A practical guide to writing about anything for anyone!

Marianne Freiberger and Rachel Thomas

There are many reasons why you might want to write for an audience that doesn't consist only of experts in your field. Perhaps it's for a job or grant application that will be read by a panel of people with different areas of expertise. Or maybe it's a paper for a mathematical or scientific journal that covers a broad range of fields, not just yours. Or maybe you'd like to write a newspaper article, or even book, aimed at an audience where little mathematical background can be assumed. This might be to inform about important research — for example to do with climate change or public health — or simply because you'd like to share the joy and beauty of your subject.

Whatever the reason and motivation, it always pays to write well. Even if you are just writing for your own peers, a clear and engaging style goes a long way to getting your message across and enthusing people for your work.

As Editors of *plus.maths.org* we have spent many years writing about the mathematical sciences for non-expert audiences, and training researchers to communicate their work. The most important lesson we have learnt is that writing is a skill, a craft, that you will get better at each time you sit down to write. Indeed we are still learning ourselves! And although there aren't any hard and fast rules, we hope our practical tips will help you when you need it most — when you are sitting at your keyboard, ready (or perhaps not so ready) to put your ideas on the page.

This guide is mostly based on personal experience, but we also include a section at the end containing useful tips on how to be worthy of your audience's trust. These are drawn from an event about communicating mathematics for the public which was organised by the Newton Gateway to Mathematics in Cambridge in January 2023.

We hope this guide is useful!
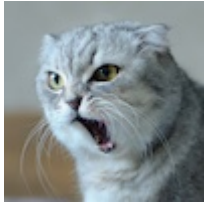
[Getting started](#) — Two questions lie at the beginning of any writing process. Who you are speaking to and what you want to say?
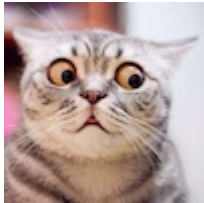
[Writing your first draft](#) — Have you found a story you want to tell your audience? Here are some tips to help you on your way.

[Writing clearly for any audience](#) — Whether you're still getting your ideas together, writing your first draft, or revising and editing, here are some tips to keep in mind to help make your piece work for any audience.
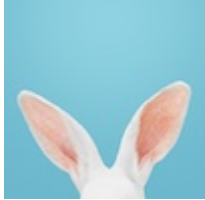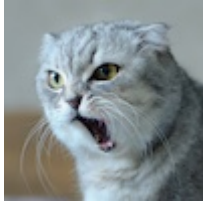
[Editing your work](#) — You don't have to get it right the first time! Find out how to edit your work effectively.

[Be clear, be trustworthy](#) — When it comes to communicating maths or science that some people find hard to accept, you cannot take your audience's trust for granted. Instead you have to be trustworthy.

Marianne Freiberger and Rachel Thomas – plus.maths.org – April 2023

Getting started

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Who are you speaking to? And what do you want to say?

It may seem obvious, but an important starting point for any form of writing is to ask yourself who you are writing for and what you would like them to take away. It is surprisingly easy to lose sight of both the audience and the main message as you delve into a piece of maths or science that may have taken you months to figure out or understand.

Here are a few questions and exercises to help you focus.

Think about your audience

- Who are you writing for?
- How do they speak?
- What do they already know?
- Why should they read it? Why should they care?
- What do you want them to remember?
- Remember, you are telling each one of them your story

Things to try

- Imagine you're speaking to a particular person
- Actually speak to someone who fits into that audience
- Think of good metaphors or examples that your reader can relate to or imagine, that help tell your story
- Make it personal
  - Can you think of a human angle to your story?
  - Does your story answer a question or concern of your reader?
  - Can you link it to something in their daily lives?
- What will make your story stand out to them? Can you make it topical? Can you think of good titles, images, movies? What will make them choose to read your story, rather than move onto the next one?


Think about what you want to say

- What do you want to write about?
- Why do you want to write about it?
- What makes it a good story?
- What do you want a reader to remember?

Things to try

- **Free writing:** This is a great exercise to use anytime during the writing process when you feel stuck. Set a timer for some bearable length of time (say 8 minutes) and then go for it. Write anything you like: stream of consciousness, a list of bullet points, or anything in between. You could even write about why you are finding it hard to write! But write without stopping until the timer goes off.

- Once you have some notes (say from your free writing exercise), **have a look at what you've written**:

    - Is all the important information there? What do you still need to include? What do you still need to find out?
    - Can anything be dropped?
    - Can you see a clear storyline or narrative?

