

REVIEW ARTICLE

The Art of Writing a Scientific Research Paper - A Guide to Beginners

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Abstract

The best authors are made, they are rarely born. For most of the novice writers, writing a scientific manuscript is quite an intimidating process. Keeping this in mind the inexperienced authors can follow certain guidelines or rules to sculpt their skills on writing an effective scientific paper and strategies for successful revision. Common errors can be avoided, thus streamlining the process and gaining the deserved success. Authors can thus use this article as a brief manual for successful publications.

Keywords: Guidelines and tips, journal publication, research paper, Scientific writing

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Introduction

Conducting clinical and scientific research are only the early steps of the scholarship of discovery. For this research to be accessible to professionals all around the globe and also for it to create awareness in the community effectively, it must be penned down correctly and wisely. Most of this research gets published in peer review journals where 2-3 peers in the concerned areas evaluate it, following which it is either sent back to the corresponding author for revision with queries(if any) or decided to be accepted or rejected. Because of this rigorous process and the strict selection, scientific journals have now become the newest and most relied source of new information that has a potential effect on the clinical decision making and practice. The process of writing a paper is a very time consuming and formidable task but this very process helps in the process of scientific thinking. The successful publication gives great contentment to the researcher and also enables dispersal of research, novel ideas, and alternate thoughts; which ultimately helps the scholarly discussion.⁽¹⁾ There are various types

of scientific contributions such as Primary research articles, Review articles Editorials, Trade publication articles, thesis etc.

Author and Co-author

Authorship confers responsibility and accountability of the published work. The author is given credits for the substantial intellectual input in the scientific field.

There are four main criteria for authorship

Criteria for authorship

1. Contribution to the concept, design, acquisition, analysis & interpretation of data for work.
2. Revision and drafting of the work for an intellectual matter.
3. Acceptance of the version which will be published
4. Accountability for the complete work in order to ensure that questions regarding the accuracy and integrity are investigated and resolved correctly

The corresponding author must take the main responsibility for keeping in touch with the

manuscript processing portal of the journal during manuscript submission, review and publication. He should also be responsible for submitting all the administrative requirements of the journal like the details of authorship, approval of ethics committee, clinical trial registration paper work, and gathering conflict of interest documents.

When a group of writers has collectively carried out the research or written it, the decision must be made in advance as to who will be the prime author. The remaining will be co-authors and also need to meet the above mentioned 4 criteria. If more than 4 co-authors exist then 'et al' can be used.

Also, contributors who meet a little less than the 4 criteria but who have helped in the work or contributed to the paper must be acknowledged in the end.⁽²⁾

Importance of writing effective Keywords, title, and abstract

The key to successful publication lies in its keywords, title and the abstract. The three elements operate in a system equivalent to a chain reaction. Once an effective title has successfully garnered the reader's attention and the keywords have assisted people in finding the research article, it is up to the abstract of a research paper to further stimulate the reader's mind and maintain their curiosity.

The words found in your title and abstract and your list of keywords are used by most of the electronic search engines databases or journal websites to decide whether and when to display your paper to interest your reader.

Without these three elements which thereby enable the dissemination of your research, the readers would not be able to find or cite your paper.

An impetuous or hasty attitude towards the writing of these three important components of the research paper format will be analogous to leaving the accessibility of the research article on luck, indirectly nullifying the time and money spent on the research and publication process.⁽³⁾

Effective paper title

It is rightly said, "First impression is the last impression". Well, it definitely holds true in

the field of publication and research. Readers take a quick preview of research paper titles in searches through databases and reference section of research papers. They conclude what a paper is about and if it's relevant to them based on the title. It could now be said that the title of your paper most importantly determines the number of people who will read it, thereby it should be compelling enough for the reviewer, or reader to want to read on.⁽⁴⁾

A good research paper title

1. Accurately highlights the essence of a scientific paper.
2. Captivates the reader's interest.
3. Helps in differentiating the paper from other papers of the same subject area

Three basic tips to keep in mind while writing a title

1. *Keeping it Simple, Brief and Attractive is the cue*

To provide a precise summary of the paper's content is basically the primary function of the title. The title should be clear in stating the objective. Active verbs should be used instead of complex noun based phrases and unnecessary details should not be provided. Moreover, a good title for a research paper is usually around 10 – 12 words long. A lengthy title may shift the focus of the reader to another tangent.

