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Commentary

Developing the culture and discipline of conducting and publishing scientific research: Guiding principles

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Abstract
The pressure to publish is a fact of life in academia. Academics are expected to demonstrate that they are active researchers and that their work has been vetted by peers and disseminated in reputable scholarly forums. In practice, however, a number of critical constraints hamper effective publication of scientific research in most developing countries. These include lack of effective mentoring system, poor facilities and inadequate funding for effective research and heavy workload where too much time and effort are spent in teaching, grading, meetings and other non-academic activities. In spite of these seemingly insurmountable challenges, with proper planning and commitment, one can still conduct research and publish to advance ones career and exchange of knowledge. The paper discusses the critical guiding principles in scientific writing and publishing in an unfriendly research environment as pertains in most universities in the developing world. The overriding principle is to cultivate the discipline of scientific writing consciously and follow it through religiously. This could be achieved if time is allocated for scientific writing in the scheme of weekly schedule of activities and made to be functional through meticulous planning and commitment. Equally important is to avoid procedural mistakes in scientific writing. While the quality of the research is the single most important factor in determining whether an article will be published, a number of procedural mistakes can help tip the balance against its publication. It should also be noted that when a manuscript is submitted to a scholarly journal, there are two audiences to satisfy: first the editor and external reviewers, and then the journal's readers. That first group must be satisfied to create the opportunity to appeal to the second. Thus, familiarity with the style and tone of the specific journal is crucial.

Keywords
Academia — research environment — planning and commitment —scholarly journal

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Content

Introduction

The pressure to publish is a fact of life in academia. Academics are expected to demonstrate that they are active researchers and that their work has been vetted by peers and disseminated in reputable scholarly forums (Furman, R. 2007). In practice, however, several critical constraints hamper effective publication of scientific research by teachers and research fellows in most developing countries. Among these constraints are lack of effective mentoring system, poor laboratory facilities, limited funds for effective research delivery and heavy workload of University teachers where too much time and effort are spent in teaching, grading, meetings and other non-academic activities. Limited networking and research collaboration as well as lack of purposeful promotion guidelines in most universities in Africa also adversely affect research culture and output.

In spite of these seemingly insurmountable challenges, with proper planning and commitment, one can still conduct research and publish in such an unfriendly research environment for career development and also to advance exchange of knowledge in the wider scientific community. Many young

faculty and research fellows find it difficult to write a scientific paper. The aim of this article is to help even the most uncertain writers to produce a clear and well presented piece of writing. The overriding principle is to cultivate the discipline of scientific writing consciously and follow it through religiously. This could be achieved if time is allocated for scientific writing in the scheme of weekly schedule of activities and made to be functional through meticulous planning and personal responsibility and commitment.

Scientific writing is the basis of going to higher institutions, libraries, and universities to gain information and present it in a concise manner abiding by the generally accepted template of most scientific papers. A good style is helped by logical planning by deciding on what to write, and writing it simply and in a sensible order to meet the aspirations of editors and readers in general (Brian, 2006).

Academic publishing describes the subfield of publishing which distributes academic research and scholarship. Most academic work is published in journal article, book or thesis form. Academic publishing relies on some form of peer review or editorial refereeing to qualify texts for publication. Most established academic disciplines have their own journals and other outlets for publication, though many academic journals are somewhat interdisciplinary, and publish work from several distinct fields or subfields. The kinds of publications that are accepted as contributions to knowledge or research also vary greatly between fields, as do review and publication processes (Furman, 2007).

Academic publishing is undergoing major changes, emerging from the transition from the print to the electronic format. Since the early 1990s, licensing of electronic resources, particularly journals, has been very common. Currently, a major trend, particularly with respect to scholarly journals, is open access via the Internet (Tenopir and King, 2000). There are two main forms of open access: open access publishing, in which the articles or the whole journal is freely available from the time of publication; and self-archiving, where authors make a copy of their own work freely available on the web.