- **Imagine you have to pitch your story to a busy editor who is not an expert in your field.** You can only present:

    - A headline
    - A subheading or sentence summarising the story. (What would you tweet to promote the story?)
    - An image or movie

  How can you make the editor take note and choose your story?
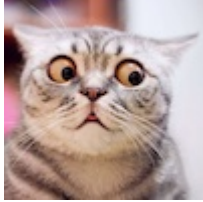
Writing your first draft

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Once you have a good idea of the story you want to tell and your audience, you can set out on a draft. Here are some tips to help you on your way...

It doesn't have to be good

Your first draft is a time to get all your ideas down, it does not have to be perfect. Our first drafts never are! Trying to edit while you write can make writing much harder. Have faith that you will edit your work later (we've got tips to help you here) so you don't have to worry about it being good now. Just get all your ideas down so you can see what you have to work with.

A good place to start

A good place to start might be the five Ws:

- Who?

- What?

- Where?

- When?

- Why?

Answering the first few of these questions might inspire the introduction to your article. For us, often the rest of the article might be expanding on the "Why?" Or explaining the "How?"

What is the main point you want readers to take away?

Imagine your reader at the proverbial "water cooler" the next day (the twitter of the olden-days) saying "I read this great article about…" How do you want that sentence to end? This may be a good basis for your conclusion.

How will you get from your intro to your conclusion?

Sometimes it helps to imagine your narrative as a set of stepping stones across a river, getting the reader from beginning to conclusion. What are the stepping stones your reader will need to get across? What questions might arise for them along the way and are you answering them?

Things to try:

- Set your timer for 10 minutes. Try writing the intro, or the conclusion.

- Set your timer for another 10 minutes: Map out how to get from beginning to end, or retrace back from the end to get to the intro.

- Repeat your timer as many times as you need to map out your story!

Remember:

- Think about your reader, answer their questions.

- Be excited – if you enjoy telling your story they will enjoy reading it!

Congratulations on your first draft!

Writing clearly for any audience

Marianne Freiberger and Rachel Thomas

Whether you're still getting your ideas together, writing your first draft, or revising and editing, here are some tips to keep in mind to help make your piece work for any audience.

Audience

- **Who is your audience?**

  Imagine telling them your story in whatever tone is appropriate.

- **Think of your article as a two-way conversation between you and the reader**

  Enjoy telling them what is interesting about your story. Anticipate your reader's questions and answer them.

Structure

- **Keep your sentences short**

  It doesn't mean you cannot use long sentences, mix up short and long, but experts say that you should aim for 15 to 20 words per sentence on average.

- **One fact per sentence, one idea per paragraph**

  Think about the beginning and end of sentences… of paragraphs and of the whole piece.

  The beginning of a sentence or paragraph catches the reader's eye when they skim read, so try and make use of that. And the end of a sentence or paragraph can stick in the reader's mind. You might want to put the important stuff at the beginning or at the end. Or start with something old and end on something new, etc…

- **Think about breaking the piece up using subheadings**

  When you first glance at an article, the subheadings stand out. They can entice the reader to dive in or lead them on to keep reading. They can highlight the key ideas and give context to what comes next. The format of your piece – particularly the paragraph breaks, the pictures and subheadings – give your readers space to pause and digest information, before moving on.

- **Read just the first sentence of each paragraph, in sequence**

  The result should be like a synopsis of your piece, that still makes sense and pulls the reader along.

Language

- **Avoid jargon**

  Speak your audience's language. It's easy to forget how unfamiliar/misleading common scientific terms can be for a general audience. For example, the term "significant result" can mean something very different to a scientist than it does in colloquial language.

  Use technical terms only if absolutely necessary. Does the reader really need to know that word; is there a colloquial term that might do instead?

  If you do need to use a technical term, make sure the sentence is readable without knowing what it means. If there isn't enough contextual information to make sense of the sentence, you could give a brief explanation (perhaps in brackets: eg. "this is a type of..." or "you can think of this as...") or you could link to a fuller explanation elsewhere (say an online resource, or an unpacked definition in a box or later subsection). Try not to let the technical term stop the reader's flow.

- **And avoid non-technical jargon too**

  Consider using an **active voice** rather than a passive one.

  An active voice is one where the thing doing the action comes first: "The dog ate my homework" is active - the dog did the eating. However "My homework was eaten by the dog" is passive, as the homework was the thing getting eaten!

Similarly, avoid **nounification** (technically called *nominalisation*) — that is, turning verbs into nouns. For example, write "This illustrates…" rather than "This is an illustration of…"

An active voice, and using verbs rather than "nounifications", usually makes your writing clearer, more alive, and more engaging. It also often makes your writing shorter.