2. *Abbreviations and Jargons should be avoided*

Lesser known or highly specific abbreviations which are not immediately familiar to the readers should not be used.⁽⁴⁾

How to select keywords

Keywords are words that capture the core content of your paper. Keywords make your paper easier to search and ensure that you get more citations. Keywords should always be written down in alphabetical order. It is indispensable to include the most important keywords that will help other authors find your paper.

Basic tips to write keywords

1. Keywords comprising of phrases of 2 to 4 words is ideal; single word keywords are also accepted, but they may falsely lead to many irrelevant matches.
2. Consider the reader's point of view and think about the keywords a reader would search in order to retrieve your article.
3. Keywords are usually picked from those words that are used repeatedly in the text. Words and phrases that are closely related to your topic should also be included.
4. Also, include the full forms of shortened words or acronyms and abbreviations.
5. Needless repetition should be avoided. For example, if the keyword "Clinic" is specified, there is no need to also request "clinical". Any match found with the latter, would be found with the former already.

General writing tips

"Our end was just the beginning." (Yuri Popoff, bassist, and composer from Minas Gerais). A scientific paper is one of the major means of uniting professionals from all across the globe of different cultures and disciplines. Writing a scientific paper is an art and it requires practice, vision and good communication skills. It is rightly said that a pen is mightier than a sword. Clarity in thoughts, the simplicity of words and accuracy are three key points to remember for a well written scientific paper. The most important 5 criteria in deciding whether to accept manuscripts for publication by reviewers are:

1. The importance, timeliness, relevance, and prevalence of the addressed problem.
2. Writing style quality
3. The applied study design
4. The degree to which the review of the literature was thoughtful, focused and up to date.
5. A sufficiently large sample size.⁽⁵⁾

Considering all the above points there are a few basic and general tips on manuscript writing.

➤ **Begin with the end in mind**

A specific target journal should be kept in the mind once you begin writing.⁽⁶⁾ For their readership, every journal has a specific list of

manuscript categories that they require. Hence always carefully check the journal requirements and the submission criteria before preparing your manuscript.

General Writing Tips

1. Begin with the end in mind
2. Describe ideas, protocols and outcomes accurately
3. Use figures and graphics where necessary
4. No plagiarism and inadvertent citation use
5. English proof reading

➤ **Describe ideas, protocols and outcomes accurately**

The primary goal in scientific writing must be accuracy and clarity in expressing thoughts and research information.⁽⁶⁾

Vague terminology should be avoided and long sentences must be replaced with shorter and simpler ones. The language of the paper must be formal and scientific. Slang language and regionally specific nomenclature (nicknames) must be avoided. According to the journal specifications generally the third person language is preferred. Also, the tense, grammar, spelling check must be checked before submitting the manuscript. Many times despite good content these small correctable errors cause rejection because it shows that less thought was put in the manuscript.

➤ **Use figures and graphics where necessary**

Figures exponentially increase the visual appeal of a paper. Graphics include tables, charts, graphs, and pictures. All these must be self-explanatory and clear. The images must be preferably colored and should not be pixelated or blur. The digital images must be at least 300dpi. Many journals want only one image in the end and thus all the images must be collaged into one color-plate. The photographs must always be attached separately and not be a part of the paper. Any figure which is taken from a journal or any other source must be cited and the credits must be given to the respective author for the same.

