Table 1.1
Types of research communication, their audience and technical content

Avenue	Audience	Technical content (1, high; 7, low)
Research papers	Researchers within and outside the discipline, university students and lecturers, senior extension workers, research managers	1
Book chapters		
Technical	As for research papers	2
General	Technicians, students, extension workers	4–5
Research reviews	Researchers outside a discipline, university students and lecturers, extension workers, commercial interests	2–4
Short communications	As for research papers	1–3
Theses	Researchers within a discipline, university students and lecturers	1
Conference paper	Researchers within and outside a field, university students and lecturers, research managers	2–3
Annual reports		
Highlights	Donors, policy-makers, government committees, extension agents, institute directors	3–4
Main text	Researchers within and outside a field, university students and lecturers, research managers	1
Newsletters	Researchers within and outside a field, students and lecturers, extension agents, policy-makers, expert farmers	5–6
Project proposals	Donors, policy-makers, research managers, institute directors	2
Websites		
Popular	General public	7
Professional	Technical audiences	3–7

Paul Stapleton

Choosing a journal in which to publish

2

2.1 Introduction

So much research is published today that there is a whole science based on impact assessment and citation analysis. Information analysts keep careful note of which papers are being cited and who is writing them. Careers depend on it, as do the success and prestige of journals, and the reputations of university departments and research institutions. So you need to target your writing and publishing to maximise the chances of someone reading it and making use of your findings.

When you have decided that you should be writing a paper, and that you have a paper to write, you must then start thinking about your audience. From the very start, you should aim at getting the paper seen by the right audience. To do this, you should direct your paper at a specific journal that is read by the people you want to contact. Before you start planning your article, you need to decide in which journal you want to publish. The choice of journal will influence the format and style of your article, and how you prepare it. For example, many of the biggest journals these days accept only online submissions.

2.2 Objectives and expected learning outcomes

After completing this chapter, you will be able to:

– evaluate a journal's publishing policy, scope and content;
– define the special requirements for producing an article for publication;
– choose the best journal in which to publish your work.

2.3 Choosing a journal

Most journals today receive many more papers than they can possibly publish. The best journals have a very high standard for papers they accept, and a very high rejection rate. Ask yourself if your paper is really good enough to send to the very best journal. It may be better that you select a less important journal, to stand a better chance of acceptance. There are a number of factors to consider. Study published copies of different journals and look at their websites. Many journals have a lot of information available to help you understand their requirements and to prepare a paper for submission.

2.3.1 What is the scientific level of the journal?

Look at past issues of the journal and ask yourself the question: is my work as good as, or better than, the material the journal is publishing? Who is the editor? Who is on the editorial board? Which authors publish in the journal? Does the journal have an international audience? Does the journal want complete research projects, or will it accept accounts of work in progress and preliminary papers?

2.3.2 What are the aims and scope of the journal?

These are often printed on the inside cover of the journal and published on the journal's website. Read their "Aims and scope" statements to find out exactly which area of your discipline the journal is interested in. It is no use sending a research paper to a journal that only publishes reviews, and it is no use sending a theoretical paper to a journal that publishes only practical research. For example, *Agronomy Journal* has the following text on its website (www.agronomy.org/publications/aj/about):

About *Agronomy Journal*

Articles relating to original research in soil–plant relationships; crop science; soil science; biometry; crop, soil, pasture, and range management; crop, forage, and pasture production and utilization; turfgrass; agroclimatology; agronomic modeling; statistics; production agriculture; and computer software are published in *Agronomy Journal* subsequent to review and approval by the editorial board. Articles should make a significant contribution to the advancement of knowledge or toward a better understanding of existing agronomic concepts. The study reported must be of potential interest to a significant number of scientists and, if specific to a local situation, must be relevant to a wide body of knowledge in agronomy. Additional details on requirements for articles are published in *Agronomy Journal* each year.

2.3.3 How often is the journal published?

Scientific publishing is usually a slow process, and a journal that is published twice a year will have a much longer potential publication time than one that appears once every 2 weeks. You have to ask yourself "Will a 15-month publication time affect the relevance of my article?". If the paper should be published quickly, then you can send it to a fast-publication journal, but if rapid publication is not essential, then the editors of such a journal will probably reject your paper immediately, just because of that, not because of its scientific quality.

