Methods and Tools for Qualitative Research Writing

P. A. Praveen

Slide 1

Good evening to all. Hope you all are doing well.
Before start my talk, I wish to express my sincere gratitude to the Management of Karpagam College of Engineering. Especially, its my duty to thanks Dr. S. Manoharan, Dean of Science & Humanities and Dr. K. Ramakrishnan, Head of Physics department.

Slide 2

So, today I have planned to discuss some of the methods and tools which I am using over a decade to assist my research writing. I have splitted the presentation into four parts. In the first part we'll see some basics of preparing manuscripts, like ethics or something like author contributions. In the second part we will see what are the key points should take care of when formating or devicing a manuscript. Of course language is a very crucial part and I will discuss few language related things that we should take care of when preparing a manuscript in the third part. Finally, we will see some useful tools which can be used to assit or improve our research writing skills.

Slide 3

Okay, let's starts with some basic aspects of research writing and publishing.

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Ethics in scientific communication

- Scientific research crucially depends on the integrity of the investigators
- Fabrication and falsification clearly are unethical
- The publication should be complete
- Should support the advancement of science

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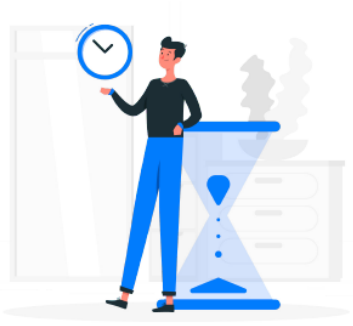
Very fundamental and very important aspect in research writing is its ethical concerns. You might have seen the quote “Stand on the shoulders of giants” in the home page of Google Scholar. Its a metaphar used by Newton about the significance of Gallileo’s work. What it actually means is scientific discoveries building of previous discoveries. Its like building castle of cards and even one card fails entire system may collapse. So, fabrication and falsification is a very serious offence and unethical in any kind of research work.

Further, science is or research is about the better future. It is meaningless to provide a society with partly or hidden works. It won’t help any of us. So, always a scientific publication should be complete and should support the advancement of science.

Slide 5

When and what to publish



- Not too early; Not too late
- Enough work with enough results
- Results lead to clear understanding
- Avoid short, incomplete descriptions
- Don't fall for 'publish or perish'

One crucial question is that you devised an experiment and have collected significant data. Now the question is when and what to publish from the acquired data?

Don't rush to publish or don't lame to publish. Just go through the literature and confirm yourself that enough work have done. Make yourself sure the obatined results are give better understanding on known issues or even it may indicated the existence of new phenomena.

Sometimes, not intentionally, but a description may lack of enough eveidence or don't have adequote material to address the problem of issue. So try to avoid the preparation of short and incomplete manuscripts.

Of course, everyone wish to publish their work. But you should belive it would take time. If a manuscript is rejected few times or got some critical reviews it doesn't mean that the work is not qualitative enough. Try to address the issue and should ready to improve at any point.

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Don't be a prey!

Always remember this:

- Reputation of an investigator is determined by the quality of research done over an extended time
- Large number of low-quality publications is not of benefit to the individual or the profession
- Don't tempted to publish the same material, or material only slightly different, multiple times

We all should remeber this. It is easy to publish a fabricated data. But there's always a possibility that it can be identified in near future. Such a defame would severly affects not only research but entire carrier.

Also, timeline of a researcher is very important. Depending upon the quality of the publications over time ones reputations will be determined. Of course a sum of publication is about quality as well as quantity. We need significant number of publications. But large numbe rof low quality publications will give arise a negative image.

One more thing is people used to publish as chunks. Or with slight modification. If you go through literature you can see similar work from same author has been published in different journals simultaneously. But now a days these are considered as very serious even in the last weeek, eight papers have retracted from Journal of Materials science, a springer own journal due to this duplication. So be careful about this too.

In fact there is a website called retarct watch which provide news about retarction of scientific publication due to several issues. Thats the one way to know, what we shouldn't do.

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Who are authors

- Colleague prepared buffers or did routine computer programming are not sufficient
- Extending research facility can't be a contribution
- People who made significant and substantial intellectual contributions
- The first author is assumed to have made the major contribution to the work
- Often supervisior is designated with corresponding author at the end

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Then there will be a question always arise, who can get authorship. If there is any Young Sheldon show fans they already should aware of this issue. Literally, anyone who contributed intellectually deserve an authorship. I have a own rule, like if something can be programmed - thats not worth an authorship. So, routine works like assisting material synthesis and running a code won't enough for an authorship.

And surely extending research facility can't be a contribution. I know, this is heavliy practised by us in Indian context as we lack of enough research facitilites. But still you should now, it is unethical.

So, someone who did major work, like from synthesis to characterization designated as first first author. Usually the guide or coordinator, who suggests or direct a research problem will be designated as corresponding author.

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Author contribution statement

- intention of recognizing individual author contribution, reducing disputes and facilitating collaboration
- opportunity to share an accurate and detailed description of their diverse contributions
- corresponding author is responsible for ensuring that the descriptions are accurate and agreed by all authors
- role(s) of all authors should be listed, using the relevant categories

Categories: Conceptualization; Methodology; Software; Validation; Formal analysis; Investigation; Resources; Data Curation; Writing - Original Draft; Writing - Review & Editing; Visualization; Supervision; Project administration

But in recent days, journals ask the excat role of listed authors. Since now a days science is more and more interdisciplinary and collaborative, most of the times everyone putforth their best. So, seconding them might hinder their contirbution.

