Enhancing students' information literacy skills

How to succeed at university in GEES disciplines

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1. Introduction – information literacy skills in GEES

Welcome to this online resource which has been designed to help you to develop and enhance a range of skills and competencies related to the effective use of information within the Geography, Earth and Environmental Sciences (GEES) disciplines. More specifically, the following sections will help you to:

- consider the contrasting characteristics of different types of resources;
- locate relevant resources quickly and easily;
- critically read and appraise the quality of your resources;
- organise and manage your information;
- make effective use of your resources within your assignments.

Making effective use of a broad range of information resources is central to success in all GEES degree programmes. With lectures and practical sessions commonly providing only the bare bones on a topic or focusing exclusively on specific issues, engaging more broadly with literature is essential to developing more comprehensive knowledge and understanding. More than this, engaging with a diverse range of sources frequently reveals a surprising amount of debate, disagreement and contradictory information that serves to illustrate both the plural and contested nature of our disciplines, and thus the nature of scientific progress. A familiarity with ongoing research debates and an ability to place your work within the context of previously-published research are particularly important within the independent research work that you will typically undertake during the latter stages of a GEES degree programme.

As such, rather than simply acquiring and re-presenting information, your degree programme will require you to think independently, to critically assess the reliability of their sources and to evaluate the basis and relative strength of competing arguments. Although coping with the sheer quantity of contrasting information can seem daunting at first, with practice and developing confidence it can help to enliven the disciplines you're studying, whilst equipping you with a suite of skills and abilities that will be of value for the rest of your life.

1.1 What is information literacy and what does it involve?

Information literacy is an umbrella term that refers to a broad range of related skills and approaches. It can be defined as:

> "…the adoption of appropriate information behaviour to obtain, through whatever channel or medium, information well fitted to information needs, together with critical awareness of the importance of wise and ethical use of information in society."
> (Johnston & Webber, 2003, p336).

This definition makes it clear that the information-literate student is a competent user of varied sources of information, has a clear need and purpose for the information gathered, and is aware of the requirement to consider its appropriate and ethical use. New students starting a GEES degree programme commonly lack a number of these essential skills, such as the abilities to use search tools for identifying appropriate information quickly and easily, to evaluate the reliability and credibility of the information obtained, and to acknowledge the use of sources through systematic referencing. As such, limited information literacy skills are something that students can struggle with when making the transition into university study. Consequently, you may find that these issues feature prominently in first-year practical and tutorial sessions.

Information literacy involves a broad portfolio of skills associated with the location, evaluation, management and effective use of different types of information resource. These skills form the focus of this guide and are addressed in the subsequent sections.

Section 2: Selecting your resources

What are the different types of information resources typically used by GEES students? Each resource has its advantages, disadvantages and recommended uses. This section provides some key tips on how to select the most appropriate mix of resources for any assignment or activity.

Section 3: Locating relevant sources of information

Searching libraries and the internet for the relevant information you need for your assignment can be scary, given the large amount of irrelevant information standing in your way. This section discusses how to ensure success through designing appropriate search strategies and making the best use of available search and retrieval tools to access the information you need. We also provide solutions to common barriers such as problems accessing the resources.

Section 4: Organising and managing your information

Now that you've downloaded lots of different journal articles, how do you best organise and manage this information? Help is at hand: this section discusses the use of reference management software to collate your materials and organise your notes.

Section 5: Critically reading scientific literature

Once you've located, retrieved and organised your information resources, the next step is to make the best use of this material to complete your assigned task. The scientific literature can be intimidating. This section provides you with strategies for designing your research strategy, how to approach your reading, and how to take notes.

Section 6: How to cite sources and avoid plagiarism

Learning how to cite your sources within assigned work is a common challenge associated with the transition to university study. Not doing so properly can lead to charges of academic misconduct. To help you avoid these charges, this section provides a worked example that clarifies what is and what is not plagiarism, emphasising how best to cite your sources.

Section 7: Onward: how to write a first-class essay

The final section draws the information literacy skills together and discusses a strategy for planning, writing, and editing your written assignment to gain that top mark you can be proud of.