Short video clips speak a thousand words and also add great descriptive value to the paper. ⁽¹⁾

➤ **No plagiarism and inadvertent citation use**

Use frequent citations to avoid plagiarism. The whole idea behind citations is to give due credit to the author for their original idea. All the citations must appear as superscripted followed by a punctuation mark. All the citations must be written in the correct manner according to the journal requirement. ⁽¹⁾

➤ **English proof reading**

The superficial errors in spellings, grammar, syntax, punctuation, and formatting are all a part of what proof reading focuses on. This is normally done at the end of the writing process as the last step before submitting the paper.

How to write the abstract

Definition:

An abstract is a quick and accurate summary, of about 250-300 words, which comprises the major aspects of the entire paper in a sequential order.

Order in abstract

1. Overall aim of the study and research problem you investigated
2. The materials and methods used in the study
Major findings and outcome of the analysis
6. Brief summary of the interpretations and conclusions

➤ **Types of abstracts**

1. Critical Abstract

The critical abstract additionally provide a comment about the validation and completeness of the study. It is usually about 400-500 words in length.

2. Descriptive Abstract

Descriptive abstract outlines the research rather than summarizing it. It describes the type of information found in the study. Descriptive abstracts are usually lesser than 100 words.

3. Informative Abstract

Most of the abstracts are informative. The informative abstracts include the results and conclusions of the research and recommendations of the author. An informative abstract is usually not more than 300 words.

4. Highlight Abstract

A highlight abstract is specifically written to gain the readers interest. It may contain incomplete sentences to cater the reader's attention. It cannot stand independent of its associated research and thus it is infrequently used in research writing

➤ **10 steps to write an abstract**

1. Once you have finished writing the paper, you can begin writing the abstract.
2. The essential objectives and conclusions from the introduction and conclusions sections are to be taken.
3. Pick out the key sentences and phrases from your METHODS section.
4. The major results from the RESULTS section are identified.
5. Now, the selected sentences and phrases are arranged in the prescribed sequence: Introduction, Methods, Results, and Conclusions.
6. Keep in mind the following basic writing tips: Information that is not in the written article should not be referred in the abstract. Avoid trade names, acronyms, abbreviations or symbols, the usage of which makes it mandatory to explain them thereby occupying more room. The title should not be rephrased or reframed. Usage of active voice over passive is preferred. Get to the point quickly and always use the past tense because you are reporting on a research that has already been completed.
7. Remove all unnecessary sentences and the sentences should be linked in such a way that there is a smooth transition of information preferably in the following order: basic study format, methodology, and techniques used; major results; summary of your interpretations, conclusions and implications.
8. There should be consistency between the information presented in abstract and in the paper.

9. Request a colleague to review your abstract and confirm if all the sections have been clearly stated.
10. Finally, the abstract should meet the guidelines of the target journal; Word limit, abstract type, recommended subheadings. etc.⁽⁷⁾

Paper writing is an intimidating process⁽⁸⁾ but by following simple rules it can become a friendly and easy journey. The main aim of any academician is to put forth his study outcomes or thoughts in the form of a paper for a majority of people to gain access.⁽⁹⁾

How to write the introduction

It is correctly stated by Euripedes” A bad beginning makes a bad ending”.⁽¹⁰⁾ Writing the introduction can often be a daunting and terrorizing, as it should stimulate interest and evoke a thought process in all the readers.⁽¹⁰⁾ It involves accurate and efficient communication of ideas, in a way that the reader feels that the research question is clear and worth of study^(1,11) an appropriate introduction should be inclusive of at least four concepts.⁽¹⁾

Concepts of Introduction

1. The importance of the topic and the reason for undertaking the study
2. The information gap associated with the currently available literature under the same heading
3. Relevant and concise literature review
4. Finally ending with a hypothesis and a brief summary of the study.⁽¹²⁾

The introduction should be written in present tense.^(1,10) One of the commonest errors made while writing the introduction is not clearly stating the problem to be addressed.⁽¹²⁾ The writer must build up an argument that would convince the readers regarding the significance of the study and the problems that form the core of the study.^(1,11) Another commonly made mistake is an exhaustive and thorough review of literature which is often unnecessary and leads to deviation from the main topic.⁽¹⁰⁾