2.3.4 What types of article does the journal publish?

Will yours fit this pattern? Many journals have a specific format for the articles they publish, for example, the IMRAD format (Introduction, Materials, Results and Discussion; see Chapter 3). If your article does not fit this pattern, the paper may be rejected. If your paper is going to be 20 printed pages long and the journal only publishes papers up to five pages, this will mean that yours will be rejected – not because of the scientific content, but just because of the format of the paper.

2.3.5 Are there any conditions to submitting to the journal?

For some journals, one of the authors must be a member of the society that publishes the journal. Sometimes there are certain types of statistical analysis that must be used, and the experiments must have been repeated a certain number of times. Many journals have page charges, where you have to pay the journal to publish your paper. The charges are based on the number of pages in the final published paper. These charges can be extremely high. Page charges are widely used throughout the scientific publishing community, and are widely accepted. For example, most US government agencies recognise the payment of page charges as a legitimate part of the cost of performing research and development work under government contracts. You should look for these conditions carefully in the journal, and consider whether you have enough money in your budget. However, some journals will not charge authors from certain countries.

2.4 Open-access journals

Most research journals are published by an academic publisher or scholarly society. These have to make money, so people have to buy the journal, or pay for access to the papers online. From 2001, the concept of open access via the internet has become more common (see, for example, www.soros.org/openaccess and http://en.wikipedia.org/wiki/Open_access_journal). Open-access journals are available to anyone who has access to the internet. Almost all provide information free of charge; some are subsidised, and some require payment on behalf of the author. Open access is the subject of much discussion, with disagreement about the concept of open access, the value of the information published, and the worth of the journal. That being said, there are many hundreds if not thousands of open-access journals available on the web, some with strict per-review procedures and very high citation indices. Much wider discussion of open access is available on the web; see also Chapter 16.

2.5 How scientists are evaluated through the papers they publish

Publications are an important output of scientific research. A good publications record, especially authorship of research papers in peer-reviewed journals, is an indicator of your success as a scientist, and a major part of how scientists and academics are evaluated for employment and promotion. Donor agencies will also look at your publications record if you submit grant proposals to them.

Journals that use the peer-review system are generally regarded as being of better quality than those that do not. Obviously, it is more difficult to get your paper accepted by them, but remember that the entire process of peer review can be considered positively as providing training in more effective writing and publishing of your research.

Journal ranking is widely used to evaluate impact and quality. Journal rankings show the place of a journal within its field, the difficulty of being published in that journal, and the prestige associated with it.

2.5.1 The impact factor concept

Nowadays, the importance of journals is ranked by their impact factor, which is a measure of the frequency with which an article in a journal has been cited in a given period. Journals with a higher impact factor are considered to be of higher rank and more prestigious than those with a lower score.

The impact factor for a journal is calculated based on a 3-year period, and can be considered to be the average number of times published papers are cited up to 2 years after publication. For example, the impact factor for a journal for the year 2011 would be calculated as follows:

Impact factor 2011 for *Journal X*:

A = the number of times articles published in 2009–10 were cited in indexed journals during 2011

B = the total number of articles, reviews, proceedings and notes published in 2009–10

Impact factor 2011 = A/B

Note that the impact factor 2011 will actually be published in 2012, because it cannot be calculated until all the 2011 publications have been received.

Information on the impact factor can viewed on the home pages of many reputable journals, or from the *Journal Citation Reports* (http://thomsonreuters.com/products_services/science/science_products/a-z/journal_citation_reports/), published annually as part of the Science Citation Index. Growing competition for research funding and academic positions has led to the increasing use of bibliometric parameters to evaluate careers by number and quality of publications and the impact factor of the journals they appeared in.

Just about all journals with measurable impact factors are peer reviewed. Peer review is criticised as an imperfect system, and indeed it has some problems. However, it is the best system that we have available at the moment, therefore we have to make the best of it. Even the Public Library of Science (www.plos.org), a series of journals published on the web under the Creative Commons system of copyright, uses peer review.