1.2 Information literacy, graduate attributes and future careers

We live in a world characterised by an ever-growing quantity of information that is of highly-variable quality, and the ability to identify, appraise and synthesise information is something we do on an almost daily basis, for example when making a significant purchasing decision or voting in an election. As Bundy (2004, p. 3) puts it:

> "The sheer abundance of information and technology will not in itself create more informed citizens without a complimentary understanding and capacity to use information effectively."

Information literacy skills are therefore one of the most important skill sets that you will develop throughout your GEES degree programme. You need to showcase these skills as key "graduate attributes" to any potential future employer. Regardless of your career path after graduation, the ability to acquire, evaluate, organise, interpret and communicate information is critical to living in the 21st Century information society. These skills are central to careers within business and consultancy where employers demand the most up-to-date information and employees can struggle with information overload (resulting from an inability to make effective use of search tools and a failure to consider the quality of the chosen information sources) (e.g. Cheuk, 2008; Thomas 2008). Therefore, when you're drafting your job application and CV, make sure that you include references to these highly marketable skills!

2. Selecting your resources

Useful and potentially relevant information can be acquired from different types of information resources, ranging from traditional textbooks through to more recent digital resources such as blogs. Academic staff commonly complain that students rely too heavily on general course textbooks and internet sites. Whilst these are easy to access, they typically lack information of sufficient detail and may be of unreliable origin. Conversely, students often struggle to make effective use of the journal literature that staff see as a key resource at degree level due primarily to the time required to find relevant articles and the complex content and language they contain (Waller & Knight, 2012).

There is no single type of information resource that is universally superior to the others. Rather, the secret is to ensure that you engage with an appropriate mix of information resources appropriate to the specific task at hand. Section 2.1 reviews the key types of information resource commonly used by GEES students as well as their advantages, disadvantages and recommended uses. Section 2.2 then considers the broader issues you should consider before devising your search strategy.

2.1 GEES-specific resources

Source material is classified as either primary, secondary, or tertiary. Primary sources are the original source of the information and include most scientific journal articles, technical reports, conference proceedings and dissertations that report on data or research performed by the author. Datasets can be considered primary source material, as well. Secondary sources report on results found in primary sources, such as review articles, biographies, monographs and advanced textbooks. Tertiary sources are even further removed from the primary source. Tertiary sources may include introductory textbooks, popular science books, encyclopaedia entries, and newspaper articles derived from a university press release for a journal article. The principal difference between secondary sources and tertiary sources is that secondary sources usually provide a more scholarly approach to their topic by including citations and references to their source material, whereas tertiary sources usually omit sources in favour of just describing the science.

The remainder of this section provides an overview of the key information resources you are most likely to encounter within the GEES disciplines. Table 1 summarises their advantages, disadvantages and recommended uses. One important point to consider before we look at the specific resources is that the information they contain will be determined in part by their date of publication. When one considers the amount of new material that is published each year and the new discoveries that are made, older publications can become outdated and superseded quicker than you might think.

Table 1: The advantages, disadvantages and recommended uses of GEES-specific resources

