



WASP (Write a Scientific Paper): Structuring a scientific paper

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ABSTRACT

Writing and publishing scientific papers have become requisites for all scientists (researchers and academics alike) to maintain their professional career. The prospects of writing a scientific paper are often regarded as somewhat daunting to the uninitiated. However a universal, well established structure format known as “IMRAD”: i.e. Introduction, Methods, Results And Discussion has been established. This paper details this methodology.

1. Introduction

With the dictum of “publish or perish”, publishing scientific findings is becoming an essential task faced by all scientists (researchers and academics). Furthermore, publishing scientific papers enables the scientist to increase the success rate for obtaining research grants in the future as well as promote the researcher's personal success and future job prospects [1]. Moreover, the publishing of research results showcases scientific work and makes it accessible to other professionals [2]. However, most scientists may not envisage themselves as qualified writers and may find scientific paper writing arduous and even intimidating. However, the structuring and writing of a scientific paper follows a number of steps that if followed, will lead to success. Hence, with the established step-by-step guideline at hand, the scientist can focus effectively on conveying and communicating novel ideas.

Before embarking into the first draft of a paper, the scientist needs to “get into the mood” for scientific writing. Furthermore, the scientist needs to have a clear vision of the aim and scopes of the paper that he/she is about to engage in. This will ensure the execution of a high quality paper that is likely to be accepted for publication. Identifying a suitable journal that most likely will publish the submission from the outset, helps set the author's mindset towards the style and layout required. [3]. It is also essential for the scientist to overcome any barriers to effective writing such as: poor writing habits, lack of confidence in writing ability, fear of failure, lack of experience and writing anxiety [2]. Practice however makes perfect.

Scientific research papers are published in peer reviewed scientific journals. There are two types of journals that one can publish in: subscription based and open access [1]. Journal articles can follow a

multitude of different formats such as an original article, case report, letter to editor, review etc. This paper will discuss the step-by-step format of an *original research article*. The structure format is broadly based on the “IMRAD” structure: i.e. Introduction, Methods, Results And Discussion. When writing a scientific paper, the sentence structure should be in the third person while avoiding vague terminology or slang language.

2. Structuring of a scientific paper

2.1. The title

The title of the paper needs to be eye catching and intriguing for the reader while highlighting the subject matter. The title should be specific and short, but comprehensive and sufficiently descriptive. Any “waste” of words such as “A study of...” or “Investigations of ...” or “Observations on ...” etc. should be omitted. It is essential that the title does not contain any abbreviations and if the paper is focused on a particular disease or region, this identifier should be within the title.

2.2. The abstract

The abstract is positioned just after the title and is the game changer for the scientific paper. The abstract either impresses the editor and the reader and coaxes him/her into reading the whole paper or else it puts him/her off, discarding the paper altogether. The abstract is the second most read section of the paper (after the title). It needs to be able to stand-alone and be as succinct as possible [4]. This section must be concise with a word limit, which is usually around 250 words. It is

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essential for the abstract to showcase information that appears within the paper. It should avoid any additional information added over and above that found within the main text. It is customary that this section is written last after the whole paper has been finished and finalized.

The abstract is a summary of the paper and is typically structured into “background, aim/objective, methods, results and conclusions”. The ‘background’ section clarifies the significance of the study in a clear and concise manner. The context and rationale for performing the research study need to be defined. The ‘objective’ section needs to contain a clear statement of the research question/s and the purpose for conducting the research. The ‘methodology’ section needs to be basic and only give an outline of the type of research conducted and parameters assessed. The ‘results’ section needs to be concise and illustrate the most important findings of the research study. Only the established main conclusions need to be stated in the ‘conclusion’ section.