Think of how you would tell your audience the story if you were talking to them in person. If an expression is usually only in writing and sounds strange spoken aloud, then that might indicate it could be replaced by something clearer and simpler.

Content

- **Simplify the writing, not the science**

  Don't shy away from difficult ideas, but use metaphors and examples to bring them across.

  Use caveats if necessary ("This simplified example illustrates the idea…")

- **Find a story that winds through the content you want to bring across.**
- **Mind your maths**

  Don't necessarily shy away from equations, but structure your piece so a reader can get through without understanding the equation — put it in a box, or specifically say they don't need to understand it. Explain in the text around it what the equation is capturing. After all, an equation is just a very succinct way of describing something using the language of mathematics.

  Also remember that metaphors are very useful — use your own mathematical intuition! How do you imagine the mathematical concept? Can you visualise it in your head? What does it remind you of? What images spring to mind?

  Don't be afraid of uncertainty or the limitations of the science you are writing about. It's important to communicate these both to be trustworthy, but also to raise awareness of how mathematical research is done. See the last section for more tips about this.

Focus

"I have made this letter longer than usual because I lack the time to make it shorter."

Blaise Pascal

One of the most important parts of writing is what you leave out. Try to pull out one main idea you want to get across to your reader: what do you want them to remember? Be bold and cut out anything that isn't helping get that message across.

Other things to think about:

- **Be correct!** That includes names, dates, places etc. Even if you don't think that something is important, there will always be a reader who does!
- A**ttract attention:** The title is the first thing a reader will see: should it be informative, witty, or intriguing? Think about pictures, movies, sound files, etc: these can work wonders in drawing in an audience.
- **Do "it", "this","them" and "that" mean what you think they do?**
- **Beware of empty words and expressions:** Examples include "actually", "really", "very", "own", "with regard to", "in the case that". See if you can leave them out. If a word isn't doing any work in a sentence – delete it.
- **Check** that your brackets, commas and dashes around sub clauses are in pairs.
- **Check** all apostrophes!
- **Take care** that persons and tenses agree, that singular and plurals match.
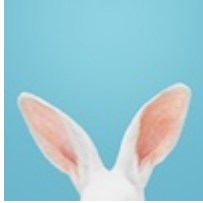
Editing your work

Marianne Freiberger and Rachel Thomas

You don't have to get it right the first time! And remember, your ears are your best editor!

Don't be afraid or put off by editing. It's a great part of the process as – knowing you will edit your work later makes it easier for you to write. And a well edited piece is also easier for your reader to understand what you are saying.

Slumbering canines and remote felines

Rewriting even just a single sentence can work wonders. If you don't believe it, have a look at the following sentences (from *How to write and publish a scientific paper* by Robert A. Day and Barbara Gastel, p201) and see if you recognise them...

- As a case in point, other authorities have proposed that slumbering canines are best left in a recumbent position.
- An incredibly insatiable desire to understand that which was going on led to the demise of this particular *felis catus*.
- There is a large body of experimental evidence which clearly indicates that members of the genus *mus* tend to engage in recreational activity while the feline is remote from the locale.
- From time immemorial, it has been known that the ingestion of an "apple" (i.e., the pome fruit of any tree of the genus *maclus*, said fruit being usually round in shape and red, yellow, or greenish in colour) on a diurnal basis will with absolute certainty keep a primary member of the health care establishment absent from one's local environment.
- Even with the most sophisticated experimental protocol, it is exceedingly unlikely that the capacity to perform novel feats of legerdemain can be instilled in a superannuated canine.
- A sedimentary conglomerate in motion down a declivity gains no addition of mossy material.
- The resultant experimental data indicate that there is no utility in belabouring a deceased equine.

Why should you edit your own writing? When should you edit?

Editing and rewriting is an integral part of the writing process. There are very few occasions where the first draft cannot be improved (we certainly haven't had this experience!). But this is a good thing: at first, you want to let the writing flow freely, not worrying about whether you are "doing it right". You want to let your brain speak uncensored. This is where creativity, passion and intelligence comes from.

Explicitly editing as you write can make it harder to write. For most people it is easier to alternate between writing freely, and then going back and editing and fine tuning. Writing is as much a craft as it is a creative pursuit.