Resource type	Advantages	Disadvantages	Recommended usage
Internet sites (secondary & tertiary)	• Quick and easy to locate • Information is easy to comprehend	• Typically lack detail • Rarely subject to any review process • High risk of inaccurate or biased content	Can provide a useful initial "heads up" on an unfamiliar topic. Can also provide access to useful figures and images for an assignment (although you should check the conditions of use).
Encyclopaedias & dictionaries (secondary & tertiary)	• Quick and easy to use • Entries are typically easy to comprehend • Specialist examples can provide detailed overviews and links to relevant literature	• General examples lack detail and may contain inaccurate or biased content	General encyclopaedias such as Wikipedia can provide an initial insight into a topic area, but should only be used as a starting point for a much broader search. Specialist examples are well worth consulting due to their greater detail and suggested further reading.
Media articles (tertiary)	• Up to date • Highlight recent events and discoveries	• Lack detail • Rarely if ever objective	Can be used to demonstrate an awareness of recent events and add a "topical flavour". Can highlight recent research findings and lead to recently published journal literature.
General textbooks (tertiary)	• Written for a student audience • Content should be reasonably reliable and accurate • Provide suggestions for further reading	• Limited detail	Ideal way to familiarise yourself with the key concepts relating to your topic area that can be used as part of a more directed search for more specific information.
Advanced textbooks (secondary)	• Usually provide significant detail • Generally more accurate and reliable than general textbooks • Inclusion of citations aids identification of additional literature	• May contain technical language and advanced material	Use to expand your knowledge of core issues raised in more general sources. May need to engage with more recent journal literature if you need to ascertain the current state of knowledge or identify areas of controversy.
Monographs (secondary)	• Extensive detail • Reliable • Cite additional literature	• Very narrow focus • Time consuming to use • May be outdated	Useful if you're undertaking an independent research project on a related area of enquiry. Otherwise they're unlikely to be of value.
Journal articles (primary)	• Extensive detail • Reliable • Cite additional literature • Recently published papers will be at the frontiers of the discipline • Provide an insight into ongoing research debates	• Use complex language and sections may be hard to comprehend • Can be difficult to locate and access (section 3)	Of potential value to most university-level assignments. Can be a challenge to use effectively, but are most likely the resources that your instructors want you to use and understand.
Review papers (secondary)	• Provide detailed overviews • Provide extensive reference lists • Highlight seminal contributions • Often easier to read than standard journal articles	• Will not contain more recently published material • Can be easy to become too reliant on a single review and the author's perspective	Ideal resource if you're lucky enough to find one that covers a relevant topic area. Great way to get a head start with the research literature, especially in relation to a literature review assignment or an independent project.

Technical reports (primary)	• Highly detailed and thorough report of a research project	• May be too detailed for most users • Could be tedious trying to read the whole document	Excellent resource if you need lots of detail about a particular project. The literature review may be more thorough than you would find in a journal article. Otherwise technical reports are generally overkill.
Conference proceedings (primary)	• Captures the science in a field at a given snapshot in time. • Most recent updates of research projects, many in preliminary form	• Usually not peer reviewed in most GEES disciplines • May be superseded by peer-reviewed literature • May be of variable quality or even incorrect	Captures a moment in time of a scientific field, warts and all. Can highlight key research themes and the state of the discipline at the time of publication.

Internet sites

Internet sites commonly provide the first ports of call during any search for relevant information due to their accessibility, familiarity and general ease of use. The level of detail and quality of the information contained within internet sites is extremely variable, and therefore it is difficult to generalise about the specific advantages and disadvantages of internet sites as a whole. Moreover, whether the source is primary, secondary, or tertiary may not be entirely clear. Suffice it to say, tutors facing a reference list dominated by internet sites are unlikely to be impressed by the effort you have put into your subject research!

Encyclopaedias & dictionaries

Encyclopaedias and dictionaries are a long-established information source that can provide a brief introduction and overview. The development of online encyclopaedias, most notably Wikipedia, has seen a renaissance in their use as an initial source of information. But, much of the information on Wikipedia, as useful as it is, may not have been written by a subject matter expert. Subject-specific encyclopaedias and dictionaries commonly written by subject experts provide more detail and can provide a springboard into the research literature. As such, these sources are well worth using in the early stages of your search for relevant content.

Recommended subject-specific dictionaries

Gregory, D., Johnston, R., Pratt, G., Watts, M. & Whatmore, S. (Eds.), 2009. *The Dictionary of Human Geography* (5th ed.). Wiley-Blackwell, 1072pp.

Hancock, P.L. & Skinner, B.J. (Eds.), 2000. *The Oxford Companion to the Earth.* Open University Press, 1174 pp.

Thomas, D.S.G. & Goudie, A.S. (Eds.), 2000. *The Dictionary of Physical Geography* (3rd ed.). Wiley-Blackwell, 624pp.

Porteous, A., 2008. *Dictionary of Environmental Science and Technology* (4th ed.). Wiley-Blackwell, 826pp.

Media articles

Media articles provide the principal source of information on recent newsworthy events for all of us, and the provision of online media outlets via the internet or even Twitter means that this information is more easily accessible and more current than ever. Whilst media coverage can highlight recent events and scientific discoveries, the material is almost invariably selectively reported and subject to reporting bias.