2.5.2 Citation analysis

Citation analysis is a method of bibliographic measurement that highlights the difference between producing a lot of average research papers, and fewer good papers. This is an objective way of measuring the quality or impact of a paper by charting how many times it is cited by other researchers. The logic is that the better a paper is, the more people will cite it, and this has been confirmed as a valid measure of research quality or impact by many researchers. So your publishing objective should be to publish not only good quality papers, but good quality papers that people will want to cite in good quality journals.

2.6 Resources

This is a complex and fast-moving field, and this chapter merely introduces the concepts. Interested readers can find up-to-date information online by searching for the following terms:

– bibliometrics
– citation analysis
– CiteSeer
– Creative Commons
– eigenfactor
– Eugene Garfield
– Google Scholar
– impact factor
– Institute for Scientific Information
– journal ranking
– Public Library of Science
– scientometrics
– SCImago Journal Rank
– Thomson Reuters

2.6.1 Useful websites

Citation index

– www.thomsonscientific.com/cgi-bin/jrnlst/jloptions.cgi?PC=K

Instructions for authors

– http://www.elsevier.com/wps/find/authorsview.authors/landing_main http://authorservices.wiley.com/
– http://journals.cambridge.org/action/stream?pageId=3608

Choosing a journal

– http://journalauthors.tandf.co.uk/preparation/choosing.asp
– http://libraryguides.griffith.edu.au/content.php?pid=220206&sid=2249695

Open access

– www.earlham.edu/~peters/fos/overview.htm
– http://oad.simmons.edu/oadwiki/Main_Page

2.7 Exercise – Assessing journals' requirements

If there is a good internet connection, search for the websites of well known journals in your field and study the Instructions to Authors and other information.

– Download pdfs of useful information for later study.
– Find an open-access journal in your subject area and study the papers available.
– Do you feel it would be worthwhile publishing in that journal?

> "From the very start, you should aim at getting the paper seen by the right audience"

Paul Stapleton

The IMRAD format for presenting research papers

3

3.1 Introduction

Breaking a research paper into the sections Introduction, Materials, Results and Discussion (IMRAD) is a well established approach to writing and publishing scientific research. It has become the main pattern for research articles in many disciplines. This classical structure does not fit some disciplines, but it is a useful and systematic way in which to approach your writing.

3.2 Objectives and expected learning outcomes

After completing this chapter, you will be able to:

– define the IMRAD format;
– recognise what belongs in each section of a research paper.

3.3 The pattern of a research article

Most types of research article follow a classical pattern, answering a logical series of questions:

Introduction	what led to the work and what are the objectives?
Materials	what was used?
Methods	what was done?
Results	what happened?
Discussion	what does it mean?
Conclusions	what are the implications of the results?
Acknowledgements	who helped?
References	who is referred to in the text?

This is known as the IMRAD (Introduction, Materials, Results and Discussion) structure, which began to be used as a standard in the 1940s and has since become the main pattern for research articles in many disciplines. It provides an easily understandable structure to separate out the different parts of your work. This classical structure does not fit some disciplines, such as sociology and economics, and most medical journals use a different structure. For example, the journal *Nature Medicine* prints the Methods section last, and in smaller type.

The IMRAD structure is very common in the natural sciences, and a clear understanding of how each part is put together will be useful to most scientists. Note that, as far as publishers are concerned, the title, authors, addresses and abstract are also essential parts of the paper.

3.3.1 Title

It is extremely important to write a good title for a paper. The title attracts the interest of the reader and it is used in bibliographic information services, so it needs to be accurate and informative. The object is to include as much information as you can in as few words as possible. Put the most important part of your work at the start of title, where it will be easiest for the reader scanning a list to see.

You can write your title as one statement, or use the main/subtitle format.

For example, you can write:

Effects of drought, aging and phosphorus status on leaf acid phosphatase activity in rice

Or you can write:

Acid phosphatase activity in rice leaves: effects of drought, aging and phosphorus status

Readers will assume that the subject that comes first in the title is the main focus of the paper, so be sure to reflect that in the paper.