So, by explicitly declaring the roles everyone will be treated fairly. The roles can be categorized from conceptuliztion to validation and even to the level of project administration.

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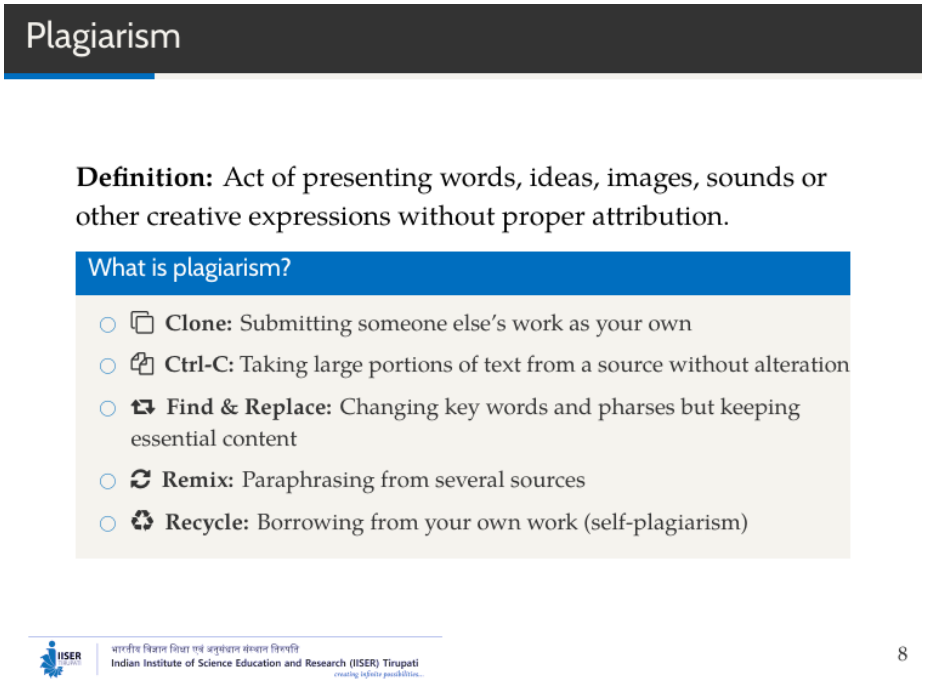

One more but an very important issue in scientific research is plagiraism. If a previously published text is cloned or simply copied or even if its remixed it falls under plagiarism. You may aware plagiarism check is the default procedure in scientific publishing even before it reaches the editorial office.

Even using your own words from your previously published text is unethical and it is designated as self-plagiarism.

Now a days UGC made it mandatory to check plagiarism even the thesis at masters level. So plagirise the text won't be a better idea for a qualitative publication.

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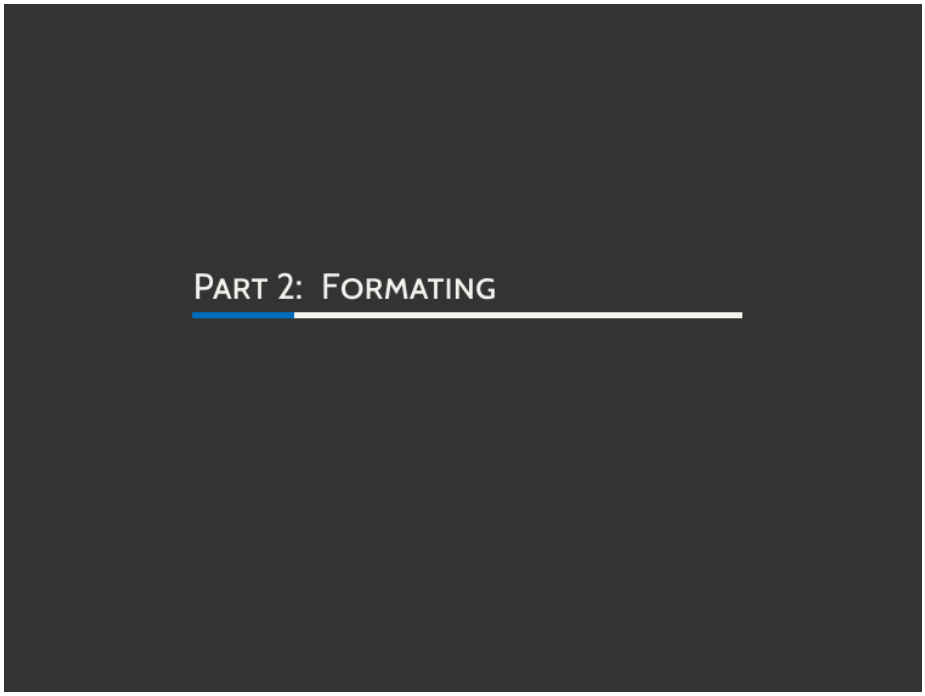

Now we will see about the general formating guidelines for a research text. Scientific publications can be broadly classfied into either as book or as journal articles. Most of the rules which we are about to discuss is same for the both the fields. So, lets start with the books.

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Types of books

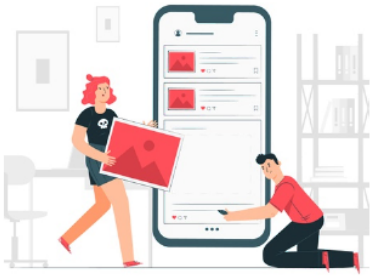
- **Proceeding volumes:** book based on meetings/conferences
- **Monograph:** books that examine a single topic in detail
- **Handbook:** large, multiauthored volumes that discuss a field in depth

Research books can be further classified into three major classes. Proceeding are the books based on meetings and conferences. Monographs are often discuss a single topic elaborately. For example often theses can be published as monograph. A handbook is often multiauthored and discuss a field in depth.