General textbooks

General textbooks provide a useful introduction to the topic area in question and help to highlight the key concepts and issues that you might want to use as the basis for subsequent searches with a more specific focus (section 3). Historically, general textbooks have been written by a single author and are therefore tertiary resources (section 2.1). Rapid research developments in the GEES disciplines, however, mean that recently published general textbooks typically comprise edited volumes with each section being written by a subject expert, meaning that the subject information should be more accurate and reliable.

Advanced textbooks

Here, the term advanced refers to textbooks with a more specific focus on a particular topic area (e.g. natural hazards, migration, carbonate geochemistry, estuaries). These textbooks invariably contain more detail than a general textbook. They tend to be written by subject specialists who are usually active researchers. In general, the information tends to be more accurate than a general textbook, although advanced textbooks may employ more technical language and more complicated material.

Monographs

The main purpose of a monograph is to present primary research and original scholarship. Written by the author of the research, they are primary sources and are usually reliable. However, they may also be lengthy and time consuming to read.

Journal articles

Journal articles are the gold standard of source material. They present the findings of original research, and they are the source that you will be expected to use, particularly later in your degree programme when your modules have an explicit research focus. Engaging with journal literature is especially important when undertaking independent research work, both to inform your initial research proposal and to provide a broader research context against which to compare your own findings.

Review papers

Rather than present the findings of original research, some journals focus on publishing review papers that provide comprehensive and detailed syntheses of the literature on a specific subject area (e.g. *Progress in Physical Geography, Progress in Human Geography, Earth-Science Reviews*). A review paper closely aligned to your assignment can be a goldmine that may provide a critical review of the relevant literature for you. If you are lucky enough to find a relevant review paper, avoid the temptation to rely solely on this source. As review articles tend to be secondary sources, you should still read any key primary literature it cites. In addition, if the review has been published some time ago there will be a need to find more recently published literature on the topic.

Technical reports

Technical reports are sometimes produced by government agencies or institutes in lieu of publishing in the peer-reviewed literature. Because length is no object, technical reports can be much more in-depth, presenting more information and details than would otherwise be available. In that sense, they can be great resources. On the other hand, that level of depth may be more than is needed by the reader. Many technical reports may undergo an internal peer-review within the organisation before being published.

Conference proceedings

In many GEES disciplines, conference proceedings serve as the instantaneous record of what was presented at the conference and therefore provide an insight into the contemporary research themes and debates. As such, some papers published in conference proceedings are often later published in the peer-reviewed literature. Other papers in proceedings end up being a dead end for researchers or the research evolves in a new direction. Other conference proceedings may later be shown to be incorrect based on more thorough investigation.

2.2 Issues to consider when selecting your sources

There are two ways to classify source material. The first is by how close the author is to the person who actually made the discovery (i.e. primary, secondary, tertiary) as discussed in section 2.1. The second is whether the source has undergone a process called peer review.

Choose primary sources, wherever possible.

When reading on a topic unfamiliar to you, it often helps to start with introductory textbooks on the subject (secondary and tertiary sources). These sources can provide a quick and easy way to understand basic concepts about the material. But, because this work is someone else's interpretation of the information, it may not be entirely accurate or up-to-date. As you become more comfortable with the material, it helps to

find more advanced books on the subject, i.e. those appropriate for upper-level undergraduate courses or postgraduate students, and review articles (secondary sources). Finally, your investigations should take you to the origins of the ideas you have read about: the primary scientific literature. Students who cite the primary literature in their assignments show that they have a mastery of the material and have taken the time to track down the original source material. Students who limit their reading to their course textbooks fail to demonstrate this mastery. As such, their marks are substantially lower.

Good practice in research is to do your best to obtain and read every single piece of primary source material that you cite. If you don't, you run the risk of relying on someone else's interpretation of the source (a secondary source) rather than reading the original. If you are unable to obtain some primary literature, the most appropriate way to cite is as follows: "(Newton 1687, as discussed in Whiteside 1970)". Remember that just because an article is old and difficult to obtain does not mean it is inaccurate or outdated, and just because an article is recent does not mean it is correct.