There is a third way of writing a title; that is to make a statement:

Acid phosphatase activity in rice leaves is decreased by drought, aging and phosphorus status

This is a very clear approach, almost a mini-summary of the paper.

3.3.2 Authors

The first author should be the person who carried out most of the work reported, with other workers mentioned in decreasing order of contribution. The scientist who oversaw the work is usually placed last. All people who are listed as authors must be aware of the paper, must have agreed to be named as an author, and must have had the opportunity to contribute to and comment on the paper. Some journal websites comment on authorship, so check on the website of your target journal.

Give the names of all authors, in the style the journal specifies. For example, this may be the first name in full, the middle initial only, and the last name in full. Most journals do not print authors' qualifications.

Do not make a distinction between men and women – do not write:

M.E. Williamson and Meryl G. Simpson.

Indicate which author should receive correspondence and proofs (the corresponding author), with their email and full postal address.

3.3.3 Addresses

You should give an address for each author you mention on the title page – that is, the address of the author at the time when the work was done. If any authors have moved, include a footnote with their present address.

3.3.4 Abstracts

An abstract represents the contents of the article in short form. There are three types of abstract: informative, indicative and structured. There is often confusion about the words 'Abstract' and 'Summary'. A summary restates the main findings and conclusions of a paper, and is written for people who have already read the paper. An abstract is an abbreviated version of the paper, written for people who may never read the complete version. So a summary is not the same as an abstract, although some journals call the abstracts of the articles they publish 'summaries'.

Informative abstracts

An informative abstract should answer the following questions:

– Why did you start?
– What did you do, and how?
– What did you find?
– What do your findings mean?

The abstract must be written so that it can be read on its own, for example, if it is output from a bibliographic retrieval system. Do not waste words by repeating the title in the abstract. Keep to 250 words or fewer for an article of 2000–5000 words, and to about 100 words for a short communication, depending on the journal's requirements.

If the reason for doing the study is not clear from the title or the rest of the abstract, state the purpose. Say what you studied and what methods you used. Give your main findings concisely and summarise your conclusions.

Try to mention in the abstract all the main information covered in the paper. Be as brief and as specific as possible, and write with non-specialists in mind. Emphasise the different points in proportion to the emphasis they receive in the body of the paper. Do not refer in the abstract to research that is not in the paper.

Generally speaking, a short abstract should be written as a single paragraph. To help computerised text searching, use significant words from the text in the abstract. Avoid unfamiliar terms, acronyms, abbreviations or symbols; if you must use them, define them at first mention. Use generic names, not trade names, for chemicals and drugs, except when trade names are the most accurate way to describe such substances. Identify living organisms by their Latin (binomial) names.

Do not include tables, diagrams, equations or structural formulae in an abstract, unless it is intended for consideration by a conference organising committee rather than as part of a journal article. Avoid citing other work; if you must include a citation, for example to a paper that inspired your investigation, include a short form of the bibliographic details in the abstract itself – "as D.G. Ngoyo pointed out (*J. Rice Res.* 2005; 4: 2111–13)" – for the benefit of readers who will read only the abstract.

Indicative abstracts

Indicative abstracts contain general statements describing what is in the text, giving readers a general idea of the contents of the paper, but little, if any, specific detail. They are more common in field reports, long papers such as review articles, and for books or chapters in books.

They are the lazy way of writing an abstract; many journals will ask for a more informative version.

Structured abstracts

Some journals now ask for an abstract with a specific structure, especially in the medical area, for reports of clinical trials. This sort of abstract is written mostly as a series of points, although the Results and Conclusions sections should be in sentence form. If your target journal wants a structured abstract, the Instructions to Authors will tell you what headings to use and how long the abstract should be. *Annals of Botany* requests a structured abstract not exceeding 300 words made up of bulleted headings as follows: Background and Aims; Methods; Key Results; Conclusions.