Slide 12

Types of journal presentations

- **Articles:** provide important new data and fresh approach to an established subject
- **Notes:** preliminary reports of special significance
- **Communications:** (or letters) - preliminary reports of special significance and urgency subjected length restiction
- **Reviews:** integrate, correlate, and evaluate results from published literature on a particular subject



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The journal articles can be classified into four types. Articles are the usual way to communicate a research work. Even though it is expected to be short and precise there is no page limit for them. Notes covers mostly single significant aspect in a research work. And third one is communications or letetrs, which are preliminary reports of special significance and urgency. Usually notes and communications are subjected to length restiction. Finally review articles summarizes research advancement over time in particular field.

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General structure

- define the problem, create a hypothesis, devise an experiment to test the hypothesis, conduct the experiment, and draw conclusions
- get a title that will reflect the paper's content and emphasis accurately and clearly within two lines
- extremely important step is to check the specific requirements of the publication targeted and follow them

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The general structure of any research article is it should have a problem to address. The researcher should hypothesize a possible soution and most often an experiment or theortical analysis is carried out to test the hypothesis and based on the collected data conclusion well be derived.

As we are going to see this part in detail in the following slides, lets see few important aspects in a manuscript.

It should have consise title about a length of two lines. And it should reflect the papers contents and emphasize the research work.

And remeber even though we are about to discuss the general structure, every journal have their own formating guidelines. So after a fair draft its a better idea to format the manuscript acording to journal guidelines.

But formating manuscript each and every time of submission is a pain and time consuming task. Understanding this now most of the journals accept free form manuscripts with certain clear formating. You even can submit the file as PDF and don't need to submit any production materials. Once your paper has been accepted then you have to format it according to the journal format and have to submit it back.

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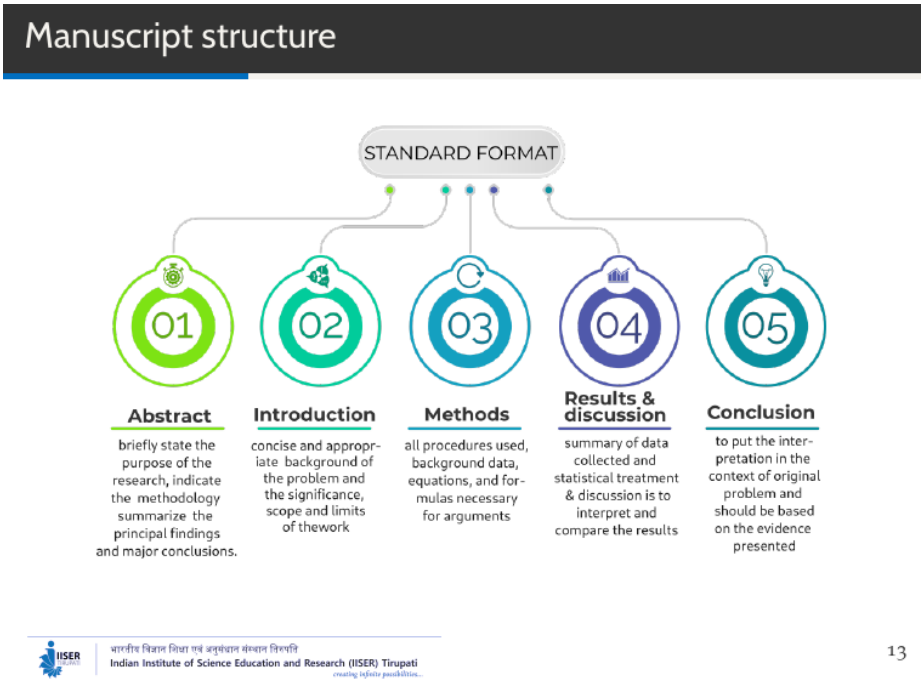

The graph shows the major part of any research publication. It should have a abstarct that should briefly state the purpose of the research, its methodology and summary of key findings. Then there is the introduction part, that should discuss the previous attempts and what is unsolved and scope of the current research work and even its limitations.

In the Methods or Materials & Methods part, brief and essential discussion about the procedures used, background data, equations should be discussed.

The data obtained from the previously described methods should be summarized in results part and the corresponding discussion and interpretation should be done here.

Finally in conlcusion section, the results in the context of original problem should be presented here.

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Few more...

- **References:** proper attribution of the contributions of others by appropriate referencing - important ideas and experiments must be cited
- **Acknowledgements:** people who have assisted in the project, but not sufficiently for authorship, and to sponsoring agencies
- **Supporting info:** data relevant to advanced reader and supporting information
- **Rule of thumb:** all aspects of the research should be fully disclosed and reasonable assistance should be given to other researchers

Apart from those major sections the manuscript should have teh following sections.

In reference section, proper attribution of research works published early should be provided. In referencing there were two aspects. One is to cite the recent works – which themselves sight an original or important work. In this way the problem look very recent. Mostly journals recommend this. Because citing a 50 year/ 100 year old publications won't contribute their impact factor. But many scientists again this proposal. I would suggest cite what you actuallu reffered and in case if you're requested to cite a recent material may be you can adopt that one.

People who have assited our research work like person who read our manuscript and offered his perspective or a friend who might have supplied you some chemicals when you re in need should be acnowledged.