Choose peer-reviewed sources, wherever possible.
The second classification relates to the process by which that source has been published. Most scientific journals have implemented a process called peer review which typically works as follows.

After a research team has written up a report of their research results, they submit it to a journal, where it is handled by an editor. The editor considers whether the report is on a subject appropriate for the journal, and, if it is, sends a request to others who are working in a similar field (peers). The requests ask the peers to read the report, write up a document recommending whether the journal should publish the work or not, and list strengths and weaknesses of the report. If the peers agree, they become reviewers, and their written document is called the review. The review may list errors in derivations, calculations, or interpretations. The review may also identify where the evidence is lacking for the authors' claims or where the text may not be clearly written. When all reviewers have submitted their reviews, the editor reads them and makes a decision. Usually the decision is accept, revise, or reject. The decision and the reviews are returned to the authors. Peer reviewers usually remain anonymous to the authors. If a manuscript receives a revise decision, then the authors have a chance to respond to reviewer comments, improve the manuscript, and resubmit it for reconsideration. Usually, after one or two rounds of reviews, the manuscript ends up being acceptable for publication and is published several months thereafter.

Although peer review slows down the publication of new research, almost all papers that go through the process are improved by the reviewers' comments and authors' revisions. For this reason, peer review is an important part of the scientific process. Peer review also represents an independent accreditation and validation of the authors' original work by the scientific community because several others agree that the paper meets minimum scientific standards. As a result, peer-reviewed research is held in much higher esteem than work that has not gone through peer review. As such, you should cite mostly peer-reviewed sources in your written work.

However, one caveat exists. Just because a journal article may be peer reviewed does not mean that it is perfect. There still may be flaws in the paper or mistakes that the reviewers and editor didn't identify. Indeed, on rare occasions a paper is later retracted after publication when serious mistakes or scientific misconduct (e.g. fabrication or falsification of data, plagiarism) are identified. Furthermore, peer-reviewed literature may be correct, but may yield conflicting results. This disagreement is a healthy part of science as the debate motivates more focused research efforts to understand the science better. Thus, do not ignore conflicting literature. Instead, embrace it! Discuss the evidence for and against each side in the debate. Such interpretation and criticism of the literature will help you achieve higher marks for your reports (section 7).

Ask yourself these questions about your source material.
When picking up possible source material, ask the following questions:

- Is this source relevant to your research?
- Is this a primary, secondary or tertiary source?
- Is this source peer reviewed?

- What kind of quality is the source? Does it provide sufficient detail?
- How accurate is the source? Does it use the technical terms correctly and appropriately for its intended audience?
- How reputable and credible is the author, the publisher, or the origin of the source?
- Would you expect the source to be biased in any way? Does the author or publisher have an agenda that this source would fulfil?

3. Locating relevant sources of information

An inability to find relevant information is one of the main reasons students use to explain their limited engagement with primary sources. When one considers the amount of published material available, finding information relevant to your assignment can seem as futile as trying to find a needle in a haystack. This section discusses a series of practical approaches and techniques you can use to help locate relevant information quickly and easily. The secret here is the effective use of the various search tools such as Google Scholar and Web of Science and the construction of appropriate search terms and phrases that will enable you to target your search. We also provide some tips on how to extend your initial search and consider what to do when you find your university does not stock the journal you need.

3.1. Developing appropriate search strategies

Before you start searching for relevant information and grappling with various search tools and abstract databases, remind yourself of the overall aim of your task and the most suitable strategy to follow. In this respect, the best strategy will depend upon whether you are simply trying to enhance your knowledge or whether you are researching material for a specific assignment. You should have a strategic approach to information resources for specific assignments, whether they are essays, poster presentations, literature reviews or independent research projects. For example, for a typical coursework essay, a suitable search strategy might involve the following steps (the various information resources have been emboldened to highlight the stages where they're used):

Check the resources for any relevant **lectures** to identify any recommended reading.

Identify and read the relevant sections from any **general textbooks** to enhance your subject knowledge and identify key concepts or issues relating to your essay.

