What's your problem? A practical approach to scientific document design

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Abstract

For science to be understood, assimilated, and further developed, it must be accessible through clear and concise writing. Science is about solving problems that often interlink with each other. To improve the clarity of scientific writing, every project should focus on solving a single problem and consequently every document should include a clearly articulated problem statement. The 'What's your problem?' exercise is a method for articulating a clear problem statement and then using this problem statement to guide the structure, design, and logic of the document. This exercise can be applied to the presentation of original research as a primary source document (papers, reports, dissertations) or to the interpretation or analysis of others' primary research (literature reviews, opinion pieces, magazine articles).

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For science to be understood, assimilated, and further developed, it must be accessible through clear and concise writing. Yet accomplishing this is a struggle for many writers, especially when composing the introduction and discussion of a document. The writer must choose which details to include or exclude, how many references to cite, how to present a project within its broader topic, and how to stick to the main point. Often, there is no clear statement of what the document is about.

Words used to describe the problem: aims, hypotheses, and objectives

Traditionally, the *aim* is designated as the focus of a paper or project. Meanwhile, the *hypothesis* is often claimed to be essential. However, most documents do not refer explicitly to either. When *aim* is used, it is often presented with *objective* as '*aims and objectives*'. Yet *objective* is often used ambiguously and indiscriminately to describe tasks and targets imposed by clients and funding organizations, outcomes, aims, methods, and expected results. *Aim* is sometimes used ambiguously to describe expected results or methods.

However, a study is more than doing; it is finding out why. The goal of science is to choose or devise an appropriate method to answer pertinent questions: questions that are relevant and answerable.

The aim of a project is to solve a problem

Hall *et al.*[1] state that the most common problem for junior writers is the inability to clearly state the question that was asked, yet this remains a common problem even for established writers. Often writers are so familiar with their area of expertise that they fail to recognise that they have not clearly explained their study. Assuming that your audience is familiar with your topic is not enough. The reader should not have to rely on their experience, knowledge, or familiarity with the discipline in order to understand what the document is about. The reader also shouldn't have to rely on the title or scour the discussion to work out the focus of the study.

Problem solving is searching for explanations or reasons why something is happening. The common denominator of all science projects is the intention or desire to solve a problem, whether the problem is to answer a question, conduct an experiment, look for the cause of a symptom or phenomena, pose or test a hypothesis, or improve knowledge by gathering information. Therefore, for all scientific projects, the statement of the problem best defines the project's purpose.

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What's your problem?

Some writers get overwhelmed trying to decide what detail to include in the background or introduction of their document, and they may discuss many problems not directly related to their project. Instead, each project should have a single aim – to solve a problem – and therefore each document should articulate a problem statement. Even large documents, such as a Ph.D. thesis, should have one central aim (see Evans 1996), with each chapter or section developing a subsidiary problem as an offshoot of the central aim.

Clear structure and design follow a clear statement of the problem. The statement of methods then stems from a clearly articulated statement of the problem. These methods explain how the problem is intended to be solved. Literature is used to validate both the importance of the problem and the choice of methods. The discussion or conclusion of the document directly addresses whether or not the problem was solved, often with recommendations on how to solve the problem on a larger scale or under different circumstances.

The 'What's your problem?' exercise

The 'What's your problem?' exercise is a method for developing a clearly articulated *problem statement*. This process is the same, irrespective of the document length or design, the topic, or the discipline. Focusing on one central problem clarifies the project aim and helps structure the document. This process may be helpful not only for scientific projects but also for many non-scientific projects.

This exercise can be used to present original research as a primary source document (papers, reports, dissertations) or to interpret or analyse the work of other primary researchers (literature reviews, opinion pieces, magazine articles).

The exercise involves answering eight questions (Q1–Q8) about one study. All questions cover the full scope of the scientific project, from statement of the problem (aim) through to discussing and assessing the results (discussion). The purpose of this exercise is two-fold:

1. *To focus your scientific thinking.* Answering the questions included in the exercise will help you concisely conceptualize all stages of the project.
2. *To produce a summary of the project or topic* that can be used as a solid foundation to further develop and finalize your document.