The introduction should end with the purpose or the hypothesis of the study⁽¹⁰⁾ though it may seem repetitive; the writer must ensure that the reader clearly understands the evolution, importance and critical aspects of the study.⁽¹⁾

How to write the methods of the study

The information provided in this section ultimately decides the validity of the research.⁽¹³⁾ It should provide a clear and condensed description of the procedures involved and the rationale behind the same.⁽¹³⁾ It should have sufficient details so that an appropriately trained person can replicate the experiment, Furthermore, the readers can judge the validity of the results and conclusions projected later in the article.^(1,13) The writing should be in the past tense.^(10,13) The method should be described in a logical sequence.

Sequence of Materials & Methods

1. The subjects and materials used in the study
2. Explaining how the materials were prepared
3. Ethical Considerations
4. Protocol Design
5. Analysis of Data

1. The subjects and materials used in the study

If human subjects are included, descriptive data regarding the demographic details, age, gender and racial composition of the sample population should be mentioned.⁽¹³⁾ In case of animals, the species, strain, weight, sex, and age should be specified.⁽¹³⁾ Therefore this includes the Inclusion and Exclusion criteria laid down for the study. For any survey or questionnaire based study the number of people to be involved is decided by the statistician by using appropriate sample size formulae reviewing past literature or the key article that one has referred. Also each subject involved in the study must be given the consent form and also informed about the entire study protocol and method. For the

materials involved or any culture samples, tooth samples etc appropriate storage and transportation criteria must be mentioned.

2. Explaining how the materials were prepared

Population studies should include the manner in which data is collected from the patients.⁽¹⁰⁾ Similarly, studies involving animals should include a detailed description of the method of sedation, anesthesia, route of administration etc.⁽¹³⁾ In case it involves any drug(s), the generic name along with the manufacturer, dose, concentration and route of administration should be specified.

3. Ethical Considerations

Projects involving human and/or animal subjects must have documentation of ethical approval by an appropriate Institutional review board.⁽¹⁰⁾

4. Protocol Design

The exact sequence of procedures and manipulations should be described in the study, along with an overall study design.⁽¹³⁾ The rationale and assumptions on which the procedures are based are not always obvious to the readers, especially when it is directed to a general audience instead of a subspecialty. Therefore, if not detailed, at least a brief explanation of the experimental procedure is of utmost importance for facilitating the basic understanding of the readers.⁽¹³⁾

5. Analysis of Data

The last portion describes the way in which data will be presented in the results section (mean vs. median)⁽¹³⁾ the statistical power based on various statistical tests performed, sample size, statistical software used.⁽¹⁰⁾ One may require assistance from a professional statistician in order to complete data analysis.⁽¹⁰⁾

How to write the results

This section forms the core of the paper.⁽¹³⁾ It is of utmost importance to distinguish the results of your paper from the discussion section.⁽¹⁰⁾ Therefore it should contain nothing other than data. No interpretation, inferences or references to other articles, just data.⁽¹⁴⁾ Graphs, tables, and figures should be used for

clear depiction of data, if the text alone is too long or difficult to understand.⁽¹⁰⁾ However, use of minimal but sufficient text to explain the data is a must.⁽¹²⁾ All the tables and illustrations should be clear, reliable and numbered in the correct sequence so that the readers do not have to constantly refer to the text to understand them.⁽¹⁰⁾ Journal specifications must be checked for their requirements as some of the journals want a particular order of data, tables, graphs/figures and also few require the tables etc. to be the last part of the paper. Out of all the graphs bar charts are the most commonly used type to depict data. If the tables used in the manuscript are already published in another paper, permission should be obtained beforehand, from the copyright owner.⁽¹⁰⁾ Additional results which are not explained in the discussion section should not be included.⁽¹⁾ Ultimately, the data should always be supported by statistics. Statistical significance of the results with the p values must be reported along with the tests used to evaluate the significance.⁽¹⁰⁾