Identify and read the relevant sections from any **advanced textbooks** to further develop your subject knowledge and help locate relevant research literature.

Search for and read any relevant **journal literature** that relate to the key points you've developed in your essay plan.

Check recent **media coverage** to determine if there have been any recent events or discoveries relating to your essay topic.

Search an **internet** image bank to locate any images or figures of potential use.

3.2. Constructing appropriate search terms

To access relevant information in all its forms quickly and easily involves the construction and combination of key search terms. Before we examine the use of online search tools and the construction of search terms, there are two important points to bear in mind.

You need to persevere.
It is unlikely that you will find a whole stack of relevant resources within five or 10 minutes of starting your search. However, if you persevere and spend 30 minutes to an hour experimenting with different search terms, then you should find plenty of relevant material. In other words, you need to invest some time to get a worthwhile end result.

You need to be specific.

Online search facilities such as Google Scholar are fantastic in that they provide access to millions of research publications. A consequence of this benefit is that they are of little use when searching for information on a general topic (e.g. climate change). Therefore, they are best used after you have done some initial textbook-related research, have identified the key points and focused topic areas that you will need to address, and are now looking for more detailed information (e.g. the impact of climate change on the incidence of waterborne diseases).

The secret to finding relevant material is the thoughtful and creative use of various "keywords" as your main search terms along with what are known as "Boolean operators" (e.g. AND, OR etc.). For example, if you were searching for information concerning the potential impacts of climate change on the incidence of waterborne disease, you could use the following search phrase:

"climate change" AND "waterborne disease".

In this example, putting the key terms in inverted commas ensures that the search tool looks for that specific phrase (rather than the words individually) whilst the addition of "AND" instructs the tool to look for articles that contain both phrases. The trick here is to generate a search phrase that will generate a reasonable number of results for you to then sift through (typically about 10–100). If your search term is too vague, then the result will be thousands or even millions of hits that you can't possibly scan through. Conversely, if it is too precise, it will produce too few hits. Adjust your search term accordingly, and recognise that it can take some time and patience to develop the most effective search phrases.

3.3. Using online search tools to your advantage

An important search facility that is often forgotten is your library's online catalogue. As we recommend starting your search with more general sources such as textbooks (section 3.1), your library catalogue is an ideal place to begin. In particular, starting your search in the library will enable you to identify any relevant textbooks that are held there as both hard copies and as electronic versions. When you subsequently shift your focus to journal literature, the library catalogue will provide information on the academic journals (often referred to as *periodicals*) that your university subscribes to and whether access is provided via printed journals, electronic documents or both.

Although university libraries used to provide a one-stop shop in the search for relevant information, GEES students now have access to a broader range of online search tools that will allow you to widen your search. Using these search tools to your advantage is absolutely crucial to locating journal literature in particular. There are a number of different tools and databases you can use, and your library website will have information on any specific examples they provide access to. Two of the most widely employed academic search facilities whose use we recommend are:

Google Scholar (http://scholar.google.com)
With an interface that is identical to a normal Google search, Google Scholar is an obvious place to start if you are unfamiliar with online search tools. The only difference is that this tool searches specifically for scholarly literature (primarily published journal literature, but also patents and case law).

Web of Science (http://wok.mimas.ac.uk/)
The Web of Science is a sophisticated database of abstracts that provides access to over 22,000 journals and 55 million articles. The search interface is more complex and can include multiple search terms spanning different categories. The results page also provides a greater degree of flexibility to refine your results or scrutinise the citation history of the outputs if you are interested in this level of detail. Although Google Scholar is free, Web of Science is a proprietary database that you may only have access to when on campus or logged into your campus virtual private network (VPN).

Rather than provide a step-by-step account on how to use specific search tools, the remainder of this section provides some more general advice on how to get the best use out of these fabulous resources.

Refining your search

If your initial search generates too many hits, then an alternative to revising your search phrase is to use the search tool to progressively refine your search. For example, you can refine your search by limiting to specific publication years, publication types, research areas or authors.

Saving your search results

Once you have generated a list of search results that you are happy with, check the papers that you want to scrutinise later and save these as a marked list. This list can then be saved, emailed to your account or exported directly to reference management software (section 4).

