

# Open-source tutorials benefit the field

*PsyTeachR Team\**

Open research is increasingly required by journals and funders but involves many new skills. Creating open-source tutorials is useful to the field and personally rewarding, but these efforts must be credited accordingly.

Researchers need to constantly update their skills, a challenge that has become especially important for research transparency in the service of open science goals<sup>1</sup>. For example, data simulations support power analysis to plan sample sizes<sup>2</sup> and enable preregistration to counter HARKing (hypothesizing after results are known) and *P*-hacking (running multiple versions of analyses and selectively reporting significant results)<sup>3</sup>. Similarly, developing reproducible code and sharing datasets increases research transparency, enables code verification and error detection, and facilitates meta-analyses, replications and secondary data analysis<sup>4</sup>.

However, open research skills are not commonly included in degree programmes<sup>5</sup>. This creates a major barrier to open research: these skills must be acquired independently, and the necessary resources might not exist, or there might be inequity in access. One solution is to improve the quantity, quality, and accessibility of tutorials on good research practice and cutting-edge techniques.

Writing tutorials can be personally rewarding. It is rare to get a thank-you note for a research paper, but it is common to receive heartfelt thanks for writing a tutorial that helped someone in their research. Here we share tips for aspiring tutorial writers on creating an effective and useful tutorial (BOX 1) and making it accessible, and advocate greater recognition of these efforts.

## Make tutorials accessible

Most academics create learning materials for their courses or research groups, but tutorials serve the field and promote open research only if they are open and accessible. Thus, additional steps are needed to ensure tutorials reach the widest possible audience.

In academia, the traditional route for disseminating knowledge is journal publications. Although methods journals will publish tutorial-style articles, this process can be slow and articles are often paywalled. We therefore recommend self-publishing before or instead of submitting a tutorial to a journal, allowing materials to be shared immediately, freely, and with more interactive elements. For example, a technical tutorial can be easiest to understand as a numbered list of tasks with frequent links to further resources, but journal articles emphasize narrative paragraphs and academic citations.

Tutorial creators can also use self-publication to get feedback. For example, Nordmann and colleagues<sup>6</sup> published their tutorial as a preprint and included a link to provide feedback, which was used to refine the tutorial before it was submitted for publication.

Many researchers self-publish by posting tutorials on a personal website or blog. Archiving a copy on a free, reliable platform provides a stable address, even if the tutorial creator changes their website or leaves academia. Multiple versions can be archived, which allows the content to be updated. Code-based tutorials are often stored on [GitHub](#), which can also host a website. Other options include archives that generate a DOI, such as preprint servers, the [Open Science Framework](#), or [Zenodo](#). These archives can host tutorial content, but they tend to be difficult to search, so it is helpful to add tutorials to curation lists such as the [Open Scholarship Knowledge Base](#) or [FORRT](#), which are more searchable and target specific audiences searching for tutorials.

The choice of distribution format also has implications for accessibility. PDFs look pretty, but are difficult to adapt and often incompatible with translation and screen-reading tools (for example, copying code or text is often impossible). PDF materials are therefore inaccessible to speakers of other languages or those with impaired vision. Instead, tutorials should be written in an open format, such as html, using blogging software or with guidance from Daniel Quintana's [tutorial on making a free personal academic website](#).

Finally, giving tutorials an [open-source license](#) promotes accessibility by encouraging sharing and reuse, applying FAIR (Findable, Accessible, Interoperable, Reusable) principles<sup>7</sup> to help combat widespread inequity due to language and resource barriers. For example, the *PsyTeachR* book series written by our group are all published under a Creative Commons [CC-BY-SA 4.0 license](#), allowing others to copy, redistribute, remix, and transform the material, as long as the original source is cited and derivatives use the same license. An open-source license enabled our books to be translated into [French](#) and [Chinese](#), expanding the reach of our original English materials. This license also allows customization, such as keeping the core technical explanations and replacing the examples with data more relevant to researchers in other fields.

