Hindawi
Education Research International
Volume 2022, Article ID 5156888, 4 pages
https://doi.org/10.1155/2022/5156888

Research Article

How to Write a Contemporary Scientific Article?

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Received 17 May 2022; Accepted 24 September 2022; Published 12 October 2022

Academic Editor: Syed Sameer Aga

Today, scientists are drowned in information and have no time to read all publications, even in a specific area. Information is sifted and only a small fraction of articles is read. Under these circumstances, scientific articles have to be properly adjusted to pass through the superficial sifting. Here, I present instructions for PhD students with almost serious advice on how to write (and how not to write) a contemporary scientific article. I argue that it should "tell a story" and should answer on the three main questions: Why, What, and So what?

1. Introduction

Therefore, since brevity is the soul of wit, and tediousness the limbs and outward flourishes, I will be brief. (William Shakespeare [1]).

Science has been industrialized. It follows a market-driven Moors law [2]: the number of scientific publications is growing exponentially with time [3–5]. At the beginning of my scientific career, slightly more than thirty years ago, we had one "library day" per week. Then we could skip the lab and go to a library instead. It was crowded in our library. People were sitting there, browsing all the newly received journals from the beginning to the end. The number of such journals could be counted by fingers. Today, 24/7 would not be enough to read all publications, even in my specific area. I do not even know the titles of all the relevant journals. Unfortunately, the dramatic growth in quantity came at the expense of quality [5]. As a result, the signal-to-noise ratio in scientific literature is reduced. Reading more does not necessarily bring more knowledge. I believe that the number of articles read by each researcher did not increase much in the last three decades. We were reading a lot before and have to work as well. To cope with the overflow of information, we use some sifting procedures. Therefore, a contemporary article should be adopted for passing the superficial sifting.

The growing complexity of modern science together with its industrialization has led to a narrowing of research specializations. We are no longer either experimentalists or theoreticians but have a much finer distinction (check e.g., academic job announcements). Narrow specialization causes difficulties in communication between scientists. It is not uncommon that experts in the same area, sitting in the same conference room, barely understand each other. Therefore, a contemporary article should be written in a manner comprehensible by not-exactly-the-specialists in your field, which often coincides with the rest of the scientific community.

Here, I present instructions that I used to give to my PhD students on how to write (and how not to write) a contemporary scientific article. I argue that it should "tell a story" with a clear and straightforward message and should answer the three main questions: Why? What? and So what? I hope that these instructions, together with many earlier advises [6–9], can help young scientists in writing more comprehensible papers with better chances to be noted by scientific community.

2. Why, What, and So What?

The goal of every author is to be read, understood, and appreciated. To succeed, first of all, the results should be of

the highest scientific value. But it is also important that the style is properly adjusted to modern realities. The article should tell a straightforward and easily digestible story. Like a Hollywood movie, it should contain a prologue, an action and a happy end, which should answer the three main questions posted above.

An introduction is the prologue of the story. It should explain the motivation: Why was it necessary to spend effort on this project and why should the reader read it? I am working in the field of superconductivity and can tell you that the majority of undergraduate students and even a large fraction of postgraduates tend to start the introduction like this: "Superconductivity has been discovered by H. Kamerlingh–Onnes in 1911." To me, this is the signature of scientific immaturity. As well, they could have started as: "Our universe was born 13.7 billion years ago." Although some historical and philosophical excursions may be necessary, minimize them to no more than one short paragraph with a strictly relevant overview. Quickly come to your point.

The results section represents the main action. It should describe what has been done. The action should not be long and boring otherwise a spectator will switch it off. "Brevity is the soul of wit" [1]. You are writing for busy scientists. Don't describe standard techniques, even if they were new for you, and skip textbook trivialities. The story should keep the reader's attention. For that, it should have a clear red line, the message. The action should follow the main story and should not deviate to technical details, or be overloaded with irrelevant data (usually this is the vast majority of acquired experimental results). As in a kitchen: if you put everything in a soup, it will become uneatable. For many students, this is counterintuitive. Technicalities are dear to their hearts because they put so much effort into struggling with them. But it is important to "see the forest for the trees." The message should be clear without technicalities. They do matter, but only after the paper is read and the message is understood. Move them to the appendix or supplementary.

