Types and Conventions of Science Writing

Types of Science Writing

The purpose of science writing is to communicate scientific research to various audiences. Like much writing, it includes both description and analysis: surveys of previous research and descriptions of current methodologies and results; and analysis related to the trends, importance, and implications of research findings. Although science writers present facts and careful reasoning based on evidence, they must also use techniques of good communication to shape their presentation of findings in an engaging and persuasive way. Therefore, most types of science writing follow a format that frames the information presented with a sense of context.

Engaging and informing the reader: The opening

An opening section introduces the topic and emphasizes its importance. This section also provides an overview of past and current research to show how the proposed or completed study addresses a gap in the body of knowledge. Finally, the introduction establishes the purpose of the literature review, research proposal, or lab report/research paper.

Making sense of all of it: Discussion and conclusions

After a survey of research trends, proposed methodology/expected results, or results of a study, the concluding section (including the discussion) provides analysis. In this section the science writer emphasizes matters of significance for the reader: demonstrates the importance of the proposed research, explains results, accounts for unexpected results, proposes changes in methodology, and/or discusses the implications or applications of the research.

The types of science writing outlined here – the review article, the research proposal, and the lab report/research paper – tend to follow conventional formats, but there are variations within these formats according to the purposes of the writers and the expectations of their audiences.

The review article or literature review

Purpose: to summarize and synthesize research that has been done on a particular topic. A review emphasizes important findings in a field and may identify gaps or shortcomings in the research. As it describes and evaluates the studies of others, its primary focus is on what the research has demonstrated through the methodologies and results of study and experimentation.

Audience: usually a science journal's broadest readership because a review is more general in its focus than a research article.

Format:

1) **Introduction** – introduces the topic and its significance and provides a brief preview of the sub-topics or major trends to be covered in the paper
2) **Body** – presents a survey of the stages or significant trends in the research
   Studies are discussed in groups or clusters often identified with subheadings. To develop the body, the writer must determine criteria for grouping: will studies be clustered according to

major advances in the research (chronological development) or areas of consensus or lack of consensus in the field? Will the body highlight similarities and differences in the findings in terms of methods, results, and/or the focus of research studies?
*Tips: the body should contain both generalizations about the set of studies under review (written in the present tense) and citations of specific studies (past tense) to identify and verify observed trends.
Topic and concluding sentences of paragraphs and/or sections should synthesize research findings and may show differences and similarities or points of agreement/disagreement.

3) **Conclusion**– provides a final general overview of what is known and what is left to explore in the field This section may discuss practical implications or suggest directions for future research.

Distinguishing Elements:

The review article is largely descriptive in that it identifies trends or patterns in an area of research across studies. However, analysis is required as the writer offers an interpretation of the state of knowledge in the field, perhaps calling attention to an issue in the field, proposing a theory or model to resolve it, or suggesting directions for future research. As well, unlike research papers that feature functional headings related to the IMRAD format, the review article uses topical or content headings to indicate the sections of the review.

The research proposal

Purpose: to convince a scientific audience that a proposed problem for investigation is worth exploring and that the proposed research approach will be effective. The proposal should present a specific, interesting research question and demonstrate the following: the question's significance, the merit of the proposed research methods, the ways in which results will contribute to the solution to the problem, and the degree to which the research will advance the state of the science in this area.

Audience: academic departments that grant approval for dissertation projects and funding agencies. Research proposals are often read by a broader range of readers than a journal article.

Format:

1) **Introduction** – presents the specific objectives and scientific significance of the proposed research and also previews the rest of the paper. Because the audience may be more general than for the research article, the introduction provides a more comprehensive orientation to the topic and to the purpose of and need for the proposed research.
2) **Background** – provides a thorough, detailed discussion of the primary literature and requires synthesis and evaluation of that body of knowledge. The Background demonstrates the researcher's breadth of knowledge and shows both how far the previous research has gone and where it needs to go. Although the major sections of the proposal are identified with functional headings – Introduction, Background, Methods – the headings within the background section are topical, according to trends in the research. This section ends with a summary of what is known and not known about the topic and a clear description of the specific research question(s) or hypothesis(es) that will be investigated.
3) **Methods or Proposed Research** – shows how the proposed research question follows logically from the research that has gone before. This section is similar to a Materials and Methods

section of a research article but is written in the future tense. It provides a detailed, heavily documented description of proposed methods, with citations that demonstrate the validity of the methodological approach. This section outlines specific aspects of methodology: sample sizes, number of replicates, sites, and how the data will be analyzed. It also provides plans to address possible problems in the research.