There is nothing more frustrating than someone misunderstanding your work — unclear writing obscures what you are trying to say. Every time the flow of reading is stopped, because your meaning is unclear, or there is a spelling or grammatical mistake, the reader stops concentrating on what you are saying. Clear, direct, and correct writing is the best way to communicate with your reader. (It is also really frustrating and embarrassing to get feedback indicating spelling and minor grammatical mistakes.) Editing is a chance to polish your work, and also a chance to appreciate your own work.

How do you edit?

There are no hard and fast rules, but here are some general tips.

- Read once through quickly, to sense if there is an overall message coming across.

- Read half-speed, paragraph by paragraph, for structure. Think like a member of the audience you are trying to reach: Am I being led through the story, is there a sense of flow? Are my questions being answered?Read slowly, line by line, to fine tune the style and language.

- Read your work aloud – your ear is an excellent editor!

- Finally double-check the accuracy of spelling, names, facts, figures, links and references.

> **Exercise**: Write out a one sentence/one tweet version that summarises the piece. Is this message clear in the piece?

We now move on to some concrete suggestions for editing techniques. These apply to all your writing – papers, theses, emails, funding applications (one of the most important times to write clearly), popular articles for non-expert audiences – any piece of writing will benefit from these.

Think about your audience

While you are editing, picture your audience in your mind and imagine telling them your story.

- Are you speaking their language? Think about the broadest audience your piece will reach, you don't want to exclude anyone you could include with some simple changes.

- Are you answering their questions?

- Why should they care? WIIFT (What's In It For Them?)

The main thing in the redrafting and editing process is to always keep the audience in mind – show them courtesy and respect, remember you have to make them want to start, and finish reading your work, and you want them to understand and absorb what you are telling them. Get in their brain.

One fact per sentence, one idea per paragraph

Ask yourself if your sentences could be shorter. This doesn't mean that all your sentences have to be the same length. You can mix up short sentences with long ones, but experts say you should aim for 15 to 20 words a sentence, on average.

A good way to keep your sentences short is to follow the rule of one important fact per sentence, perhaps with an additional sub clause giving context. Something similar goes for paragraphs. When you start a new idea, start a new paragraph.

Exercise: Go through your draft and try to spot and then break up long sentences and paragraphs.

Put the important stuff at the beginning…. or the end
Start with something old, end with something new

You can apply these principles to the structure of a sentence, a paragraph, and even to the whole document. Thinking about the beginning and end of sentences and paragraphs improves the flow of reading. Remember that as the reader scans the page their eye is pulled to the beginning and end of paragraphs, particularly the opening sentence – use this to draw the reader in.

The important stuff might be something relevant – a fact or an idea the reader can relate to, something surprising, or the nuts and bolts of what you are explaining.

You might not examine every sentence in this way, but it is a good tool to have in your kit. You might want to at least read each paragraph with this in mind.

Exercise:

Read the first sentence from each paragraph in sequence. It should still make sense, like a synopsis of your whole piece, and it should pull the reader along, hitting most of the important points. Imagine this was the only thing your reader saw, is there anything missing? Does each sentence indicate the idea developed in that paragraph?

This is a good tip to help you make sure your paragraphs are in a logical order, and that you have a paragraph for each main point. Obviously this experiment is more easily applied to shorter pieces, but the principle applies to any cohesive chunk for any piece of writing. You can apply it to a section, or a chapter of any longer piece of work.

Final checks

- Keep a look out for jargon and the other things to think about from the writing tips.

- Check for spelling mistakes and typos.

- Take a minute to admire your work!

Be clear, be trustworthy

Marianne Freiberger and Rachel Thomas

In some situations – for example when you are communicating research on COVID-19, or climate science – trust can be an issue. People may have strong prior beliefs about the subject and recent research has shown that people trust balanced information more.

You cannot expect to be trusted by your audience – instead you have to be trustworthy.

But how do you do this? David Spiegelhalter and his colleagues from the Winton Centre for Risk and Evidence Communication have developed *Five rules for evidence communication*:

- Inform, not persuade
- Balance, but not false balance
- Disclose uncertainties
- State evidence quality
- Inoculate against misinformation

As David told us in March 2020:

"Trustworthiness has been characterised quite well by Onora O'Neill, a philosopher of Kant. She describes what she calls *intelligent transparency.* This involves making sure that information is accessible, which means repeating it again and again making sure it's available from many sources. The information has got to be comprehensible, people have to understand it and you should check that they are getting the right impression. And the information has to be useable — answer people's questions and concerns: you have got to listen."

"The final and crucial point, which people fall down on all the time, is that the information must be assessible: you shouldn't just have to take it on trust. Most

people will take it on trust, but there are people out there who know a lot about what is going on, and these people should be able to check your working."