2.3. Keywords

It is customary that a list of five to six keywords is provided just after the ‘abstract’ section. Keywords are composed of one or two words that describe the article and serve as keys to indexing and abstracting services. The ‘MeSH on Demand’ tool from the US Library of Medicine provides acceptable scientific keywords [5]. Judicious use of keywords may increase the ease with which interested parties can locate the article in a database search e.g. in PubMed or Google Scholar

2.4. Introduction

The introduction of the paper should set the stage by outlining extant knowledge about the topic under consideration. Gaps within the current knowledge need to be pointed out while illustrating the rationale for conducting the current research and how it would help fill in the gaps. The introduction thus needs to answer two questions: “What is the paper about?” and “So what? - Why should the reader care?” [6].

The scientist therefore needs to clearly provide the scope, novelty and significance of the paper. The introduction should first start with a general introduction on the topic then move to the specific gap/niche that the research performed aims to address. It is important that unnecessary background information is not included in the introduction section. Neither should the author over-exaggerate the importance of the current research work [6].

The introduction should conclude with the purpose/s and hypothesis/es of the research work. This should clearly relate to the knowledge gap that was earlier discussed [2]. It is paramount to avoid plagiarism. When relying on the work of other workers, only referenced paraphrasing of the literature is acceptable. Indeed, referencing of all literature is paramount while avoiding plagiarism.

2.5. Methods

The method section needs to answer the ‘what’ and the ‘how’ of the study. It should have sufficient information to allow any other researcher to replicate and confirm the work being presented [7]. Hence, a detailed description of all the study populations, the materials, procedures, theories and definitions used in the research need to be included in this section, along with all the calculations, techniques, equipment and calibration plots used. The inclusion and exclusion criteria need to be stated clearly. There are a number of readily available checklists and guidelines that can be used when reporting different research studies designs methods. These include the CONSORT guidelines for randomized control trials [8], the STARD checklist for diagnostic accuracy studies [9] and the PRISMA checklist for meta-analyses or systemic reviews [10]. ‘A picture is worth a thousand words’, therefore the use of graphical designs such as the CONSORT Flow Diagram Format may be more appropriate to illustrate multiple study groups.

Furthermore, all analytic methods followed during the study, including references to any specialized statistical software need to be mentioned in this section. It is important to detail the ethical concerns related to the study and how these were addressed. This is particularly important when human or animal studies are involved.

2.6. Results

The results section should communicate the facts, measurements and observations gathered by the scientist. A description of the sample population characteristics (if the paper is a clinical study) needs to be provided. The factual answer to the research question that was described in the ‘Introduction’ section needs to be clearly illustrated. It is essential for the results section to be organized in a logical manner such as from the most to the least important findings, or in a chronological fashion. The use of tables and figures might enhance the delivery of the results. However, repetition should be avoided. Information provided in graphical (table or figure) format should not cover information found within the main text. As a general rule, text should be used when the data being described is limited, tables when there is a copious amount of data to be described, and figures where trends or correlations need to be shown. If tables or figures are used, these must be referred to in summary within the body of the text. A concise self-explanatory title should always accompany the tables and figures – these should be stand-alone sources of data [11].

When constructing tables, it is essential to organize the table so that ‘like elements’ are read down and not across the table. Vertical lines that separate the columns should be avoided unless of absolute necessity. Data should not be presented in a table (or figure) format if the information can be easily replaced by a sentence or two of text. When constructing figures, the legend provided needs to be succinct yet provide sufficient information for the reader to interpret the figure without reference to the text. The axis of the figure should be brief but informative including units of measurements used. It is important not to extend the axis of the figure far beyond the range of the data so that, for example, if the data ranges between 0 and 78, the axis should not extend further than a value of 80. Coloured figures should be avoided unless absolutely necessary since these are very expensive when it comes to publishing.

