that also one should, now after looking back one should look forward. that these are the things which have been achieved and these are the things which can be achieved in future. So, implication you know if it is from medical background, patient care or for theory, suggestions for future research, this is kind of recommendation generally is given. As also mentioned in some other lectures or discussion that no research is ever complete. is a ongoing continuous process. Some part we have done. Now, we leave with the recommendations of future or look forward that saying that these were the limitations of this study. However, if such things made available, high resolution data is made available or better instrumentation is available. then better results can be achieved. So, that kind of one or two sentences at the end of discussion can be mentioned. So, while writing the results section which we have earlier covered in this discussion, report what was found without speculating on why, include figures, table charts, write in past tense and the active voice. This is another important thing though it is related with English. And, I said in the beginning of this course that I am not going to talk much about the English. But, here these two things are important that whenever you are writing results, write in the past tense and always try to write in active voice rather than passive. And you know depending on the work if it is very extensive work then 1000 word limit is not required. But if it is a PhD thesis then again this limit is not required. But if it is a paper manuscript then maybe 4-9 paragraphs are sufficient for result section. Now, for tips for writing discussion section, interpret the meaning of results, make inferences and significance that importance of the results. importance of your study that should always be there. So, put the results in context, explain why the results matter and connect the results to previous research studies. That earlier research was done up to this, I have innovated something, I have added the novelty in it, I have done a complete different way of analysis.

So, that difference with the previous research should be shown here or rather

highlighted. and also make explicit connections back to the research questions or objectives or hypothesis which we have raised. So, here one should again cover in this discussion section. Include an explanation about how the results might be generalized. This is another important thing that if it is possible. do not try always to generalise results. That with limited data sets, you have done a research or a study and now you are generalising. That would be too much. But try to generalise as per realistic generalisation. Do not generalise which may go in a different manner. also emphasize the implication of the findings, the importance basically. Whatever the results which have come, how they are important, how they are implicated. So, that part can also be explained how the work is significant, importance. provide the most general claim that can be supported by the evidence. All whatever you mention, you should have evidence for that. And those evidence will be coming in the data section and results section. So, that thing should be there. Then only you can generalize these claims. Otherwise, one should not do it. Provide a future perspective on the work, means how the future work should be done with what kind of, this kind of recommendations is generally in one or two sentences is given in our write-up. Now, how to write an impactful discussion section. So, important points while writing an impactful discussion section. Address the problem stated in the introduction. Review the findings in the context of supporting literature and existing knowledge. Critically analyze results. You should analyse results by yourself very critically. Include future research directions as I have just discussed the recommendations. Avoid repeating information given in the introduction section. So, all sections should have uniqueness. The matter, paragraphs should not be repeated in these one. Further, drive conclusion unless the journal requires to be discrete section. Discrete section means separate section and we are only discussing that part as result and discussion as a one or separate. So, if some journals would prefer that you should have a separate section, so no problem. Sometimes just presenting results is not sufficient, a discussion section should be there. If discussion section is not supported by a journal, then the last paragraph of result section can have a discussion on that. Author needs to explain the significance of results. This is all the time important. Importance of your study, why it has been achieved, what are the achievements of this study that should be done. And discussions should narrate a story which should include the explanation observed phenomena with supporting studies to justify validate the findings. This is another variable. Now, this whatever the tips which we have discussed, nine tips here in the discussion section, basically which will help to effectively write separate result and discussion sections. But, depending on the write-up, requirement, research, all tips need not to be followed. As per the requirements, one should use them. But, if you want to have a very impactful discussion, acceptable discussion, then it is better to follow these tips. So, now we are coming to the end of this results and discussion section. So, you know in a nutshell or in a summary there may be requirement for results and discussion to be combined section. So, what are the advantages and

disadvantages here. So, in summary what I am trying to show here that when we are having a separate section then results should include the experimental data, but not the interpretation and incorporation of statistical analysis where applicable, follow sequential organization when presenting data, include text figures and tables, avoid speculations in the results section. And while writing the discussion section, explain any surprising, unexpected or inconclusive results. If it is there you are unable to explain or in your findings then you can try to explain these things here itself. List all the major findings of your study. Interpret and explain the findings effectively also if possible. Provide the inferences and significance of your results or study. Also mention limitations if any. This is another good thing. Maybe in the last, before you write the recommendations, you just write that these are the limitations of the study. Because no study is ever complete, no study will not have any limitation. All studies will have some limitation. So, if we can just write one or two lines for limitations of the study that is useful for readers and for future workers as well. And finally, relate to what others have done. This is important. So, you are trying to link the review work which we have discussed already, review work related with your discussion so that a completeness in your write-up will come. So, with this I thank you very much.