Distinguishing Elements:

The research proposal is a persuasive piece of writing that needs to account for audience to a greater degree than the other types of science writing. It should show an alignment of the proposed research with a granting agency's goals and priorities. In this type of writing, the persona of the researcher is more important than in other types, so the proposal demonstrates the researcher's experience and expertise. Finally, in keeping with the persuasive nature of the proposal, the Methods section contains fewer details than in an article but more explanation for the rationale behind the methodological approach.

The lab report

Purpose: to present either the results of primary research accomplished through study/experimentation or theoretical developments in a particular field. In both the lab report and research article, the writing is both descriptive/factual and analytical/ persuasive. It accurately reports the details of the research but also attempts to convince readers of the importance of the research in terms of its contribution to the advancing knowledge in the field.

Audience: for the student writer, most often a professor or teaching assistant; for the report writer, a wider audience – a journal editor, peer reviewers, a community of specialists in a discipline, the general scientific community.

Format: follows the dominant format of articles in science journals – Introduction, Methods, Results, and Discussion (IMRAD).*

Section	Purpose	Answers These Questions
Introduction	• Introduces topic of investigation and its importance • States central question or hypothesis • Cites any relevant literature • May identify gap in the research • States objective or purpose	• Why is this topic significant or interesting? • Why did you undertake this investigation?
Materials and Methods	• Describes the research design • Details the experimental procedure step by step	• How could someone else replicate your study or experiment?
Results	• Reports in detail the findings of the investigation • Provides figures and tables to support the text	• What actually happened? • How can you report all relevant results most efficiently?

Discussion	• Summarizes results and draws tentative conclusions • Comments on results related to research question or hypothesis • Examines other supporting or contradicting evidence • Suggests refinements or applications of research • Offers possibilities for further study	• Why did you obtain these results? • Did you obtain the expected results? Why or why not? • How do your conclusions relate to other research on the topic? • How might your study or experiment be improved or used? • What next?

*Note: If the focus of a paper is theoretical or historical rather than experimental, the IMRAD format will not be suitable. A more variable structure, with topical rather than functional headings, may be needed to propose new theories, models, formulations of hypotheses, or interpretations of previously observed phenomena.

Distinguishing Elements:

Although they use the same format, lab reports and research papers differ in terms of scope and the complexity of their analyses.

Description (subject, scope, style):

Lab reports focus on only one experiment or repeated experiment and report results in a spare, concise way. Research papers may report on a sequence of experiments or other wider subjects. Because the focus of the research paper is broader, it may address matters that don't relate directly to experimentation – such as definitions, new research methods, or reinterpretations of data – and thus its style is more expansive.

Analysis (context, interpretation, and conclusions):

While a lab report provides a relatively short introduction and review of the literature, the research paper presents a thorough introduction of the topic and the importance of the research in the context of other work in the field. It provides a comprehensive review of all relevant literature.

A lab report interprets only specific aspects of the data related to the study / experiment at hand. It may not present any general conclusions aside from possibly recommending avenues for further research. A research paper, however, offers an extensive interpretation of results and may include both definite and tentative conclusions, alternate ways of interpreting results, and/or other kinds of speculation, in addition to possible applications and research directions.

Abstract

The abstract is a short summary of the main points of a research report, proposal, or review article. It is usually 150-250 words and a single paragraph, though it may be longer; proposal abstracts are often one page or 200-300 words. The purpose is to provide the reader with a complete, accurate synopsis of the larger text and will reflect the structure of that text. The abstract for a research paper will follow the IMRAD format used in the report and contain these elements: topic (a sentence or two, written in present tense); background/rationale for or purpose of the study (several sentences, with no references to previous research); methods and results (written in past tense); and conclusions and implications (present tense).

Abstracts not following the IMRAD format will be structured differently; for example, they may reflect the line of reasoning in an article. The proposal abstract is structured according to the content of the proposal itself; it summarizes the research problem, goals, and proposed methods. Depending on the discipline or field, some abstracts are structured more formally, with the following headings: Objectives, Design, Setting, Participants, Intervention, Measurements, Results, Conclusions. In many formats, abstracts often conclude with a brief list of keywords.

References

There is no standard style of documentation in the sciences; styles tend to be journal-specific. Two common styles are the name-and-year system and the citation-order / citation-sequence system.