2.7. Discussion - conclusion

The discussion must aim to answer the research questions that were posed in the ‘Introduction’ section, while explaining the meaning and significance of the results obtained within the context of the previously known knowledge. It is of utmost importance that the results are not repeated verbatim [2]. Furthermore, it is essential not to present results for the first time within the discussion section. The findings of the study need to be compared with other literature findings. An explanation needs to be present as to whether the current findings fit, extend, refute or confirm previously established findings. Overstatements or strong statements need to be avoided in the discussion; for example “Findings support...” or “Findings suggest...” rather than “Findings prove that...” or “this means that...” [2]. The final paragraph should include the *take home message/s* that was/were obtained from the study.

2.8. Acknowledgements

An acknowledgement section follows the discussion/conclusion section where silent partners are recognized for their contribution. These partners would not have made a significant intellectual contribution and would therefore not be included as authors, for example: colleagues, institutions, organisations, financial help, laboratory and secretarial staff.

2.9. References

The Reference list should include all the literature sources used within the paper. These need to be acknowledged through citations within the text and a reference list at the end of the scientific paper. There are a number of different referencing styles available, the most common being the Harvard and the Vancouver reference styles. It is important to know the particular style of referencing required by the potential journal that the paper is to be submitted to, so that one cites and references in the correct manner from the very beginning. Examples of both types of referencing styles are provided below:

- Harvard style: The in-text citations should include the author/s surnames (up to three authors), followed by 'et al.' if more than three authors are present. This is followed by the year of publication. At the end of the scientific paper within the 'Reference' section, the whole reference is written. The order of referencing at the end is based on the alphabetical listing of the first author's name. An example of a Harvard reference for a journal article is as follows:
 - Grech, V and Cuschieri, S. (2018) Writing a scientific paper (WASP) – a career critical skill. *Early Human Development Journal*. 117:96–97. DOI: 10.1016/j.earlhumdev.2018.01.001
- Vancouver style: The in-text citation should be in Arabic numbers. There are variations as to how such a citation number is written i.e. whether it is within brackets or square brackets or superscripted at the end of the sentence. It is important to identify the correct format required by the journal. At the end of the scientific paper within the 'Reference' section, the whole reference is written in order of appearance in the scientific paper. An example of a Vancouver reference for a journal article is as follows:
 - Grech V, Cuschieri S. Writing a scientific paper (WASP) – a career critical skill. *Early Human Development Journal* 2018; 117:96–97. DOI: 10.1016/j.earlhumdev.2018.01.001

It is paramount to read carefully and comply faithfully with the *Instruction to Authors* provided by the journal (this could preferably done prior to starting to write the paper).

3. Successful publishing

In order for a scientific paper to be successfully accepted for publication, one needs to remember that the scientific paper needs to be accepted by the journal's reviewers and abide to the publishing style guidelines. The following are five criteria that reviewers tend to base their decision on [12]:

1. The relevance, importance, timeless and prevalence of the problem under study.
2. The writing style quality (clear, easy to follow, logical and straight forward).
3. The appropriate, comprehensive and rigorous study design.
4. The thoughtfulness of the literature review as well as whether the literature review was up-to-date and focused.
5. The presence of sufficient sample size to avoid biases.

In fact, the top five rejections rationale are [12,13]:

1. Incomplete, inappropriate or insufficient statistics.
2. Over-interpretation of results.
3. Suboptimal, inappropriate and insufficient description of the populations.
4. Biased samples.
5. Poorly written paper or incoherent.

The scientist may choose a journal but that does not mean the journal will automatically choose the scientist's paper. This does not

mean that the work is unpublishable but rather that the correct journal was not identified. If the referee's comments have been provided, it is essential to go over them since this free advice will help to improve the paper. The scientific paper can then be re-submitted to another potential journal. It is extremely important that yet again the submitted paper abides faithfully to the new journal's *Instruction to Authors* guidelines.

4. Conclusion

A scientific paper disseminates the conducted scientific research in the form of a story: from the background literature already out there, to the reason as to why further research was required (the gap in knowledge), how such a task was performed and what came out of it. This is followed by a discussion of the findings, comparisons with other published findings and justifications of the results that were established. One should finish off with the main message provided by the study.

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Conflict of interest statement

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