Scientific papers are an important, though poorly understood, method of publication. They are important because without them scientists cannot disseminate knowledge efficiently and get research funds from the government or from universities. They are poorly understood because they are not written well (Furman 2007). A good example of the latter phenomenon occurs in most introductions, which are supposed to introduce the reader to the subject so that the paper will be comprehensible even if the reader has not done any work in the area.

You have spent years on a research project and have finally discovered that the project is not as simple as you thought it would be and you cannot actually solve the problem you set out to solve. Nonetheless, you have a responsibility to present your research to the scientific community. It must be noted that negative results can be just as important as positive results, and also that if you do not publish enough you will never be able to stay in the world of science (Brian, 2006; Björk, 2007). In essence, every research is publishable and must be published.

Equally important is to avoid procedural mistakes in scientific writing. While the quality of the research is the single most important factor in determining whether an article will be published, a number of procedural mistakes can help tip the balance against its publication. Undoubtedly, when a manuscript is submitted to a scholarly journal, there are two audiences to satisfy: first the editor and external reviewers, and then the journal's readers. That first group must be satisfied to create the opportunity to appeal to the second. Thus, familiarity with the style and tone of the specific journal is crucial.

1. Developing research culture

Governments and policy makers need to appreciate that the only way Africa could meet the old and emerging challenges is through the harnessing and fostering of the nations' most precious resource—the intellectual knowledge and capacity of their people through training and research. It would therefore be useful for governments in Africa to establish Research Fund to provide the required financial support for research and technology generation in the continent. Governments and Policy makers must also appreciate that, although costly, scientific research is a good investment and most productive when many scientists and institutions work simultaneously on the same key problem. African governments and institutions of higher learning must embrace scientific capacity building as integral part of their developmental philosophy and agenda. To this end it must be reiterated that the distinction between "useful" and "not-useful" research is bogus. The track records of advanced countries tell us that fundamental or basic research is often at the root of transformational changes in the world. Yet universities in Africa are being pushed toward an ever more utilitarian approach in the name of the so-called demand-driven research. We must push back and make a strong case for the values of the entire spectrum of the African universities engagements in education and critical research.

1.1 Science without research is dead

The unavailability of adequate funds for research is the single most important challenge to research culture in the developing world. For example, the proportion of the national resources committed to scientific research in most countries in Africa is less than 0.1% of the Gross Domestic Product (GDP) although all countries in the AU signed the declaration to commit at least 5% of GDP to research. It is ironical that budgetary allocation for national Research Institutions in sub-Saharan Africa covers emoluments of staff and administrative expenses. There is hardly any budget for research, which is the core business of such institutions. What this unfortunate situation means is that governments in these countries are willing to pay research scientists their salaries for doing nothing.

Within this hostile research environment only well focused and serious research minded academics can break the dogma

and conduct meaningful research that can eventually be published. It is important for young faculty and research fellows to consult and seek advice in good time (both professional and technical) with respect to research proposal writing, research design, data collection and analysis. It is crucial to develop your own capacity in proposal development to meet the aspirations and requirements of different donor agencies. Investing in research and publishing by young faculty and research fellows, in particular, to advance their careers is a rewarding adventure. As a young faculty or research fellow, it would be useful to guide against patronage or bootlicking and rather take control of your destiny. As much as possible, network and collaborate with colleagues and others both locally and internationally. Above all, effective supervision of undergraduate and graduate research projects is a good starting point in developing research culture.

2. Scientific experiments

In 'objective' research, scientists and those who aspire to that status, collect data as a critical part of the research process and in all cases 'scientific method' must drive the process and must have effect on how data are collected. Experiments are central to scientific method, particularly as part of the deductive approach. Experiments are used primary to test hypotheses. We can define an experiment in this context as '*any systematic process that allows the testing of a hypothesis, involving the collection and analysis of specified data.* A key characteristic of scientific experiments is the search for control and the consequent need for simplification. Scientists studying complex systems usually want to 'simplify' them (in the experimental sense) so that they can focus on the area in which they are interested. Such simplification may involve removing the influence of factors that are thought not to affect the variables being investigated or factors whose influence have already been studied and understood. The process by which we define exactly how a particular experiment is to be conducted is called experimental design. Such a design involves completely specifying the components of the experiment, including