Also, it is not possible to present each and every data that we obtained in a results and discussion section. That might not important in the view of present discussion but might have significant value for a seasoned researcher

So the general rule of thumb, is since most of the research work done is based on common people money we scientist should responsible for that. Only if a research work is completly disclosed it would be useful for the future advancmeent of the field.

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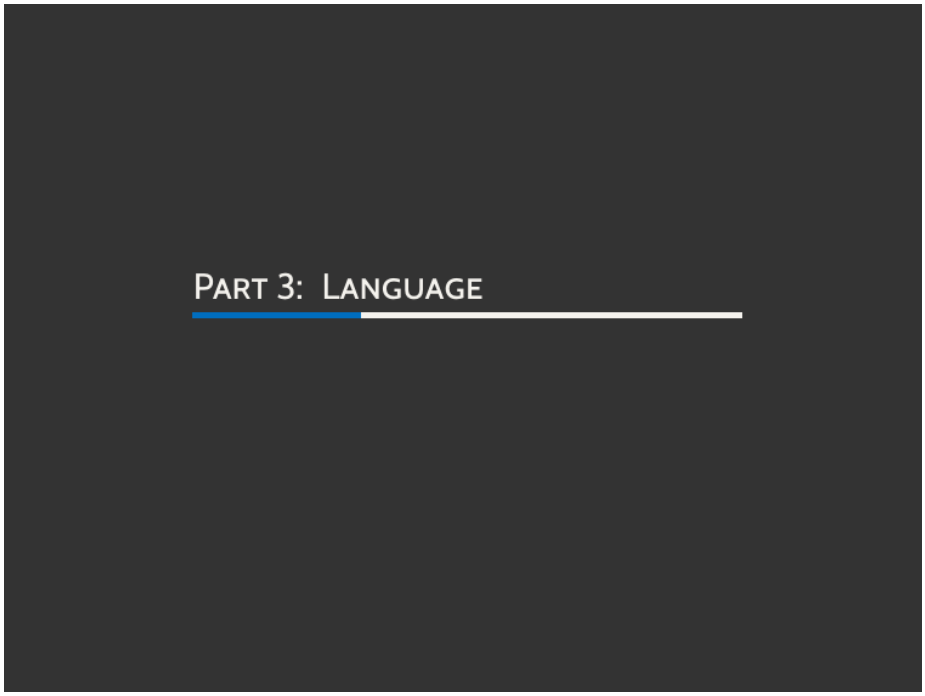

Lets move on to the language part. Here I assume that we all are going to use English as the communication language. Even if you're writing in other language the scientific descriptions could be the same.

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Sentence structure

- short, simple declarative sentences
- sentences that make statements, rather than pose questions
- straight forward and easy to read
- avoid slang and jargon

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In a manuscript, always use shor and declarative sentences. Your statements should look like a fact rather than poetry which may arise a lot of questions. Sentences should be straight forward and should be easy to read. Use love for books instead of bibilliophilia. No dosen't mean you have a translate each and every scientific word, but try to be simple.

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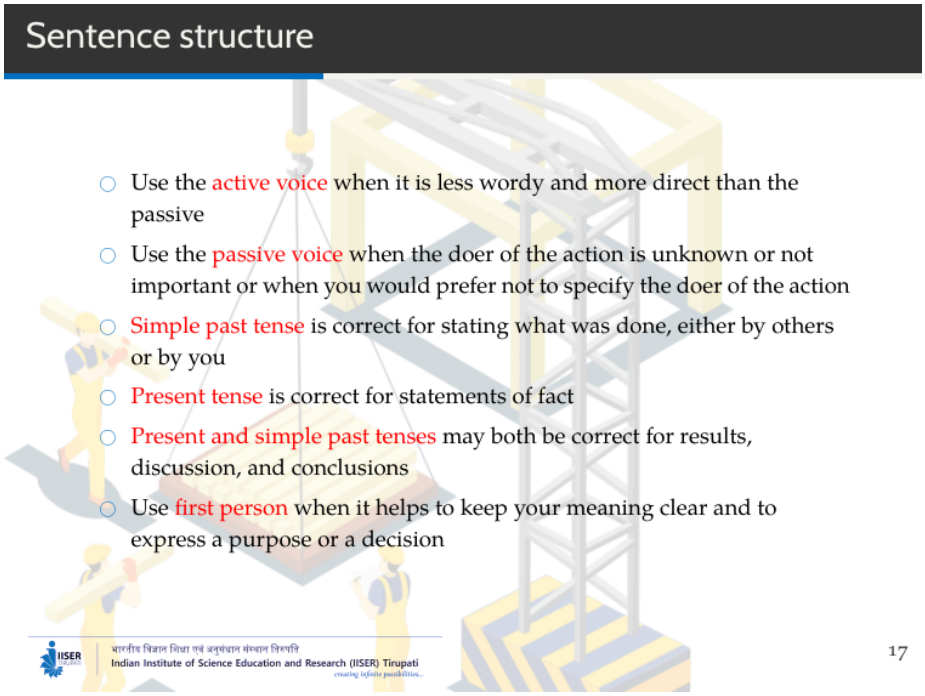

Scientist don't need to be an expert in language or in grammar. But it is important that our sentences should not confuse others. Its good to publish a paper on encryption. But it shouldn't be your paper itslef encrypted. Considering tenses and voices,

- use active voice when its less wordy
- use passive voice when the doer is not important. Like the samples were annealed at 200 deg C.
- For describe what was done use simple past and to describe facts use present tense
- Most of the paper written in the combination of simple present and simple past tense. Both are fine to discuss the results and conclusion part.
- finally, use first person when it helps to keep you meaning and express purpose or decision

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Key to right sentences

- Be brief. Wordiness obscures your message and annoys your readers.
- Omit empty phrases
- Omit excess words
- Omit too much exaggeration
- Write economically (and usually more precisely)

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Scientifc language like doing a math problem. There's no space for jargon and excessive words. Of course reverse is also true. But alwyas try to be brief. Omit emty pharses. Omit excess words. Importantly dont give too much exaggeration to the work. Even now a days journals advising researchers to avoid the word novel in their manuscript. For example if people synthesizing 1000 new materials in a year and every one designate their material as novel, the word itself looses its meaning. Finally, not only in your life, in your manuscript too, you should be economical. Spend for necessary things but always save for the future.