Apart from technicalities, many students tend to focus on problems and failures. The reason is the same—they represent the most painful and memorable moments of the project. A report on successful work may sound like a complete disaster. The story must be written in the major key! If there are no successful results or a message to tell then the article should not be written in the first place. Otherwise, be positive! The reader does not need to know all your mistakes. There are infinite ways to do things wrong and only one way to do it right. Describe how it was done in the end. For example, if the current was too small to be measured directly and an alternative indirect technique was used for this purpose, do not write: "we failed to measure the current." Write instead that "we estimated the current from lock-in measurements, as described in Ref. [10]." In Figure 1 I sketched the two typical mistakes.

Finally, discussion and conclusions sections represent "the happy end." They should answer the toughest question, So what? Here, the key result, its novelty and importance have to be explicitly articulated. However, unlike in a movie, this should not be the first and only catharsis. For the message to sink into a human brain, it has to be repeated three times. Therefore, to avoid misunderstanding, there should be: (i) a spoiler in the introduction, (ii) a message claim in the results, and (iii) a moral in conclusions.

3. Title and Abstract

Today we are not sitting in libraries but are using the Internet: Google, the Web of science, and so on. This makes the title, the abstract, and the cover art of special importance because they are passing through the first sifting grid, especially the title. When I was a student, I was taught to write excruciatingly detailed titles. My first paper was called: "The extended Bean critical state model for superconducting 3-axes ellipsoid and its application for obtaining the bulk critical field H_{c1} and the pinning current J_c in high-T_c superconducting single crystals." Informative, is not it? But today, titles should be both informative and eye-catching. Unfortunately, these two requirements are often contradictory. Much stretching towards a popular catchy title leaves a bad aftertaste. There should be a golden mean. If the choice is between an informative or catchy title, I definitely recommend the informative. Yet, even in this case, there is some flexibility. The title may be informative, e.g. about the key result or the main message (which do not need to be identical). Keep in mind that other researchers will be searching for information on a specific subject. The more closely your title reflects the content, the more successful their search will be, increasing the probability of your article being read. Google search for the chosen title yourself and see if it ends up in the right category.

An abstract appears at the second step of sifting. It should tell the story and bring the moral, like a fairy tale in one sentence. This is not easy. The only advice I have is to leave abstract writing to the end, when the first draft is ready and the message is crystallized.

4. Figures

At the final stage of sifting, we look through the article (often from the end) and, just like kids browsing a new fairytale book, we focus on Figures. Therefore, Figures should tell a self-consistent story like a comic's book.

Students can hardly imagine that in old precomputer times, graphs were drawn by hand. Special draftsmen draw axes and symbols. Thanks to computers, modern articles contain much more detailed visual information. However, a misuse of computer graphics can lead to crowded and unintelligible pictures. A general advice: avoid insets and use the minimal amount of text in the figures. Imagine that someone would like to repost a part of your graph. In this case, overlapping with excessive information on the same graph would create a problem. The modern trend is to have figures with several simple panels. This helps to tell a story in a sequential comic's book fashion.

I always recommend starting writing a paper by assembling figures. They form a skeleton of the future article,