Example of a structured abstract

Background: The scientific article in the health sciences evolved from the letter form and purely descriptive style in the seventeenth century to a very standardized structure in the twentieth century known as Introduction, Methods, Results, and Discussion (IMRAD). The pace in which this structure began to be used and when it became the most used standard of today's scientific discourse in the health sciences is not well established.

Purpose: The purpose of this study is to point out the period in time during which the IMRAD structure was definitively and widely adopted in medical scientific writing.

Methods: In a cross-sectional study, the frequency of articles written under the IMRAD structure was measured from 1935 to 1985 in a randomly selected sample of articles published in four leading journals in internal medicine: the *British Medical Journal*, *JAMA*, *The Lancet*, and the *New England Journal of Medicine*.

Results: The IMRAD structure, in those journals, began to be used in the 1940s. In the 1970s, it reached 80% and, in the 1980s, was the only pattern adopted in original papers.

Conclusions: Although recommended since the beginning of the twentieth century, the IMRAD structure was adopted as a majority only in the 1970s. The influence of other disciplines and the recommendations of editors are among the facts that contributed to authors adhering to it.

3.3.5 Key words

Key words or phrases for indexing are often printed at the end of an abstract. If the journal asks for key words, choose the most important and most specific terms you can find in your paper. Refer to previously published articles in the journal of choice for guidance. To help readers to find your paper, do not include very general topics such as 'soil' or 'potato'. Be specific, to allow readers to focus on your work. Include the binomial of the main species you are working with. Note that essential words in the title should be repeated in the key words since these, rather than the title, are used in some electronic searches.

“The IMRAD format is a well established approach to writing and publishing scientific research”

3.3.6 Introduction

The Introduction should answer the questions "Why did you do the work?" and "What did you want to find out?" It should contain three parts:

– the background to the work and a brief review of the relevant literature, to allow the reader to evaluate the present work;
– the logic that led you to do the work, and your hypothesis;
– a clear statement of the objectives of the work.

You need to show the logical development of your theory or objective within the context of existing work. Explain how your hypothesis came about, briefly reviewing previous published work on the subject. Use references to support everything you say. Most authors initially make the Introduction too long by including too much background material, for example, "This crop is one of the most important food crops in the world". If you have exceeded two pages of typing, you have probably written too much.

3.3.7 Materials and Methods

Here the questions are "What did you use?" and "What did you do?" In this section, you only describe the materials you used, and the methods you used in the work. You do not need to interpret anything. However, you must make sure you have described everything in sufficient detail so that another scientist could repeat your experiment after reading the description.

Justify your choice of one method or treatment over the others available. State the assumptions that you have made. This will allow your readers to understand the purpose of the methods you are about to describe. Follow a logical order; this section falls naturally into two sections: the Materials first, then the Methods.

Materials

Describe all the materials – chemicals, animals, plants, equipment, etc. – that you used. Identify chemical compounds (fertilisers, etc.) so that other workers will be able to obtain the same materials. If you use trade names, you should include the full chemical name or active ingredient the first time you mention it. Some journals ask you to give the name and address of the supplier or manufacturer of the material.

Use internationally recognised standards for naming materials, and also use metric units, standard nomenclature, etc. Give the full genus, species, race, strain, cultivar or line of any experimental plants, animals or microorganisms you used. Species names can be abbreviated once they have been fully described.

Check the journal's Instructions to Authors for correct usage and terminology.

Methods

In this section, you answer the questions "What did you do?" and "How did you do it?". Describe your experiments in a logical order. If you have used well known methods, just give their names and a reference, but if you made any changes, these should be explained. The readers of the paper will be scientists themselves, so you do not need to describe familiar things in detail. Be brief, but do not leave out important information such as sizes or volumes.

Describe the statistical techniques you used, but do not go into detail. Most tests are well known and do not need much description. If a technique is not so well known, then you can give a reference. Only if the method is new or original should you describe it in detail. If a journal demands a certain type of statistical treatment, then you must follow the recommendations exactly.

3.3.8 Results

In the Results, you describe what happened in your experiments. You can present your results making no comment on them, giving your own interpretations later in the Discussion section. Another approach is to interpret the results up to a point, to make some connections between the different statements, but to give more detail in a separate Discussion section. A third way is to combine the results with a discussion of each point.