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Gender neutral language

- Instead of 'man', use 'people', 'humans', 'human beings', or 'human species', depending on your meaning
- Instead of 'manpower', use 'workers', 'staff', 'work force', 'labor', 'crew', 'employees', or 'personnel', depending on your meaning
- Instead of 'man-made', use 'synthetic', 'artificial', 'built', 'constructed', 'manufactured', or even 'factory-made'
- Instead of 'he' and 'his', change the construction to a plural form ('they' and 'theirs') or first person
- Using passive voice or second person ('you', 'your', and 'ours') also works sometimes
- Instead of 'wife', use 'family' or 'spouse' where appropriate

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An important aspect in language is usage is to use gender neutral language. Like any fields, in science also women are restricted to enter. So, earlier texts contains words that directly indicatin men. With advancement of societies, women are no longer any par below and their contribution are any less. So, it is advised to use gender neutral language in our research texts.

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Spacing

- Do not use square brackets, parentheses, or braces around the symbol for a quantity to make it represent any other quantity
- Use italic type for subscripts and superscripts that are themselves symbols for physical quantities or numbers
- Use roman type for subscripts and superscripts that are abbreviations and not symbols
- Exponents should follow subscripts
- Use a slash (/) in all subscript and superscript fractions, with no space on either side.
- Leave no space around operators in subscripts and superscripts
- Leave no space around other expressions in subscripts and superscripts, unless confusion or misreading would result

Brackets

- **incorrect**
  where V is volume and (V) is volume at equilibrium
- **correct**
  where V is volume and V_e is volume at equilibrium

Italic

- C_p for heat capacity at constant pressure
- C_B for heat capacity of substance B

Exponents: ${T_{2m}}^{-1}$
Slash: $t_{1/2}$
Space: $E^{(350nm)}$

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Units

- Use metric and SI units in all (possible) technical documents
- Abbreviate units of measure when they accompany numbers
- Leave a space between a number and its unit of measure
- Do not use a period after an abbreviated unit of measure (exception: in. for inch)
- Do not define units of measure
- Do not leave a space between a number and the percent, angular degree, angular minute, or angular second symbols
- Use °C with a space after a number, but no space between the degree symbol and the capital C
- Do not add an 's' to make the plural of any abbreviated units of measure. The abbreviations are used as both singular and plural

As shown in slide

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Mathematical concepts

- Define all symbols for first time you use them in the text
- Do not define standard mathematical constants such as π , i, and e
- Do not use an equal sign as an abbreviation for the word 'is' or the word 'equals' in narrative text
  eg. PV = nRT, where P is pressure (not where P = pressure)
- Do not use a plus sign as an abbreviation for the word 'and' in narrative text
  eg. a mixture of A and B (not a mixture of A + B)
- Do not use an asterisk to indicate multiplication except in computer language expressions.

As shown in slide

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Mathematical concepts (cont.)

Use italic type for:

- variables: T for temperature, x for mole fraction, r for rate
- axes: the y axis
- planes: plane P
- components of vectors and tensors: $a_1 + b_1$
- elements of determinants and matrices: g_n
- constants: k_B, the Boltzmann constant; g, the acceleration due to gravity
- functions that describe variables: $f(x)$

Use boldface type for:

- vectors
- tensors
- matrices and
- multidimensional physical quantities: **H**, magnetic field strength.

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As shown in slide

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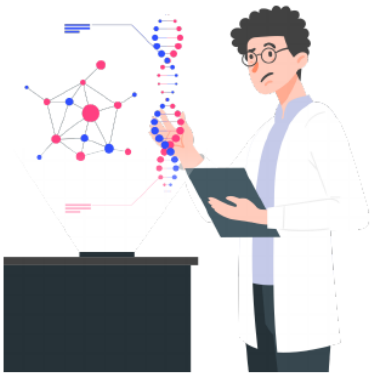
Chemical names



- Greek locants, with no space after the comma
- Use hyphens to separate locants and configurational descriptors
- Do not use hyphens to separate the syllables of a chemical name unless the name is too long to fit on one line
- 'Poly' is a syllabic prefix, not a descriptor, and no special treatment for that

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Examples:

1. β,4-dichlorocyclohexanepropionic acid

Others as in slide

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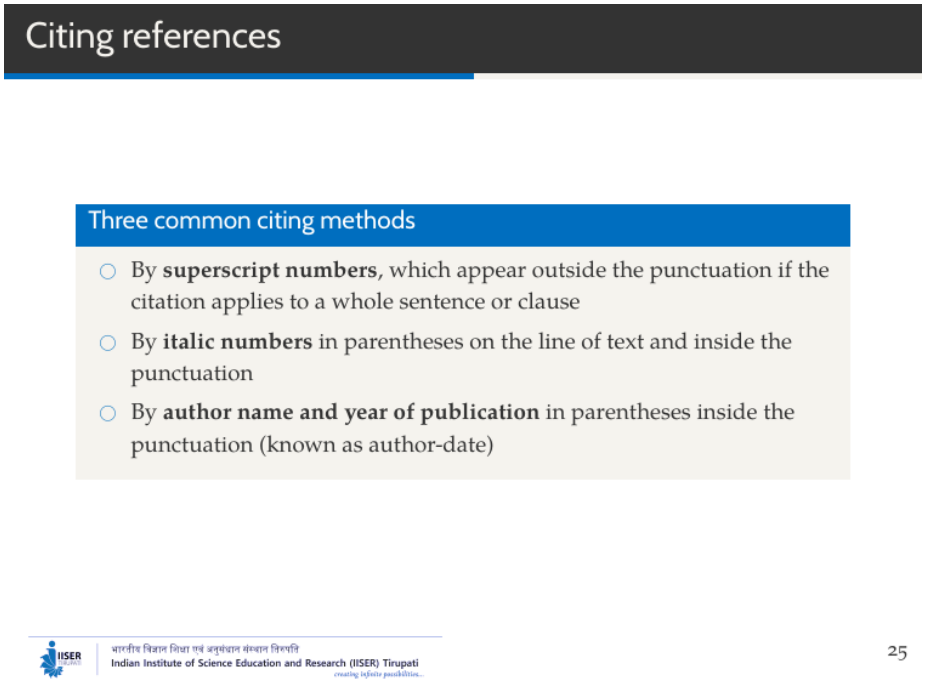

As shown in slide

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Citing references

- If a reference has two authors, give both names joined by the word 'and'
- If a reference has more than two authors, give only the first name listed, followed by 'et al.'
- Do not use a comma before et al.; always use a period after 'al.'
- To cite more than one reference by the same principal author and various coauthors use the principal author's name followed by 'and co-workers' or 'and colleagues'
- When citing more than one reference at one place by number in one of the numerical systems, list the numbers in ascending order and separate them by commas

As shown in slide

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Graph or Table?

- **Use graphs**
  - if basic point to be communicated at a glance
  - if reader to see trends and relationships
- **Use tables**
  - if the reader to see exact numbers
  - if want to communicate a lot of information with words

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When comes presenting data, there would be always an confusion like, whether I should present this a graph or as table? The thump of rule is if you want to convey the points at a glance or want to show the trends or relationship between different parameters, graph is preferebale.

For example if you record a UV absorption spectrum which has charateristic absorption peak or peaks its better to mention it in the text itself. On the other hand, you want to show the variation in absorption spectru with respect to different environments its better to use a graph.

Consider graph when you want discolse the exact numbers. For example instead of showing an AFM image it is better to list different physical parameters obatined from that studies like roughness, skewness etc.

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Tables

WHEN TO USE TABLES?

- when the data cannot be presented as narrative
- when many precise numbers must be presented
- when meaningful interrelationships can be better conveyed
- tables should supplement, not duplicate, text and figures.

HOW TO CITE TABLES?

- capitalize the word 'Table' when it is followed by the table number
- number tables sequentially with arabic or roman numerals
- discuss tables sequentially so that Table 1 is discussed before Table 2

1 & 2 as in slide
For example variation of mobility with respect to differen temperature.
follwoing as in slide

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Tables

How to prepare tables?

- formal table should consist of at least three interrelated columns and three rows
- if you have only two columns, try writing the material as narrative
- if the columns do not relate to each other use a list of items
- if table has unusual requirements, perhaps it should really be a figure
- tables should be simple and concise; arrange all data for optimal use of space
- if you have many small tables, consider combining some
- be consistent with symbols and abbreviations among tables and between tables and text
- each table should have a concise title and appropriate coulmn headings

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Figures

WHEN TO USE FIGURES?

- when the data can be highlighted, clarified and summarizing results
- figures can be graphs of data, photographs, sketches, flow charts, etc.
- line graphs show trends. Bar graphs compare magnitudes
- pie charts show relative portions of a whole
- photographs can provide absolute proof of findings
- excessive number of figures can dilute the value of any individual figure

HOW TO CITE FIGURES?

- capitalize the word 'Figure' when it is followed by the table number
- number figures sequentially with arabic numerals
- parts of the figure can be designated as combination of arabic and roman numerals or even alphabets

Overall, figures should give more understanding and be less complex

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Figure preparation

- for high qulaity printing `TIFF` or `EPS` formats preffered
- for web-rendering `JPEG` or `GIF` formats preffered
- `PNG` and `PDF` formats are universal
- set figure resolution to 300 dpi; 600 dpi is preffered for photograps; scan can be between 800 - 1200 dpi
- use similar font to text - make sure the font copyright
- follow color trends in subsequent graphs

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Note on copyright

- most often publisher own the copyright of the manuscript
- authors requested to sign a copyright transfer form
- an exclusion is paid or open source journals
- utilization of data from previous publicatins require proper permission
- CC license can be used based on license terms
- all material should be attributed properly

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Sometimes you may need to use figures or tables or someother material from the previous publications. Unless explicitly declared all the scientific contents are copyright potetected. Once your manuscript has been accepted for publication, the published would ask you to provide a copyright transfer form. It means all the copyright of the text has been transferd to the publisher. After this even for use your own figures and tables you have to get proper permission from the publishers. So open access journals like Nature Communications or RSC Advances, charge you an amount and will publish the manuscript as open or in creative common license. Open means people can freely access the manuscript and CC includes many terms that includes anyone can use any thing without any permission. In all the cases proper attribution is required.