The name-and-year system includes a list of references at the end of the report that are arranged alphabetically. This system uses in-text citations in the body of the report to indicate information that comes from sources, for example (Anderson and Wyatt, 2010). In both the citations and the References section, the year of publication appears directly after the authors' names.

> Hargrave, C. W., K.D. Hambright, and J. W. Weider. 2011. Variation in resource consumption across a gradient of increasing intra- and interspecific richness. Ecology 92: 1226-1235.

A reference from an internet source would appear this way:

> Anderson I, Wyatt D. 2004. False positives for the defibrillator: the effects of stress on cardio-pulmonary distress in emergency room patients. Emergent Care [Internet]. [cited 2005 May 31]; 24(330): 343-352. Available from: http:// (full URL).

The citation-order system also includes a list of references at the end of the report, but they are arranged in the order in which they appear in the text, rather than alphabetically. Each reference is given a number, and only one number, no matter how often it appears in the body of the report. When the reference is referred to in the text, only the number is given [6]. The full publication information for the source will appear in the References section.

> [6] E.M. Iancu, D.E. Speiser, N. Rufer, Assessing ageing of individual Tlymphocytes: mission impossible? Mech. Ageing Dev. 129 (2008) 67-78.

In the citation-order system, the year appears later in the reference than it does in the name-and-year system. Because there are many variations within and between systems, science writers must be aware of specific requirements of journals and follow those guidelines closely.

Acknowledgement:

Penrose, Ann M. and Katz, Steven B. (2010). *Writing in the Sciences: Exploring Conventions of Scientific Discourse (third edition)*. New York: Longman.

Conventions of Science Writing

The purpose of science writing is to accurately communicate observations and analyses and their importance in a way that will convey a sense of context to the reader and possibly allow for repeatable experiments. Science writing demonstrates both the expertise and objective stance of the writer and is marked by a style that is clear, concise, and accurate.

Demonstrating expertise and objectivity

Emphasize facts and observation

Science writing often relates to experimentation and contributes to building a body of knowledge, so its primary focus is on facts and conclusions drawn from careful observation, not opinion. Conclusions should be directly supported by the data presented and/or by others' research.

Use technical language appropriately

Science writers should be aware of the level of expertise of their audiences in order to determine what technical language to use. If the audience consists of readers in the same field, then technical terms common to the discipline should be used to refer to familiar theories, processes, and practices, and to achieve conciseness. If the audience is general, technical terms should be avoided or clearly explained.

Write with a formal tone

Science writing uses a formal tone that is consistent with its emphasis on the research rather than the researcher. Writing is free of contractions, colloquialisms, and informal language, and often uses the passive voice and/or the active voice in a limited way.

Passive voice

The passive voice emphasizes the object receiving the action rather than the actor performing it.

The samples were diluted with 100 ml of H2O.

Here the subject (samples) receives the action of the verb (to dilute). While the passive voice has been commonly used in science writing, the practice is changing in many disciplines because the passive voice can produce wordy, awkward sentences and because there is a growing acknowledgment of the role of the researcher in the scientific process.

While use of the passive voice is giving way to more active, dynamic writing in the sciences, the passive voice may still be appropriate (and required), particularly in lab reports in the Methods and Results sections and/or in the Abstract.

Active voice

The active voice places the actor performing the action at the beginning of the sentence.

The researcher diluted the samples with 100 ml of H2O.

Here the subject (researcher) performs the action of the verb (to dilute) on the object (samples). There are a number of ways to use the active voice in science writing without using the first-person "I." Use the following alternatives to "I" as the subject of active-voice sentences:

1. We – We modify the above model as follows.
2. A figure, table, or section – Figure 1 illustrates…; The introduction highlights that…
3. Results of studies – Experimental evidence shows that…
4. A technique or procedure – PCR analysis produced clones…
5. The researcher(s) – Jones and Martin (2010) found that…

When in doubt about whether active or passive voice is expected or required, consult articles in your field for guidance or check with course instructors or supervisors.

Avoid unsupported definitive conclusions

To support an objective stance, it is important to acknowledge limitations by explaining results in a way that allows for a degree of uncertainty. Thus, results suggest, indicate, or are significant rather than prove. If you use somewhat definitive statements, be sure to back them up with evidence.

Writing clearly

Organize material effectively

If you indicate an order for your sections early in your paper or report, it is important to maintain this order throughout so your reader can progress easily through your document.

Use plain language

To balance necessary technical terminology, science writing should be in plain, direct language.