Accessing the article

The search tool will highlight which articles you can access directly as full papers. If you can directly access and download what appears to be a relevant paper straight away, then this can save you both time and money.

Extending your search

You often only need to find a single gem of an article in order to break into a larger body of useful literature. Once you have found this article, then you can do two things to extend your research to other related literature.

Scan through the reference list to look for other relevant articles and papers. If you use the online version of the paper rather than a downloaded PDF file, then you will be able to identify and immediately access the cited papers from journals that your library has electronic subscriptions to. Obviously you will only be able to locate literature older than the current article.

Check the papers that have cited this paper in their reference list. The search tool will feature a link ("cited by" or "times cited") that enables you to access the papers that have cited this article within their reference lists. This feature will allow you to identify more recently published papers on similar topics.

Using citations as an indicator of impact

Most search tools will indicate how many times an article has been cited by other authors. This measure can provide an estimate of the academic impact of the article, with those that have been cited more times generally being more influential and potentially more highly-regarded. With this in mind, sorting the results of your search list according to the number of times cited can help reveal the most important articles in the field. Although providing merely an estimate of the impact, the number of citations should be used with caution for several reasons. First, the typical number of citations varies between disciplines – articles in the larger, faster-moving disciplines (e.g., medicine, chemistry, climate change) generate citations more rapidly than those in smaller, slower-moving disciplines (e.g., soil science, weather forecasting). Second, the number of citations will be necessarily small for recently published articles. Third, not all citations are captured in some of these search engines. For example, Web of Science only measures citations from journals that they track. Finally, the reasons for the high number of citations to a particular article might relate to some controversial or disputed findings!

Identifying "big names"

Once you've scanned through an initial search list, you might find that the same authors' names keep appearing. This might suggest that these authors are key players in their field or specialise in this particular topic. After having identified these names, another way to extend your search is by searching the web for

their personal web pages with their publication lists and by other searches aimed specifically at papers written by these authors.

Be inventive and experiment

The functionality of the available search tools is constantly evolving, and the advice listed above is largely the result of trial and error and a dash of lateral thinking. The final piece of advice we offer is simply to experiment, to try different approaches and ultimately identify what works best for you!

3.4 Access issues and alternative strategies

One of the most frustrating situations you're likely to encounter – more frequently than you'd like – is to identify the perfect article only to find that your library doesn't subscribe to that journal. Rather than throw your hands up in despair, the first question to ask yourself is do you really need to access the whole paper? Usually, you have access to the abstract for any published paper, and a well-written abstract may tell you everything you need to know for your assignment. If you conclude that you need to read the whole paper, then there are some alternative strategies you can employ.

Try a standard Google search using the title of the paper as the search term
You may find that a person or organisation has published the paper elsewhere on the internet.

Check the lead author's webpage
Academic authors sometimes publish PDF versions of their papers on their personal academic websites.

Email the lead author
Send a polite email to the lead author. Say how keen you are to read their paper, You may be surprised how many times you receive a PDF in reply.

Arrange for an inter-library loan (ILL)
Your library will be able to obtain a copy of almost any item you may be interested in through the ILL scheme. This is worthwhile if all else has failed and you're desperate to get hold of the literature. However, this can be costly and therefore needs to be used judiciously.

Take a trip to a different library
Although your library may not subscribe to a particular journal, the library of a nearby university may do. There are reciprocal arrangements that allow students to use the libraries at other universities. Check with your own library staff to find out how this is arranged at your institution.

4. Organising and managing your information

An effective search for relevant information can yield hundreds of potential sources of information. As a consequence, information overload can set in. Adopting a well-organised approach from the outset and having a clear process for managing all the information will help prevent this. In this respect, whilst technology has enabled us to locate greater quantities of relevant information, it has also provided effective ways of managing the information we collect.

4.1 Managing and organising your search results

The best way to manage and organise the results of your literature searches is through the use of commercial reference management software such as Endnote or RefWorks. These software packages are databases designed to import, manage and export different types of information resources, and they provide a range of features that can help you save precious time.