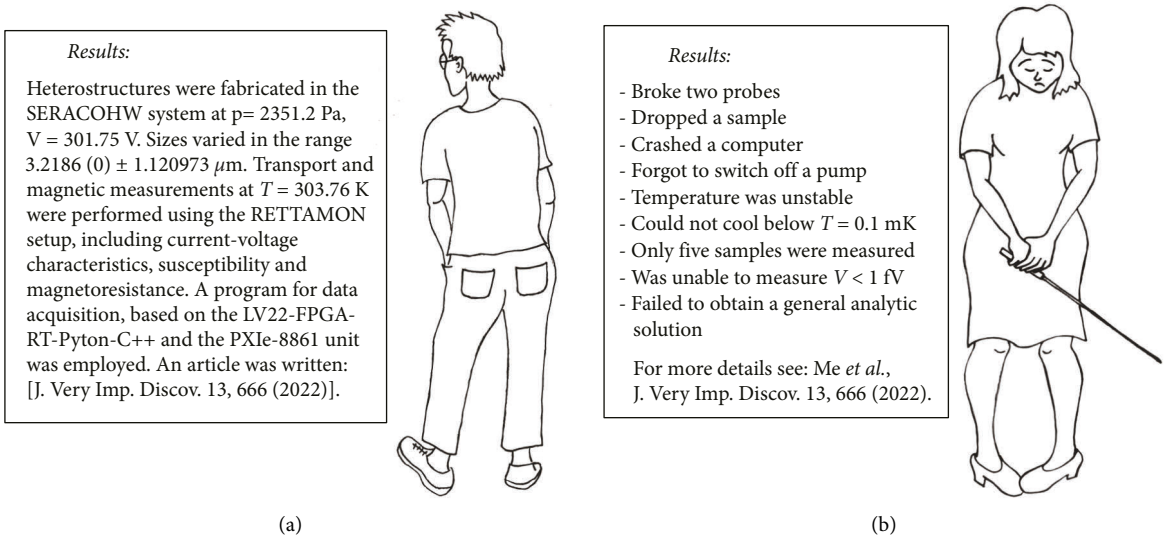

Figure 1: Typical mistakes made by students: extreme technicality (a) and extreme negativity (b).

which is then developed by adding text and description. In an experimental work, figures represent the quintessence of the article. They illustrate the results and carry the message. It is not uncommon that the message is revealed only after arranging all the figures.

5. References

Every scientific journal requires fair representation of earlier publications, which puts an article in a proper historical perspective. Therefore, an article should contain a good volume of references. Too few raise questions if the authors are aware of the field, is the representation fair, or is the field important? Excessive self-citation causes irritation. Self-citations should not exceed 20–25% of the total list. Try to include works from as many different research groups as possible. Think that the article will be reviewed by several experts in the field. They would not be happy if their important (as they think) work was not properly cited. Scientists can be very petty and picky when it comes to priorities. Citing is also the best way to draw the cited authors attention to your article.

The main purpose of a reference is to provide material for deeper reading on the subject. Make sure that each reference is cited in a relevant context. Read them all! Topical reviews are the trend of our time. They are useful for quick orientation in the field. Unfortunately, they also became a popular lazy reference "about everything." I recommend being restrictive with reviews. Cite original articles instead, both for providing focused information to readers and for giving scientific respect to pioneers.

6. Submission

Thoroughly check the publication criteria in the chosen journal. Referees are asked to provide answers to specific questions (novelty, originality, impact, and so on). Try to put yourself in the referee's shoes. Count on having at least one referee from outside your field. Things that are obvious to you may not be obvious to the referee. Address the specific questions in the text to help the referee.

Don't rush with submission. Polish the text very carefully. Don't ignore small details (e.g. mismatch of figure styles, fonts colors, language, and so on.). A good piece of work written in a sloppy manner will get less credit. You may not have a chance to improve the manuscript afterwards. Let the finished manuscript rest for two weeks. You will likely discover that it reads somewhat differently, the logic is not as straight as it seemed, and the text contains bugs. Repeat this step until iterations converge, and only then press the submit button.

7. Conclusions

I have argued that a modern article should answer the three main questions. Here, I address them to myself:

Why? Our time, with an overflow of information and a narrow specialization of researchers, requires proper adjustment of epistolary scientific style. Contemporary articles should tell an easily digestible story with a clear red line and an explicit message in order to pass the superficial sifting process.

What? I have written down instructions that I used to give to my PhD students. By the way, similar rules apply to conference presentations.

So what? I hope that the presented advices can help students write more comprehensible articles with a better chance to be noted by the scientific community. Young scientists should learn the art of clear and laconic expression of ideas if they want to stay in academia. However, I want to emphasize that the best strategy for having your paper read is to maintain a good scientific reputation by not producing "scientific noise." There are no magic tricks that could make mediocre research good. Yet, even a good researcher, presenting excellent results, should try to help stressed and pressed contemporary readers.

Data Availability

Data available on request.

Disclosure

Initial version of the manuscript is available at E-print repository [11].

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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