One thing I want to mention here. Sometime people download an image from internet and cite it as from google. It is like you get some article from google search and cite it like from google. We should find the actual source of the image and that should be cited.

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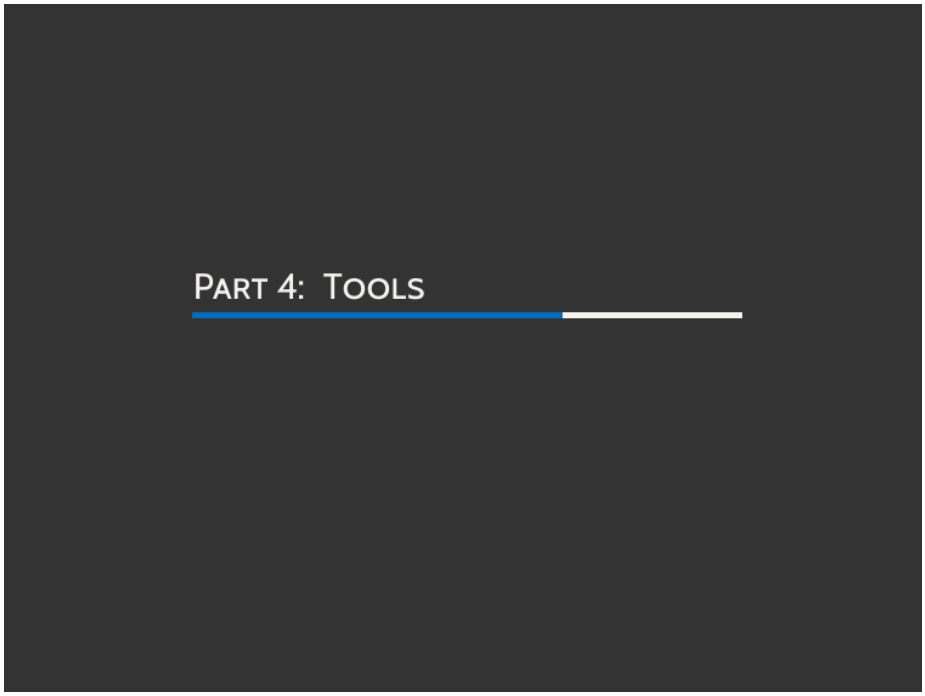

Now let us move on to the tools part. Research writing requires different tools for writing to graphing and other related works. Here I summarize few tools which I have either used or tested. Since science is very braod area and there were numerous inter disciplinary based softwares one may not know each and every tool. So here I provided a generalized version.

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Types of packages

- open source
- freeware
- shareware
- network license
- single user license
- software as a service (SaaS)

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Writing tools

WYSIWYG Editors:

- Office packs: Combine word processor, sheets and presentation softwares
- Cloud based tools are preffered now **eg:** Office 360 & Google Docs
- LibreOffice is powerful alternative

But not suitable for big documents like thesis and vc

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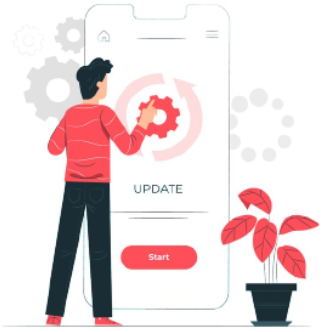
Version Control



Definition: Version control involves a process of naming and distinguishing between a series of draft documents which lead to a final (or approved) version, which in turn may be subject to further amendments.

- traceability
- identifiability
- clarity
- reduced duplication
- reduced errors

AIS

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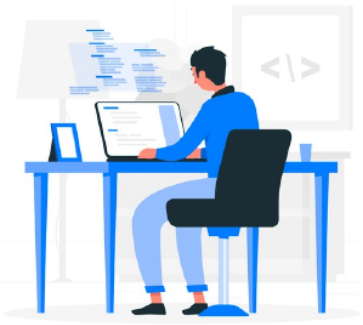
Text based processors

- text based editors are great for version control
- two major languages are: LaTeX | MarkDown
- GUI editors: Gedit | VS Code | Atom
- CLI editors: nano | vim | emacs
- standalone packages: Kile | latezila | typora | simplenote
- repos: Github | Bitbucket | GitLab



AIS

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Graphing Packages

- GUI packages: Origin Pro | SciDaVis | Kst | Grace
- CLI editors: gnuplot | KMplot
- Note: check line densities in MS EXcel
- others: XYplot

KST for astronomical data

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Simulations

- MatLab | Octave | SciLab
- Mathematica | SageMath | Maxima
- R | GoLang | Python | Julia
- Always check: stackexchange | stackoverflow
- *Note on:* IPython and Jupyter notebook

Numerical computing Computer algebra system

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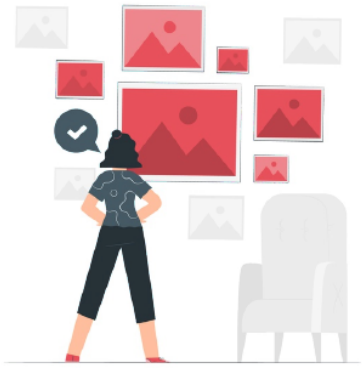
Images & drawings



- Images: Photoshop | GIMP
- Drawings: TGIF | Illustrator | InkScape | CorelDraw
- 3D: Maya | Blender | Google Sketch | LightWave
- others: MS Publisher | LibreOffice Draw

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Chemical drawings & simulations