- the type of experiment design to be used
- the sample and/or population to be studied
- the factors to be controlled in the experiment
- the variables to be measured during the experiment, including the scales of measurement and the method to be employed
- the type of analysis to be carried out on the collected data after the completion of the experiment

Generally, all experiments are controlled, in that they are distinct from the (non-participatory) observation process. In the latter we observe events as they happen, but do not attempt to alter these events by our intervention. Specifically, controlled experiments are where we consciously attempt to exert our influence over the course of events. Examples are laboratory and greenhouse experiments- growing plants in a greenhouse so that we can exert (almost) total control over the environmental conditions under which they grow. We substitute a controlled environment for the more complex, uncertain, natural world. Controlled experiments aim to simplify the experiment by removing extraneous factors.

2.1 Ethical issues in scientific research

Researchers whose subjects are people or animals must consider the conduct of their research, and give due attention to the ethical issues associated with carrying out their research. It is essential to justify the research through objective analysis of the balance of costs. As a researcher, you are responsible for your own work, and for your contribution to the whole research project. To comply with ethical standards, the consent of any subject involved in the research must be sought in advance and ensure that all subjects participate voluntarily. Transparency, openness and honesty in dealing with other researchers and research subjects are critical. Under no circumstance must subjects be exploited by changing contractual agreements made with them either verbal or written. You must take all reasonable measures to protect subjects physically and psychologically. The rational for the execution of the research must be fully explained to the subjects in advance and regular de-briefing may be carried out afterwards. The possible long-term effects of the research must be anticipated and managed effectively. Of absolute importance is the maintenance of confidentiality at all times no matter what.

2.2 Developing the culture of publishing research

There are fierce competing demands on the time, efforts and resources of young faculty. In particular, the heavy workload of young faculty, who spend too much time and effort in teaching, grading, attending meetings and other non-academic activities, is a daunting challenge. This unfortunate situation arises as a result of the inability of African universities to recruit highly qualified faculty to replace ageing academic staff in the face of increasing student numbers admitted each year but dwindling resources allocated to African universities.

In the light of this seemingly unfriendly research environment it is crucial for young faculty to cultivate the discipline of scientific writing consciously and follow it through religiously (Culler, 2003; Germano, 2004). Quality time must be allotted for scientific writing in your weekly schedule of activities and make it functional through meticulous planning and commitment. Personal responsibility and sacrifices are critical. Providing portfolio of excuses for your own inadequacies is not helpful. It must always be remembered that in the university setting promotion is mainly through scholarship manifested by publishing research findings in scholarly journals and books published by world acclaimed publishers. Books printed by 'mushroom' printers are highly unacceptable and must be avoided. Consistency and diversification of publication in space, spread and time must be encouraged.

To promote and enhance exchange of scientific knowledge it is essential to publish in several reputable scholarly journals. Publishing only in local journals does not demonstrate scholarship and could affect promotion especially at the professorial rank where one is expected to demonstrate scholarship at the international stage.

Avoid procedural mistakes in scientific writing. While the quality of the research is the single most important factor in determining whether your article will be published, a number of procedural mistakes can help tip the balance against you. Be abreast and familiar with the journal you wish to publish in. Avoid grammatical and proofreading errors (e.g. awkward sentences, unclear, long and clumsy sentences, ungrammatical constructions, improper word usage, misuse of punctuations, poor paragraphing). These are the same things you expect your students to avoid.

3. Scholarly paper

In academic publishing, a **paper** is an academic work that is usually published in an academic journal. It contains original research results or reviews of existing results. Such a paper, also called an article, will only be considered valid if it undergoes a process of peer review by one or more *referees* (who are distinguished academics in the same field) in order to check that the content of the paper is suitable for publication in the journal. Peer review is a central concept for most academic publishing; other scholars in a field must find a work sufficiently high in quality for it to merit publication. The process also guards against plagiarism. A paper may undergo a series of reviews, edits and re-submissions before finally being accepted or rejected for publication. This process typically takes several months. Next there is often a delay of many months (or in some subjects, over a year) before publication, particularly for the most popular journals where the number of acceptable articles outnumbers the space for printing. Spreading the spectrum of journals for publication of research findings is therefore necessary to enhance the consistency, diversity and rate of publication over time.