How to write the discussion

The purpose of the discussion section is to put the results in a broader context.⁽¹⁾ All the results included in the above section have to be described in detail and not just the statistically significant ones.⁽¹⁾ Many papers with interesting results are rejected due to inadequate or incorrect interpretation of data.⁽¹⁰⁾

Points should be in the Discussion

1. The major findings of the study along with explanation
2. Draw comparison with other related published articles
3. Addressing the strengths and limitations of the study
4. Discussing the implications and clinical significance of the study
8. Suggestions for further research.⁽¹⁰⁾

One of the greatest pitfalls in writing this section is overstretching the details and significance of your results.⁽¹⁰⁾ It is

inappropriate to make strong statements like '... the study proves that....' or '... means that....' Words like 'suggest' 'support' 'possibly' 'likely' should be used to soften the findings.⁽¹⁰⁾

The entire length of the discussion must be put in 6-7 paragraphs and must be lesser than the sum of other sections(Introduction, material and methods, and results). The maximum number of words in any paragraph must be 200 words.

The entire discussion section can be further divided into three parts

1. *Introductory*

It should contain the prime idea of the study performed and without repeating the 'introduction' in the earlier section. The paragraph should start with an unquestionable sentence. The basic findings of the entire study must be summarized in the first paragraph only.

2. *Intermediate*

The main approach for this paragraph must be the 'divide and rule' tactic. Each finding of study must be written down in the order of importance and it must begin with an undisputable sentence followed by a couple of supporting sentences. The past literature findings regarding your study can be mentioned for reinforcement of your findings. One can also state whether the findings were in accordance or in conflict with the previous study results.

3. *Concluding*

The last part of the discussion must contain that strongest point of your study without using extremely assertive sentences. The limitations of the study can be mentioned in this part. Also, any future directions or potential future applications can be stated.⁽⁹⁾

Conflict of interest

Any manuscript for articles, original research reports, and editorials etc. which are submitted to any journal must be accompanied by conflict of interest disclosure or statement stating that none of the authors have conflicts of interest to declare.

Copyright form

When submitting any article to the publisher the copyright form must be submitted which states that the manuscript has not been published or considered for publication elsewhere.

How to write references

While writing any scientific paper any information which is obtained from any journal, article or any other source must be cited. One can provide more than one citations for a sentence if several studies have proven the same. A statement of fact which is not common knowledge must be cited properly. Any number or piece of a date that one has written in their manuscript also needs to be cited. If multiple sentences in one paragraph are taken from one particular source one cannot cite it at the end of the paragraph. Instead, every sentence needs to be cited. The various sources of information can be: Journal article, Books, Chapter from a book, M.S. thesis or Ph.D. dissertation, Government document, E-journal.

All citations must include

1. Author- this is the first piece of information. The first author must be listed by surname, followed by a comma and his/her first and second initials. If two or more authors are responsible for the information, the remaining author(s) must be listed with their initials followed by their surnames. In the text of the paper one can use the Latin term 'et al' for more than two authors but not in the bibliography section.
2. Year- this is the second piece of information. The year corresponds to the year of publication of the journal, book, e book etc.
3. Title- The third piece of information is the title. The first word and proper nouns are the only two which should be capitalized in the title.
4. Journal Name, Volume Number, and Issue Number- The fourth piece of information is the name of the journal in which the article was published, followed by the volume in which it appeared and the page numbers on

which it was printed. Some journals also need the book information.

There are various styles of referencing like the MLA, APA, Vancouver, Harvard, Chicago etc. one must carefully read the journal publication specifications and cite it the corresponding manner.

Conclusion

Writing a scientific paper may be an intimidating yet highly satisfying endeavor. For a novice author following certain simple methods and steps can enable them to have developed skills of communication to put forth their ideas and research. Also by abiding by these ground rules can help eliminating errors which cause rejection. Hence, the impact of our research, ideas, treatment protocols and policies are judged by the fineness of the literature that one publishes.

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