The process of defining 'What's your problem?' is shown in Fig. 1. The linking of Q8 with Q1 represents the continuous nature of science; answering one scientific question often generates new questions and new problems to solve.

Q1. What is the overall problem under consideration?

The first step is to make a list of the problems linked to the project. Narrow down the list to the problems that are directly relevant. Next, summarize these problems into a single paragraph that encapsulates one broad problem and includes a characterization of the main features. Ask yourself, 'What is known and what is unknown about the topic?' This paragraph will form the background to the topic. Your problem statement (Q3) will be an offshoot of this broad problem summary. If you find that you have more than one broad problem that needs solving then you may need to consider writing an additional document.

Q2. Why is this problem important?

Describing the importance of the problem helps justify the area of study and helps form the background of the document. Ask yourself how this project is important scientifically and worthwhile to society. Draw on the literature to help explain and verify the importance of the problem. However, do not rely only on literature citations to explain the importance of the problem. Although the literature is the source of knowledge about the problem, a paraphrased statement of the importance of the problem is still needed.

Q3. What problem do you aim to solve?

Focus the problem statement towards what can be addressed within the document. A clear statement of the problem should directly place the project or topic within the broader field of endeavour. For example, consider the statement, '*We aim to improve the management of patients with heart disease*'. The problem that needs to be solved, or improved upon, is the management of patients with heart disease, whereas the treatment of heart disease is the broad field encompassing the project. Details of subsidiary or related problems that cannot be adequately solved or addressed within the document can be summarised in the background (Q1 and Q2) or raised as directions for future research (Q8).

Q4. How do you aim to solve this problem?

Summarize the methods or analytical approach used in the attempt to solve the problem. This is a summary of the materials and methods and

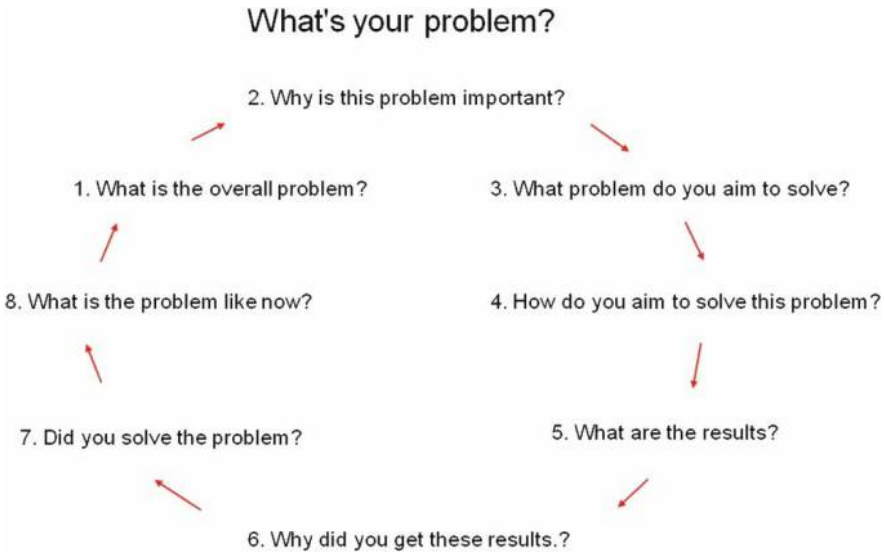

Figure 1: What is your problem?

includes the scope (time and magnitude) of the project.

Q5. What are the results?
Summarise the results. What was the consequence of the actions (methods) or analysis? What was the answer to the question(s)?

Q6. Why did you get these results?
Explain why the results were obtained. What factors explain the results? What caused these results? What was the reason for these results?

Q7. Did you solve the problem? Did you achieve your aim?
What do the results mean? Did you solve or partially solve your problem? Did you effectively answer the hypotheses or question(s)? The solution to the problem is ultimately a scientific statement that may be used to develop a conclusion, propose a hypothesis or uphold a principle or rule. Therefore, what interpretations and conclusions can you make from these results?