Some journals, particularly newer ones, are now published in electronic form only. Paper journals are now generally made available in electronic form as well, both to individual subscribers, and to libraries. Almost always these electronic versions are available to subscribers immediately upon publication of the paper version, or even before. Sometimes they are also made available to non-subscribers after an embargo of two to twenty-four months, in order to protect against loss of subscriptions. Journals having this delayed availability are generally called delayed open access journals.

3.1 Sentence construction and choice of words

The purpose of any paper is to convey information and ideas. This cannot be done with long and clumsy sentences. Keep sentences short, not more than 30 words in length. A sentence should contain one idea or two related ideas. A paragraph should contain a series of related ideas. Words have precise meanings and to use them correctly adds clarity and precision to prose. Look at the following pairs of words that are often used in scientific texts and learn how to use them correctly: Fewer, less; infer, imply; as, because; disinterested, uninterested; alibi, excuse; data, datum; later, latter; causal, casual; loose, lose; mute, moot; discrete, discreet. Use a standard dictionary and Roget's Thesaurus of English Words and Phrases to find the correct meaning of words.

3.2 Correct spelling, including the use of plurals

Some words have alternative spelling e.g. tyre, tire, grey, gray; draft, draught; connexion, connection, plow, plough, often the difference is between the American and British spelling. In other cases an apparent misspelling is a misuse of a word e.g., principle and principal; practice, practise (The former is a noun, the latter is a verb). The plural of many words in the English language is achieved by adding an s (or es) to the single. For example, car becomes cars and potato becomes potatoes. However, some words have the same form in both the singular and plural. For example, sheep - there is no such word as sheeps. Other words are already plural such as people and equipment, so do not use peoples (unless you are referring to different groups of people or different ethnic groups) and equipments. Adopted words sometimes take on the plural of the original language, for example datum becomes data and fungus become fungi.

One mistake commonly made is to not match the verb with the noun. A singular verb must always be associated with a singular noun, and similarly a plural verb with a plural noun, although a number of exceptions exist where a singular noun is used in a plural sense (for example, 'number') or, less commonly, a plural noun is used in a singular sense (for example, 'headquarters'). The verb then can, and usually should, agree with the sense of the noun's usage. Difficulties arise especially with nouns which do not end in 's' in the plural form. For example livestock and data are plural.

3.3 Use of superlatives and qualifying the absolute

Very, more, much, have a place in scientific writing when used economically. As superlatives they are out of place in scientific writing. Superlatives such as gigantic, earth shattering or fantastic should never be used. Some adjectives are absolute and cannot be modified such as: sterile or unique. Other adjectives, such as "pregnant", have to be qualified with care. A petri dish is either sterile or not sterile. It cannot be very sterile, quite sterile or fairly sterile; An object is unique, and although a woman can be recently pregnant, she can not be slightly pregnant.

3.4 Avoid verbal obscurantisms

Always say what you mean and use simple words. Some phrases show sloppy thinking. For example, the phrase '*It has long been known that*' usually means that the writer has not bothered to look up the reference. *Correct to an order of magnitude* probably means that the answer was wrong. *Almost*

reached significance at the 5% level usually means a selective interpretation of results. Text is easier to understand if simple words and phrases can be used to replace more complex or foreign ones. For example, *ameliorate* can be replaced by improve; *analogous* by similar; *anthropogenic* by human; *Ceteris paribus* by other things being equal; component by part; *ingenuous* by innocent; *ingenious* by clever; *inter alia* by amongst other things; *utilise* by use; *Prima facie* by at first glance; *remunerate* by pay; terminate by end; *pari passu* by at the same rate, pace or time and *peruse* by read.

