
# Technical Writing

## Basics of Scientific Research

# Technical Writing

Technical writing is the kind of writing utilized for academic purposes, and is the kind of writing you will read in peer reviewed journal articles. To express your ideas, results, experiments, analysis and conclusions, you will use technical writing.

It isn't easy to exactly explain how to do technical writing, but the quality of technical writing can be clearly seen in each **sentence** and throughout the entire **manuscript**. We will start big, and work our way to the specifics.

## The Manuscript

Before getting into the manuscript structure, keep in mind that manuscripts are always written in past tense, and research proposals are written in future tense. Regardless of the type, most technical writing is typically written in **Third Person.**
The structure of scientific technical writing can be seen in nearly every peer reviewed publication. Aside from an abstract, which is essentially a summary of the study, you will start with an introduction:

### Introduction

The introduction section of a technical paper, or scientific article, is a literature review. In this section, you summarize other articles and information that form the basis of your study, along with an explanation backed by evidence of the real world impact or importance of your study to the field of science your paper is about. The source of all information should be cited with a proper APA in text citation at the end of each line.

Here is where the first and most important word of technical writing appears: **LOGIC**

Logic is the essence of scientific thinking, and as technical writing expresses the ideas of science, it should be the physical embodiment of logic.

Logic is what makes the introduction section not just a regurgitation of relevant literature, but a guide explaining the development of your project idea from piecing together information from the articles in your literature review.

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So how does this work?

The answer is in the logic flow of an introduction, which goes like this:

1. Broad statement of the topic/problem
2. Real world or scientific importance of the topic/problem
3. Retracing of the project idea development through summary of reviewed literature (what you read to get the project idea)
4. Explanation of logic and planning of the study conducted in the paper.

The fourth part, a critical aspect in the introduction, is called the **Rationale** of the study, and it essentially means the **reasoning behind it.**

So essentially, to break it down further, you first give the reader a general idea of what area of science your project is about, then interest them about your topic through describing its importance. Then, you summarize all the necessary, relevant information that you used to come up with the idea, and then explain how you came up with it!

Methods

If you have ever read a recipe, then this is a little similar. It is essentially a **sequential explanation** of what was done in the experiment or engineering process.

And this is where the next two magic words of technical writing appear: **Precise and Concise**

In the methods section, whether you are explaining the materials or describing the procedures, precision is key.

For example, in your materials list, you wouldn't just say "Silver nitrate", you would list "100 mL of 0.1 M silver nitrate purchased from Carolina Biological". In this case, precision means leaving no questions unanswered. For a chemical, you will always list **how much volume** of **how much concentration** purchased **from where.**

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In the procedures, again, **precision** means leaving nothing up in the air. Instead of saying "The bacteria was grown on a petri dish", you would say:

"*E. coli* K-12 cells were plated onto the agar of a petri dish with an inoculating loop from a liquid culture and spread evenly. The petri dish was then placed in an incubator at 37 degrees celsius and incubated overnight."

Note that in the proper procedure, the bacteria species, the individual actions which consist "growing bacteria" and what tools were used for the action are detailed very **precisely.** This is how technical writing is precise in writing methods.

Now let's look at **concise**:

You could say "LB broth was taken from the storage. A sterile disposable 100 microliter pipette tip was fixed to the tip of the blue 100 microliter micropipette, and the volume of the micropipette adjusted to 50 microliters through the spinning dial. 50 microliters of LB broth was then drawn by the micropipette, and these 50 microliters of LB broth were added to a 2 mL microcentrifuge tube"

However, that's not concise. It is not your job to explain every detail or common laboratory practice, and only the critical, constructive steps that comprise each procedure need to be explained, with no excess wording.

So for that previous example, you could simply say:

"50 microliters of LB broth were pipetted into a 2 mL microcentrifuge tube"

**In technical writing, only what needs to be on the page is on the page. Do not include information that isn't relevant.**

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Results

So the results section is where your data collected is. This is where your tables, graphs and charts will be located. Accompanying those visual representations of data should be text that analyzes the data, making connections and conclusions from the data. If you conduct statistical analysis in your study, this is where that analysis should be shown as well. If your study is multifaceted, break this section down further into analyzing each observation, in sequential order.