Q8. What is the problem like now?
The problem has now changed because of the findings (results and interpretations of the results). What are the implications of these findings? What are the recommendations? Can new principles be generated from the evidence? Can these principles be applied to other situations? What are the limitations of this study? If the results are unclear, this is still an important aspect of the project. In this case, why were the results unclear? What problems remain unsolved? What are the new problems that need solving? What are the future directions for research in this topic? What new research can now be carried out?

An example

As an example, the exercise is applied to a published article on a clinical trial with the use of direct quotes and paraphrased statements.[2]

Q1. What is the overall problem under consideration?
'*Clinical trials to test effectiveness of HIV preventative methods are increasingly being conducted in Sub-Saharan Africa where HIV incidence is high. Women at risk for HIV recruited for these trials are often at risk of pregnancy, yet are asked to avoid pregnancy whilst on investigational products, regardless of the trial phase, as safety to the unborn child is usually unknown*' (page 2).

Q2. Why is this problem important?
Women who become pregnant have their safety at risk from the study treatment. This can also reduce the efficiency of the trial. '*Being able to identify women at higher risk for pregnancy at screening may enhance participants' safety and minimises time off study product, which increases trial efficiency*' (page 2).

Q3. What problem do you aim to solve?
'*Pregnancy risk during vaccine trials is poorly characterised.*' '*…findings …suggest that pregnancy risk can be modified. It is particularly important to identify factors that can help African women avoid pregnancy in vaccine trials… Findings from this analysis may improve screening and support of women in minimising pregnancy during HIV prevention trials in sub-Saharan Africa*' (page 2).

Q4. How do you aim to solve this problem?

'*…we report pregnancy rates and outcomes during and after the vaccination period and identify factors reported at screening that were associated with incident pregnancy during this trial*' (page 2).

Q5. What are the results?

'*…pregnancy incidence was 9.6/100 women-years overall… …pregnancy was reduced among women who: enrolled at sites providing contraception on-site; entered the trial as injectable contraceptive users or as consistent condom users* (page 1). *… although the difference in pregnancy rates during and after the vaccination period was not statistically significant, there was a trend to higher rates after the vaccination period* (page 4). *Predictive factors were identified and women with two or more risk factors* (*heavy drinking and marijuana use*) *had increased pregnancy incidence* (page 8).

Q6. Why did you get these results?

Women's access to effective contraception and the requirement that the participants use at least two forms of contraception during the trial were important in reducing the risk of pregnancy. The reasons why heavy drinking and marijuana use increased the risk of pregnancy were not discussed.

Q7. Did you solve the problem? Did you achieve your aim?

Yes, pregnancy risk factors were identified. '*It is possible to screen South African women for pregnancy risk at trial entry. Providing injectable contraception for free on-site and supporting consistent condom use may reduce incident pregnancy. Screening should determine the substance use, partnering, and HIV status of both members of the couple for both pregnancy and HIV prevention*' (page 8).

Q8. What is the problem like now? What new research can now be carried out?

'*The …preliminary implications for clinical trialists are that women reporting multiple risk factors, but not heavy drinking alone, should be flagged for increased pregnancy prevention counselling, and may be especially suitable candidates for trials given their increased risk for HIV, and their need for the risk reduction packages offered within trials*' '*Factors examined were… …highly predictive of pregnancy risk. This bodes well for future trials as women can be readily screened for pregnancy using a few questions. Limitations of this analysis were the variable pregnancy prevention messages and pregnancy outcome ascertainment once the trial was interrupted*' (page 8).

Conclusion

Clear and concise writing arises from articulating one problem statement for each project. The 'What's your problem?' exercise helps you define the problem and then uses the problem statement to guide document design, structure, and logic. This exercise not only clarifies the writer's thinking, it also helps build solid structure and content for a wide variety of documents and topics.

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