- Sketch: ChemDraw | ChemSketch | MarvinSketch
- Visualization: Avogadro | Gabedit | Pymol | Mercury
- Simulation: Gaussian | ORCA | MOPAC
- Structure: IUPAC | COD | RCSB-PDB

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Language tools

- Grammar: Built-in tools
- Online tools: Grammarly | Language Tools | Slickwrite
- Others: WhiteSmoke | Ginger
- Plagiarism: Urkund | Prowriting Aid | Paperrater
- Good with pyhton? Check github repos for self checkers

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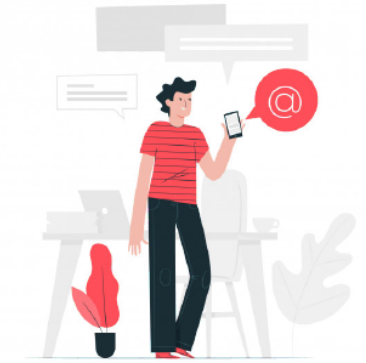
Reference managers

- Mendeley | Zotero | EndNote
- Google Scholar | Scite.ai
- Bookmarks: Raindrop | Pocket
- Paperpile | Citavi | JabRef



Scite.ai

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Preprints & journal selectors

List of preprint servers:

- *Difference between preprint & journal article*
- Arxhive | Zenodo
- ChinaXiv | INA-Rxiv
- Chemarxiv | Bioarxiv | Engrxiv
- OSF Preprints | Preprints.org

Journal selectors: Edanz | Cofactor

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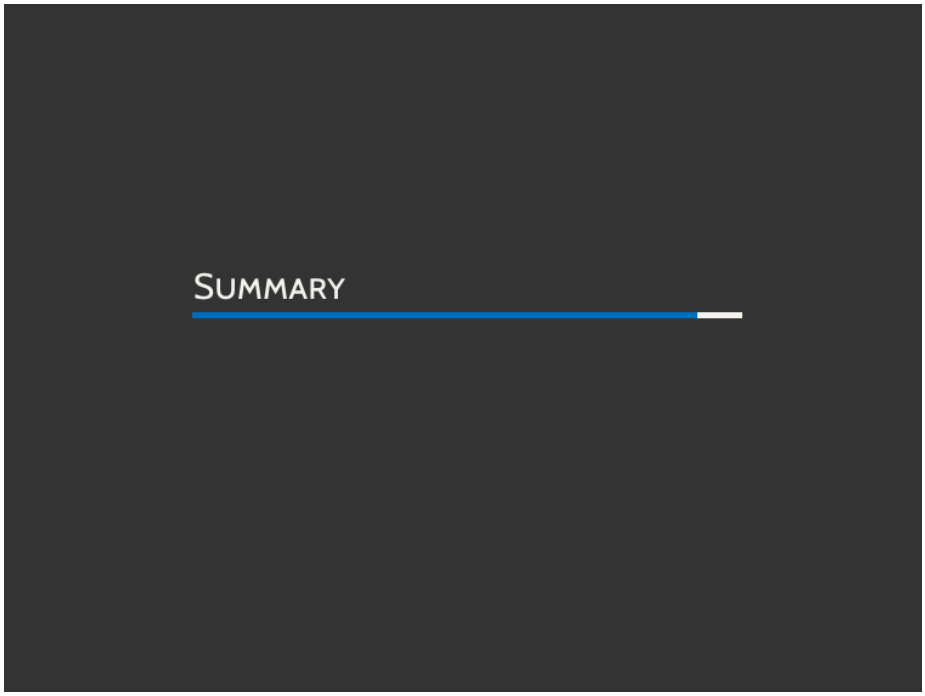

So here's the take home message.

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Take home message

- Ethics: ground rules
- When & what to publsih?
- Language and formating
- Which tool to choose?

- Be sure your work is ethical and you followed all standard guidelines
- Publish when you feel the work is complete - not publish for credits alone.
- One better way is internal circulation among peers or seniors and ask their comments
- Make sure proper language and formating rules are applied to your manuscript.
- Again the better way is ask a friend or senior colleuge for comments. If possible you can contact the language department experts.
- And if you're rich enough can go for journals language assitance option
- Regarding tools, I would suggest you to consider open-source. After all science doing science is mostly non-profit, usage of tools may also be. Moden open source tools are equivalent and in some cases much better than the commercial tools. Take GIMP or InkScape, I personally feel they are much better than Photoshop or illustrator. But its upto you. People often go for pro version due to the reason they're available as pirated version. This might also create some issue in feature. More and more softwares are network oriented, it is easy to detect a pirated copy. Then you're supposed to buy one or have to adopt a open source software which includes a learning curve. But its all upto you. The soldier chose his own weapon.

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Selected Read

1. Barrass, R. Scientists Must Write: A Guide to Better Writing for Scientists, Engineers, and Students, 2nd ed.; Routledge: London, 2002.
2. Day, R. A. Scientific English: A Guide for Scientists and Other Professionals, 2nd ed.; Oryx Press: Phoenix, AZ, 1995.
3. Zinsser, W. Writing To Learn; Collins: New York, 1993
4. AIP Style Manual, 4th ed.; American Institute of Physics: New York, 1990
5. ACS Style Guide, 3rd ed.; American Chemical Society: Washington DC, 2006

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At the end of the day I wish to express my sincere gratitude to some my friends and colleuge who always supporting me and especially supported me by lending their expertise to make this talk possible.

I thank,

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Finally thank you all for your participation. Especially for the ones who didn't leave the screen after login. I think its not possible to address each every ones querys. So if you have some suggestions or questions, you can right an email to me. Thanks again.