- Not *utilize* but *use* Not *elucidate* but *explain*
- Not *modification* but *change* Not *determinant* but *cause*
- Not *systematize* but *order* Not *numerous* but *many*

Include short sentences

It is important in science writing to avoid overly complex sentences that include too many ideas or too much information for the reader to process. Short sentences convey information in a manageable way; combined with longer sentences, they also contribute to an interesting style. Further, sentences that begin with the subject and verb deliver meaning to the reader most efficiently.

Not *As either a direct modifier (PPA) or a blowing agent (PPA or H_3PO_4), phosphoric acid is a likely cause of the excessive ageing in Site A because it is known to gel asphalt cement, which leads to reduced stress relaxation, increased thermal stresses, and increased levels of cracking distress.*

But *Phosphoric acid, as either a direct modifier (PPA) or a blowing agent (PPA or H_3PO_4), is a likely cause of the excessive ageing in Site A. This agent is known to gel cement, which leads to reduced stress relaxation…*

Watch your verb tenses

- Use appropriate tenses for various purposes in science writing to clarify progression:
- To discuss concepts or generally occurring processes, use the **present tense**.
- *Cellular replication involves one cell dividing itself into two identical copies.*

- To describe what you or someone else did or asserted (particularly in the Methods and Results sections of lab reports), use the **past tense**.
- *We observed that the inclusion of the N-protonated and N-alkylated guests within the CB[7] cavity caused the normally rapid chair/chair interconversions to become sufficiently slow …*
- To present a plan for a proposal, thesis, or article, use the **present** or **future tense**.

In the next section we (will) state and put into context previously published dynamical models of telomere shortening.

Writing concisely

Avoid wordiness

To eliminate wordiness, try these strategies:

Substitute a single word for a phrase

- Not *due to the fact that* but *because*
- Not *at this point in time* but *now*

Use simple, active verbs instead of verb phrases

- Not *make an assumption* but *assume*
- Not *come to a conclusion* but *conclude*

Use abbreviations when appropriate

For conciseness, replace frequently used terminology with abbreviations. After the first use of a term, identify the abbreviation in parentheses and use it thereafter.

Writing accurately and precisely

Use accurate word choices

It is important to use the most accurate wording possible in science writing, even if repetition is the result. A precise, accurate word that is repeated is better than a somewhat ambiguous, less precise substitution.

Frequently misused words: *data* (this word is always plural, as in *data are collected*), *criteria* (this word is also plural; *criterion* is the singular), *affect/effect* (*affect* is a verb meaning *to influence*; *effect* is usually used as a noun meaning *result*)

Definitions:** a ***hypothesis is a possible explanation for what causes something to occur (e.g., wasps find their burrows using landmarks); ***a prediction*** is an expected result that should be observed if the hypothesis is true – a pattern in the collected data (e.g., if the above hypothesis is true, then moving the landmarks should cause wasps to go to a different place).

A ***study*** usually means an observational study in which researchers observe subjects and measure variables but do not assign subjects to treatments or manipulate them in any way. In an ***experiment***, researchers control/manipulate the primary variables and usually assign subjects to treatments.

Be sure your writing is detailed

Science writing should provide enough detail about the context and purpose of the research that the reader knows why the study is important and interesting. Materials and methods should be described specifically enough for someone else to repeat an experiment. Detailed writing in the analysis will show the chain of logic used to draw conclusions from the data.

With guest 2, we observed the splitting of two of the methyl resonances, which suggests that these positions are sensitive to binding of both the 1:1 and 2:1 complexes.

While writing with sufficient detail is important, it is also important to include only information and description that is relevant to the purpose of the paper.

Include quantitative rather than qualitative observations

In describing the results, use specific, concrete wording rather than vague, qualitative language:

Not: *The section of road north of Highway 33 had some transverse cracking in addition to some minor wheel path cracking.*

But: *The section of road 9.5 km north of Highway 33 had two transverse cracks, both a quarter lane wide, in addition to 19.8 m of minor wheel path cracking.*

Avoid using modifiers such as *much, very,* and *really* because they are subjective and imprecise.

Note: use the modifier *significant* carefully and accurately – in science writing, a result is significant if it is **statistically** significant.

A note on referencing

Science writing does not generally include direct quotations from sources because what is said is considered more important than how it is said. Instead, information is summarized or paraphrased in the writer's own words and cited using one of a number of styles of documentation. To determine which style to use, observe the references of journal articles in your field for direction.

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