Remember, always be **precise and concise.** Especially, in the results section, the **logic** of the section must be the strongest. This is where you explain the reasoning you make based off of the data you see.

For example, say I grew bean plants in the closet and on the windowsill and measured the height of the plants to see the difference between the two locations. The results I measured are as follows:

Height of Plants in Closet (in cm)

| | Plant 1 | Plant 2 | Plant 3 |
|---|---|---|---|
| Day 1: | 0 | 0 | 0 |
| Day 2: | 0 | 0 | 0 |
| Day 3: | 0 | 0 | 0 |

Height of Plants on Windowsill (in cm)

| | Plant 4 | Plant 5 | Plant 6 |
|---|---|---|---|
| Day 1: | 2 | 1 | 1 |
| Day 2: | 3 | 3 | 4 |
| Day 3: | 5 | 7 | 8 |

Here is what I would say to explain my reasoning and draw conclusions based on just the data above (without using statistical analysis):

"The bean plants on the windowsill were found to have grown significantly more than the bean plants in the closet when measured by height. The varying amount of sunlight in these two locations, the only difference in experimental conditions between the two groups of plants, is thus likely the agent affecting the difference in growth between the bean plants in the two locations. As plants require sunlight for the photosynthesis reaction and photosynthesis is required for plant growth, it can be deduced that varying amounts of sunlight impact plant growth."

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To break it down: The difference in the data is concisely identified. The variable changing between the two experimental groups (amount of sunlight) is then identified and stated as the potential cause of the difference in the data. The potential cause is then connected with known information to make a deduction on why the identified cause results in the observations made.

Observation in data -> identification of variable -> potential cause -> potential mechanism for identified cause

Though it sounds silly in this particular situation, when the variable and cause are quantities that we do not already understand, then we can't be so sure that the cause we identified is truly the one causing the observations we made about the data. Similarly, not understanding that the identified variable/cause indeed results in the observation made in the data is the reason why we must also reason why the variable/cause scientifically results in the observations we saw in the data.

Discussion

This section is where you generalize on the conclusions you made during the results section (summarize your findings), and discuss the impact of your study/project on your field of science and the real world.

The discussion could also potentially include plans for future development of your study, as well as address limitations in the design of your study or unaccounted factors.

Using the example of growing bean plants above, here is a snippet of a discussion section based on that experiment:

"Through the findings of this study, sunlight was identified as an important factor for plant growth. With this deduction, agricultural yields may be imporved through increased consideration for the exposure of plants to sunlight"

As you can see, the main conclusion of the study is identified, and the application of the conclusion made in the study is explained.

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## Sentences and Wording

Sentence structure is very important in technical writing. Sentence structure needs to be **logical and concise**, and read very straightforwardly. Sentences can be general statements of actions or observations made, or the sentence structure could begin with a statement of an observation or action, followed by the deduction or reaction taken. As is its nature, the writing is highly cause and effect, showing the process of reasoning.

For example:

"It was found that (observation) , suggesting that (deduction)"

"Through utilizing (method), (action) was able to be achieved"

"(Method) was conducted, and the (characteristic) was analyzed"

"With the (observation), the employment of (action) was deemed necessary"

"Following the deduction that (variable) is a likely agent in the presence of (observation), the conclusion is drawn that (deduction) has an effect on the experiment"

Next we will look at **wording**. So obviously, the words you will utilize depend highly on the terminology of your field of study, but there are common words that should not appear in technical writing, most notably words that are vague, such as "thing", "something" or "big", and "cause", as you can never be sure that a certain variable caused a certain outcome. Always be **concise and precise.**

Here's some good words to use! (Only a few common, general ones)

**Things and Events**: mechanism, function, apparatus, assay, phenomena, object, substance
**Observations**: increase/decrease, correlation, relationship between,
**Adjectives**: Novel, significant/insignificant, distinct, rapid, efficient
**Actions**: Deduced, extrapolated, conducted, utilized, performed, identified, analyzed
**Characterizing time**: subsequently, prior to, simultaneously