In January 2023, the Newton Gateway to Mathematics organised the event *Communicating Mathematics for the Public*, which gave a wealth of information about communicating important ideas clearly, accessibly and in a trustworthy way. You can watch many of the talks from the event online, but here are some particularly useful tips.

Statistics and uncertainty

Based on the talk by Mark Pont from the Office for Statistics Regulation.

Statistics aren't certain facts but are often presented as if they were. You want to be clear on the caveats but you don't want to undermine trust.

Always ask yourself, or the researchers you are working with: are there uncertainties involved in the mathematical or scientific research that should be highlighted to the reader?

Communicating uncertainty is hard, but it is very important to be honest about the limitations of any statistics or results. Here are some recommendations from Mark's talk, and from a very useful review on presenting uncertainty, produced by Full Fact in 2021:

- **Be transparent** about the quality and limitations of the data.

- **Be specific** about what exactly is uncertain. Be specific about whether uncertainty it is due to incomplete understanding of a process, unreliability of measurements, insufficient data, or other sources. Don't make it sound like nothing can be trusted.

- **Not every number needs to have the word "estimate" around it.** Intersperse this occasionally, to clarify give the narrative that these numbers are not absolute facts. Rounding numbers is also helpful, as it avoids spurious accuracy.

- **Indicate uncertainty** in existing data using numerical ranges in brackets, after the main value. For example, say "unemployment is estimated at 3.9% (between 3.7% and 4.1%)" at least when you introduce the figure for the first time.

- In case of future predictions, **use verbal expressions to indicate the general direction of travel,** but supplement these with numerical probability ranges, and wherever possible access to underlying data. Do say, for instance,

"global warming is likely (66% chance) to reach 1.5°C between 2030 and 2052 if it continues to increase at the current rate".

- **Take care when using large numbers and jargon**. If jargon is necessary, remember to explain it. When using large numbers, remember that the difference between 1 million and 1 billion is clearer if the latter is expressed as 1,000 million.

Charts and visualisations

Based on the talk by Martin Ralphs from the Office for National Statistics.

- **Simple is (usually) better than complex.** Charts should work on their own, without having to read the stuff around it. This is particularly useful if someone is likely to reuse your chart or graphic elsewhere.

- **One main message per visual:** you only have 10-15 seconds to get the message across.

- **Have a good descriptive title** that conveys your main message. If a statistical description is necessary it could sit beneath this main title, or be in the caption. If you can embed the title in the chart or graphic itself should it be reused elsewhere.

- **Try to bring uncertainty into any graphics:** Uncertainty is your friend in statistics. Try to embrace it and embed it.

- **Accessibility really matters.**

Accessibility

Based on the talk by Hannah Thomas from the Government Analysis Function.

Digital accessibility is all about making content published online easy to access and use for all users, regardless of impairment, medical condition or disability.

- **All non-text content should have a text alternative that serves the equivalent purpose.** For example, what is the message of your chart? Answering this question. will make your chart better. Include a fully descriptive text alternative directly under your chart, before information on sources, notes, etc.

- **Do not use colour alone to communicate a message.** If you can't differentiate between the elements in your charts legend, you won't be able to differentiate between the categories of your data.

- **Use 3 to 1 contrast ratio for adjacent colour elements in visualisations.**

There is some guidance specifically on the use of colour and on accessibility more generally, from the Government Analysis Function.

Useful resources

- Uncertainty

    ○ Guidance on writing about and presenting statistics from the Office for National Statistics
    ○ Uncertainty Toolkit for Analysts in UK Government (and one page summary
    ○ Guidance on communicating quality, uncertainty and change from the Government Analysis Function
    ○ How to communicate uncertainty from FullFact

- Accessibility and visualisations (all from from the Government Analysis Function)

    ○ Guidance on charts, tables and the use of colour
    ○ Guidance on infographics
    ○ Guidance on communicating uncertainty

- Trustworthiness

    ○ *Five rules for evidence communication* by Michael Blastland et. al, *Nature*, November 2020
    ○ *Transparent communication of evidence does not undermine public trust in evidence* by John R. Kerr et al, *PNAS Nexus*, December 2022
    ○ *Communicating the coronavirus crisis*, *plus.maths.org*, March 2020 – Our interview with David Spiegelhalter where he explained trustworthiness and intelligent transparency.

- Other resources

    ○ *How to write numbers* – a free online course aimed at journalists from the Royal Statistical Society, aimed at journalists
    ○ Resources for journalists from the Winton Centre for Risk and Evidence Communication