Whichever way you choose, you should present the results in a sequence that corresponds to your original objectives. Report any negative results that will influence your interpretation later on. Present all the relevant results in this section so that you do not need to introduce new material in the Discussion. Remember your original purpose. In an experimental paper, your objectives tell you what you should be writing about. Results that do not relate to them should not be mentioned.

Many journals nowadays will allow you to upload large tables or other forms of data to a dedicated website and allow you to link to that site in your paper. This allows you the freedom to publish complete data sets, without trying to include them all in your limited-size paper.

3.3.9 Figures and tables

Write in relation to tables and figures that you have already prepared. There is no need to repeat boring lists of statistics in the text when they are already in the tables or figures. Describe the overall results, not each individual value.

Do not say:

“The results of experiment A are reported in Table 1”;

say instead:

“The treatment used in experiment A gave 50% greater yield than the control (Table 1)”.

Make sure you mention every table and figure in the text, and include each table and figure that you mention. See Chapters 8 and 9 on how to prepare tables and illustrations, and Chapter 10 on statistics.

3.3.10 Discussion

In the Discussion, you must answer the questions: “What do my results mean?”, “Why did this happen?” and “What are the implications?”. This is the most thoughtful and demanding section of the paper, but also the most important. You must interpret your results for the readers so that they can understand the meaning of your findings. You need to distinguish among a mass of information and select that which is most relevant to your argument. Use a series of findings or statements to come to a clear conclusion. This conclusion must match your originally stated objective.

Use the Discussion to interpret your results, giving particular attention to the hypothesis or objectives that you put forward in the Introduction. 'Discussion' is really short for 'Discussion of results'. It is not a section in which you review the literature on the subject. All literature cited must have the function of supporting arguments about your results. Relate your findings to previous work, and if they do not agree with your work, then discuss why not. Discuss any negative results.

In this section, you discuss why something happened and why things did not, highlight the strengths and explain the weaknesses of your work. You discuss the relevance of your research to the specific field, point out how it relates to other fields, and make recommendations from your work. You can also mention work in progress, and point out unanswered questions and possible avenues of further research.

Say what is important, with statements such as "The most important aspect of these results is …". But do not use this formula too often, as readers will quickly tire of hearing how 'important' your work is.

One of the most common faults of the Discussion is that it is too long. It may be difficult to follow, or too much data may be repeated from the Results.

In the Discussion, you should generalise, make comparisons and draw conclusions.

3.3.11 Claims and evidence

The central element in every report is its major claim or its main point. You cannot just make the claim. You need:

– good reasons for the claim;
– reliable evidence to support it.

Your evidence needs to be substantive, contestable and explicit:

– substantive – having a firm basis in reality, and so important or meaningful
– contestable – able to be defended during an argument;
– explicit – clear and detailed, with no room for doubt.

Your claim is supported by evidence, which must be accurate, precise, sufficient and authoritative (reliable because it is true and accurate).

Accurate (correct)

Your data must be correct above everything else. Any suspicion that your information is not accurate will make the reader disbelieve your work. Ask yourself, "What evidence am I certain of?". Then question what evidence could be more reliable. You can include questionable evidence if you acknowledge its quality, and you explain anomalies in the data. In fact, highlighting such problems reinforces the credibility of your other data.

Precise

You should be precise in presenting your data, corresponding to your data-gathering techniques. Do not be over-precise, or too vague, and always quantify your claims. You need to present data in the form that best illustrates what you want to demonstrate. You also need to digest raw data so that the underlying patterns and trends are obvious. This is usually done using statistics, tables, figures and graphs. Spell out what you want readers to understand. Do not assume a trend that is obvious

to you will be obvious to the reader. Introduce a figure or table by pointing out what you want readers to notice, and explain why this is interesting.

Sufficient

You need to present enough data to convince your reader that the claims you make are based on enough evidence. For example, many agriculture journals will not accept papers based on data from one growing or cropping season. They want to see repeatability demonstrated in the data.