3.5 Punctuation

A colon (:) is used when a list or explanation follows, a semi colon (;) is used to separate two or more related clauses provided each clause forms a full sentence. Note the proper use of comma in scientific writing. Paying attention to these little things add to the quality of a scientific paper.

3.6 The layout of a scientific paper

The layout for a scientific paper is normally:

- A title,
- An abstract,
- An introduction (background, problem, justification and main objectives),
- Materials and methods (Methodology),
- Results,
- Discussion,
- Conclusion,
- Acknowledgements and a
- References.

4. Sources of scientific information

A scientist should critically review the available literature, and determine any modifications that might be necessary. There are a large number of sources that can be accessed to find the relevant information, to write an essay or to write a scientific paper. Some of the information sources are less reliable than other sources. Information from popular sources tends to be less reliable than information direct from scientific papers because it is second or third hand. The list below indicates the usefulness of the various sources available, from 1 the most popular to 11 most scientific, up to date and reliable. The low numbered references are useful as background reading and to provide an overview of the subject. The higher numbered sources, particularly 8, 9, 10 and 11, provide accurate and up-to-date information.

1. The World Wide Web.
2. Scientific textbooks.
3. Newspaper articles, articles on science subjects in popular journals.
4. On-line journals (not refereed).
5. Popular science journals, e.g. New Scientist.`http://www.newscientist.com`
6. Review articles in scientific journals (e.g. Nutrition Abstracts and Reviews or in 'Trends' journals such as Trends in Plant Science). `http://www.trends.com`
7. Grey literature (i.e. information not readily available), for example, conference proceedings, research reports, annual reports.
8. Abstracting journals, e.g. Grassland and Forage Abstracts, Veterinary Bulletin http://www.cabi.org; Databases containing annotated bibliographies (e.g. by CABI).`http://www.cabi.org`, On-line-searching of database titles; Current contents.
9. Science citation index.
10. Higher degree theses.
11. Scientific papers in scientific journals (including refereed on-line journals).

4.1 List of references

The reference section contains a list of all the references cited in the text. In general references should be arranged in alphabetical order (according to the name of the first author). Each reference to an article should contain the following:

- Name (or names) of author(s), (each) followed by initials.
- Year of publication in parenthesis.
- Title of article.
- Title of journal, either in full or abbreviated according to the World List of Scientific Periodicals.
- Volume of journal.
- Number of first and last pages of articles.

Attention should be paid to uniformity of format and punctuation in accordance with the style of the journal. For example, the names of journals should be written either in full or abbreviated but not both. Please check the list of references carefully, since it is very frustrating for the reader to find that references in the text are not included, or that they are wrongly quoted. Make sure that references in the text are in the reference list. Programs such as Word, Papyrus, and Endnote can assist with this chore and that of putting references in order.

4.2 Basic principles (ABC) of Publishing in a Journal

It must be noted that, when you submit a manuscript to a scholarly journal, you have two audiences to satisfy: first the editor and external reviewers, and then the journal's readers. You need to satisfy that first group so you can have the opportunity to appeal to the second. To enhance the chances of your manuscript being accepted for publication in any scholarly journal certain basic principles must be followed through (Wellington, 2003; Furman, 2007). These include:

- The title of the paper describes the content of the paper and must be accurate, concise and specific. It should also have as many key words as possible and modeled on the style adopted by the publication for which you are writing. Above all the title must be as easy to understand as possible.
- Familiarize yourself with the types of articles that a journal publishes and only submit work appropriate for that journal.
- Pay close attention to the tone and style of work published in the journal and try to duplicate it in your write up. It is important to follow religiously, the style and guidelines used by the journal. No hybrid styles should be submitted to the journal for consideration.
- Only submit work that you believe to be the final, publishable copy. A poorly proofread manuscript wastes your time and the editors/ reviewer's time.
- Do not submit a conference paper to a journal without taking the necessary steps to convert the paper to a form appropriate for publication in a journal.
- Placing your work in the context of articles previously published in the journal is good scholarly practice and helps make your article a better "fit" for the journal.
- Follow the journal's submission requirements/rules.
- Make sure you use words according to the precise meaning understood by the average person. Write well-formed sentences, and keep their structure simple. Ideally, check whether every word used in your manuscript could be deleted or replaced by a better one. In all cases aim at economy, precision and clarity.
- Do not use *however* or its synonyms twice in one paragraph, because changing the direction of an argument twice in one paragraph may annoy readers.
- Keep jargon (technical terms) to a minimum. Explain any that you have to use.
- Avoid the so-called *non-human* agent. For example, use t*he authors concluded that*... rather than the study concluded that....
- Avoid colloquialisms, such as *steer clear* of..; *While* sounds more modern than whilst
- Do not generalize unnecessarily. For example, do not say some if you know of only one instance.
- *This* on its own is known as an *ambiguous antecedent*. Use instead this test or this *problem* or whatever
- Avoid hype (hyperbole). Words like very and *extremely* are usually unnecessary.
- Note the use of these singular and plural forms: criterion, criteria; datum, data; medium, media; phenomenon, phenomena.
- Use the past tense to report results (yours or others'). Use the present tense to discuss them. *We have found that...;Obeng-Ofori (1989) reported a similar result. A simple explanation of these findings is that...*
- The first sentence of a paragraph usually sets the topic for that paragraph. Do not have any unlinked ideas in the same paragraph. A paragraph must consist of more than one sentence.
- Try to make the ideas within each section flow together. Do not put things in the wrong section or subsection.
- Check that you do not contradict or repeat yourself in different sections of the article.
- Aim for simplicity: many readers are less intelligent and less knowledgeable than writers.
- The discussion of the paper should compare its conclusions with those drawn by other workers, indicate the practical implications of the findings and indicate what further research is needed.
- Cite references consistently in the style required by the publisher. If the style does not exist in your referencing software you will have to find something close, then either edit the style or edit the final list of references. Make sure every publication referred to in the article is in the reference list, and vice versa.
- The following rules are broken so frequently that I doubt whether they can be considered rules any more. *Which* or *that*? Simple rule: Which always follows a comma (and a pause), but *that* never does. *This study, which cost $5,000, was a success. The study that cost $5,000 was a success. Owing to* or *due to*? Simple rule: *Owing to* always has a comma, *due to* never does. *The data were lost, owing to computer malfunction. The loss of data was due to computer malfunction.*
- Develop a healthy attitude toward rejection of manuscript. Avoid being overly defensive. You must know from the onset that competition is fierce, so maintain a positive

attitude to rejection of your manuscript and move on. Do not attempt to argue or react badly to editor's rejection or to persuade editors to change their minds. It is counterproductive and you risk alienating the editor and weaken your odds of future publication.

- React favourably to reviewer's reports. Mounting elaborate responses, pointing out all the flaws in the critics' interpretation of the manuscript is not editorially productive.

- Do not assume that your manuscript has been judged substandard simply because a journal decided against publication. Editors are always dealing with matters of "fit" and your article might be excellent—just that it is not a good fit for a number of reasons. You may be successful in another journal.

- Try to respond to as many recommendations as you can, in good conscience. If there is a recommendation that you cannot follow, explain why, carefully and politely, in a letter to the editor.

5. Conclusion

The pressure to publish is a fact of daily life in academia. Academics are expected to demonstrate that they are active researchers and that their work has been vetted by peers and disseminated in reputable scholarly forums. Several critical challenges discourage the conduct and publication of research findings in universities and national research institutions in sub-Sahara Africa. In spite of this seemingly hostile research environment it is possible to conduct research and publish if only you plan and commit yourself to the task. The overriding principle is to cultivate the discipline of scientific writing consciously and follow it through religiously. This could be achieved if time is allocated for scientific writing in the scheme of weekly schedule of activities and made to be functional through meticulous planning, personal commitment, responsibility and sacrifices. A good style in scientific writing is helped by logical planning. Decide what you want to write, and write it simply and in a sensible order in accordance with the tone and style of the journal.

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