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## Box 1 | Tips for creating a tutorial

Before writing a tutorial, think about the user problems that your tutorial will solve. Acquiring new knowledge is easier when it is directly related to prior experience, so use concrete and realistic examples that will resonate with your intended audience<sup>8</sup>. For instance, Richard McElreath's [tutorials on Bayesian inference](#) use examples from ecology and anthropology so learners can practice making realistic inference; and the [Open Stats Lab](#) uses open datasets from papers published in *Psychological Science* to support lessons on introductory statistical concepts.

A good tutorial keeps users interested and engaged. To this end, add interactive elements such as [self-checking quizzes](#) or [web apps for demonstrations](#). Following the multiple representation principle in multimedia<sup>9</sup>, combining visual materials to illustrate text explanations can facilitate understanding. Videos embedded within text tutorials can be particularly engaging. For example, Erin Buchanan's [Statistics of DOOM](#) YouTube channel includes video walk-throughs of statistical techniques that have earned hundreds of thousands of views.

Prior knowledge plays a key role in learning and predicts success in MOOCs (massive open online courses)<sup>10</sup>, so signpost prerequisite skills, such as competence in a programming language or statistical procedure. Finally, set expectations for the user about time commitment. For instance, in our experience, gaining introductory skills in R takes about three full days.

To showcase tutorials in different media and aimed at different audiences, we have curated a non-exhaustive [list of tutorials](#), organized into sections such as articles, blogs, and translations, and ranked where appropriate for beginners to advanced users.

### Give and receive credit for tutorials

Providing useful learning materials is a great way to gain visibility and reputation by getting your name out in the field in a positive way. However, it can be challenging to demonstrate their impact. There are several ways to leverage web analytics to track engagement. Tutorials hosted on a platform such as YouTube or a preprint server will automatically track engagement. Metrics platforms such as [Altmetric](#) can track materials shared on social media with a hyperlinked DOI. Detailed Google Analytics can be obtained by adding a few lines of JavaScript to any webpage.

However, tracking engagement does not by itself ensure that tutorial writers are appropriately credited. Although tutorials for advanced statistical methods can be highly cited, especially when published in methods journals, tutorials that explain the fundamentals of a technique are seldom cited, despite arguably having a greater impact on research and teaching. For example, established researchers using tutorials to transition from GUI-based analysis platforms to coding their analyses might use boilerplate code from a tutorial. However, they might not cite the tutorial because the analysis method has not changed, only the tool they used to carry it out.

Despite their potential to improve learning, citation of websites, videos or online tools is not standard practice. Thus, an important step to receiving credit

is to ensure that people can easily find a citation. We recommend obtaining a DOI through a service such as the OSF or Zenodo and highlighting the full citation on your tutorial, website, CV or twitter feed, or wherever you might promote your materials. Many preprint services allow the DOI of a published version to be added so that citations amalgamate.

The field at large must take action to support these efforts. Researchers can cite tutorials that influence their research, even if the materials are not journal articles or the topics are general rather than advanced techniques. Journals can explicitly encourage the citation of all relevant materials and eliminate reference limits. Methods journals can create more innovative article formats so that tutorial writers can enjoy both the pedagogical and accessibility advantages of interactive online formats and the prestige and reach of journal articles. Grant agencies can fund the development of open-source learning materials.

Crucially, hiring and tenure committees and funders should recognize the expertise, effort, and altruism involved in producing high-quality tutorials. They should consider the value of tutorials despite being less likely to have traditional evidence of impact such as citations. A good tutorial can take as long as a research paper or book to write, reflect decades of experience, and have an enormous positive impact on the field. They should be recognized and rewarded accordingly.

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### Competing interests

W.T., E.N., P.M., R.L., L.D. & D.B. teach paid workshops using the open-source tutorial materials they developed. The other authors declare no competing interests.

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