Authoritative

All your claims need to be supported by evidence, either from your own data or from the literature. Reference material needs to be primary (that is, from journals or conference proceedings) and current. A list of references that is out of date is not convincing. Secondary sources, such as book references, also need to be authoritative rather than popular.

3.3.12 Conclusions

Often you will not need to write a Conclusions section because you will have already stated your main conclusions in the final section of the Discussion. You should certainly never include a Conclusion just to repeat what you have said in the Discussion. However, if your results and the subsequent discussion have been especially complicated, it may be useful to bring all your findings together.

3.3.13 Acknowledgements

Here you should acknowledge technical help and advice that you received from others. Bodies or individuals granting money that supported either the research or the authors of the paper should be mentioned. Keep this section short.

3.3.14 References

See Chapter 7 on how to cite and list references.

3.4 Resources

3.4.1 Useful websites

Guide to writing: http://classweb.gmu.edu/biologyresources/writingguide/ScientificPaper.htm

3.4.2 References

Day, R.A. and Gastel, B. 2006. *How to Write and Publish a Scientific Paper* (6th edn). Greenwood Press, Westport, CT, USA.

3.5 Exercise – The structure of a research paper

List the five most popular journals in your field. Find samples of articles in these journals online.

Look at the structure of the articles in these journals. Are they using the IMRAD structure? How well do you think it works? Could there be an alternative structure?

Find one research journal that does not use this structure. Why do you think this is?

Write first an indicative, then an informative, abstract of one of your own papers or reports, then write a corresponding structured abstract. Which do you think is best?

Paul Stapleton

Writing a research paper

4

4.1 Introduction

Many young scientists think that writing a paper is difficult and time-consuming. However, approaching the task systematically, just like any other work in science, can make the job easier. Breaking the process into steps that build on each other is a process that can simplify writing a research paper.

4.2 Objectives and expected learning outcomes

After completing this chapter, you will be able to:

– construct a skeleton or plan for a research paper;
– produce a preliminary draft of a scientific paper;
– produce a final version of a paper that is suitable in form and content for your chosen journal;
– submit a paper a suitable format, either online or on paper.

4.3 Initial steps

Some scientists can conceive a paper in their head and just start writing, but most people cannot do that. The easiest way to write a paper is to plan it first, get all the material together, and then start writing. But before you can start planning, you must have something to say – a message to describe. You usually need to look at all of your research and select part of it as the content of an individual paper. Most research journals are looking for "significant results" or "papers reporting a significant advance in knowledge". That will be one of the first questions the editors of the journal will ask themselves when they receive your paper. Is the information in the paper significant, as well as new?

You must try to look at your work objectively, as if someone else had written it. Put yourself in the place of an editor or a referee. They will be asking themselves the question "Why should I publish this paper?" You have to make sure that the answer is "Because it reports significant results." What you write will have to stand up to the examination of the editor and the criticism of the referees.

4.4 Journal style

Once you have decided on a journal, you should prepare your manuscript in that journal's style and format (see Chapter 2). Most journals publish detailed guides to authors or 'Information to Contributors'. They are usually available online, as a separate booklet, or published in the journal itself, often in the first or last issue of the volume or year. You must obtain a copy, read it carefully, and apply all the requirements to your manuscript. If someone else is actually preparing or typing the paper, make sure they understand the requirements too.

4.5 Making a plan for the article

Look at the way the articles in the journal you have chosen (see Chapter 2) are subdivided. The different sections (see Chapter 3) will give you a first guide on how to start planning your article. It is best to use the subdivisions that are most common in the journal. The editor will prefer it and so will the readers, as they are all familiar with the format. A logical arrangement makes specific information easy to locate. However, if you have good reasons for making up your own divisions, you should go ahead and do it. If it is sound, the editor will usually accept your plan. So long as the layout you decide on is suitable for the material, most journals will respect your decision.

The questions you answer when planning a paper help you break the paper down into its elements, which can be explained as follows:

– what was known, and what was not known, before the investigation was started;
– what the work was expected to show, or the objectives, and the hypothesis under test;
– setting and conditions of the experiment that eliminate variation;
– experimental plan;
– methods used;
– how the data were collected;
– methods of analysing the data and statistical techniques;
– results obtained;
– validity and meaning of the results, and conclusions to be drawn from them;
– implications of the results in relation to other work;
– directions for future work;
– references to other work in the field.

4.5.1 Prepare the figures and tables first

It is usually best to put your results in graph and table form before you start writing. Usually you will have a lot of data, and you must select parts of it to support the arguments in your paper. While you are doing this, you will also be deciding exactly what you want to show, and the best ways to illustrate your findings.

4.5.2 Build up the paper in sections

The basic idea is to build up your paper step by step. Look at the list of elements above, and start thinking about the answers. This will help you start to develop an outline of the paper.

First, decide on the main divisions of the article. That means you have an overall plan that will help you in your next task, which should be to make separate plans for what you will include in each section. Look at a single heading, for example, the Materials and Methods. You can immediately break that down into a Materials section and a Methods section. Now think about what materials you did in fact use. You can write down headings such as Chemicals, Animals, Equipment, Soils, etc. That is, you start making a list of subdivisions or sections.

Many word processing programmes, such as Microsoft Word, have a document-mapping facility that allows you to review all your headings easily. What you have is a list of section titles that will go together to make up, for example, the Materials part of the Materials and Methods section. You are already developing a plan of the paper. You can do this with each part of the article in turn, planning the content of each section. Spend some time doing this, because writing from a plan is always easier than writing from start to finish.

4.5.3 Expand your plan

Now that you have your master plan, what should you do? Some people will start writing, because they feel confident that they know what they want to say. But if not, you can continue your step-by-step approach, making notes on the content of each part of each section. Once you have finished making notes, what you have really done is finished writing the paper. From now on, the paper should write itself.

“Breaking the task into steps that build on each other is a process that can simplify writing a research paper”

4.5.4 Review the raw material

Now is a good time to look back at what you have done. Examine all your evidence again. Is it all relevant and vital to the paper? Could a table be better expressed as a graph? Do you really need all those long tables? Can they be expressed more simply as figures? If you do not do it now, the editor and referee will certainly ask you to do it later. Have you left anything out? Is there going to be too much detail? Try to ask yourself the most difficult questions now, so that you can change the structure of the paper before you become too involved in writing.

4.6 Start writing

Sometimes it is difficult to start writing. Consider your working day, and when you can work on your paper. You need to develop a working method that will suit the way you write in the time you have available. You might choose to begin writing the easiest section, the Materials and Methods, which is a simple description of what you used and what you did. Then you could go on to the Results, again because you only have to describe what happened. By then, you should be involved with the paper and ready to start on the most difficult task of interpreting the results in the Discussion. Another way is to try to write the most difficult section first, the Discussion, which contains much interpretation and independent thought. Everything after that is easier.

Once you start writing, you should write as quickly as you can. Do not worry about language, grammar, style or spelling. Just write down as much as possible while the flow of whatever section you are working on is clear in your mind. Try to write simply. In this way, you will lay down a basis to work on later. It is always easier to come back to something than to start filling in a blank screen. Concentrate on scientific content and nothing else.

Write in the language that is easiest for you. You can always translate it later – that is just mechanics. Most important at this stage is to turn your notes into written language. Finish with each section before going on to the next one. Do not go back and start revising parts of what you have written until you have completed your writing. Be practical as well.

4.7 Revising content

Once your first attempt is finished, you can start revising the paper. You should always be prepared to revise what you have written. Ask yourself:

– Are all the parts of the paper properly described?
– Are there any major changes needed?
– Is the logic of the paper sound?
– Is the order of presentation satisfactory?
– Is all the text needed?
– Can any figures or tables be eliminated or combined?
– Is each piece of text in the correct section?
– Is the sequence of paragraphs correct?
– Are there enough, or too many, headings and subheadings?

Review the scientific content of the paper until you are certain it is correct, then put the paper aside for several days, then reread it. A short time away from the work gives you a perspective that will allow you to judge what you have written. Once you are