Saving searches
If you have generated a marked list related to a Web of Science search for example, then you can save the results of the search and whatever fields you would like to include as a file that then can be imported directly into the reference manager software.

Navigating and searching your sources
Once you have imported your search results into the reference manager software, then searching through your sources to find the specific reference you need is easy.

Keeping everything in one place
One of the easiest ways to lose track of your resources is to have various pieces of information in different places. You might have a list of search results in one file, a series of PDF downloads of various articles in a different folder and then a set of personal notes in another document on another computer. If you use reference manager software, you can integrate all of these pieces of information into the same software package. You can also upload this information into an online library that will allow you to access your material from different computers and other devices.

Creating reference lists
A final advantage of reference manager software is that it can create a reference list in different formats. How this typically works is that you cut-and-paste a temporary citation from the reference manager into the word processing package you are using to write your essay. You can then select an appropriate referencing style and the reference manager will convert the temporary citations into appropriately formatted citations. The software will also compile your reference list for you. As with any software, there may be some glitches in the process and therefore you should carefully check the end product as part of a final proofread.

When researchers deal with hundreds of references or more, reference manager software is well worth investing some time and effort to use. Even if you're studying towards an undergraduate degree, getting into the habit of using this software has the potential to save you significant amounts of time and effort. Many universities have a site license for the software, which means you can use it for free. Your university may also offer free training courses in their use. Even if your institution doesn't provide site access to one of the more sophisticated commercial packages, there are various other reference managers that are free to use such as Mendeley and Sente. In addition, EndNote Basic can be used as a free online reference manager.

4.2 Making effective notes

Once you have organised your sources and identified those that you want to read, then the challenge becomes one of taking effective notes in which you are seeking to extract the gems and highlight these within

the notes you record (section 5 – step 3). The most common approach, particularly when reading printed material, is simply to use a highlighter pen to pick out these gems. Although this is undoubtedly a quick and easy approach to take, when you come to write your essay it can be difficult to remember where that highlighted point is located within the stack of papers resting on your desk. Therefore, invest the time to write some supplementary notes in a digital document that you can subsequently use as the main resource when writing your assignment. These notes might involve no more than a full reference and a set of bullet points of relevant and the most important results. If you need to go back to the original article to remind yourself of a key point or extract some more detail, then this is easy to do. Of course if you are using the reference manager software described in the previous section, then you can integrate your notes into the database or even annotate the attached PDF.

5. Critically reading scientific literature

Many writing tasks that you are assigned at university require researching source material. This can be a daunting task, and we sympathise with you. For example, some assignments might be to write about a topic as broad as global climate change (over a billion search results on Google and two million on Google Scholar) or even as narrow as carbonate deposition (only six million results on Google and 900,000 on Google Scholar). You need a strategy to tackle this potentially large amount of relevant information (and even more irrelevant information). You need an approach to identify the most relevant sources, assess their quality, narrow the focus, and write your report. In this section, we give you that approach and guide you to evaluate the literature that you're reading.

The key to this approach is to recognise that the source material for your report is potentially unlimited. Even after many decades of combined research activity, the authors are still discovering previously published literature that they have not previously encountered. You would be foolish to think you could master all the literature on a given topic within a single semester.

Instead, you must focus the topic of your paper. Many assignments are intentionally left broad so that students have some flexibility to explore a subtopic of their choosing. (If in doubt, check with your instructor.) So, rather than writing a report about carbonate deposition (about which whole books have been written), focus the topic down to something where the number of papers you need to read is substantially less. For example, by searching for "carbonate deposition Saudi Arabia" on Google Scholar, only 11,000 results are returned with many of the top hits being especially relevant to the topic.

If you feel your researching and writing process could be more efficient, you may try the following approach. This section will help you structure your approach with five simple steps. To accomplish these steps, **you need to start sooner than later**. There are three reasons for this.

> **Reading the scientific literature and writing are both time-consuming tasks**. Give yourself enough time to complete these two tasks.
>
> **Part of critical thinking is allowing enough downtime to subconsciously ruminate over difficult concepts**. Ever notice how you have good ideas that seemingly come out of nowhere while taking a shower or walking? That's your brain working subconsciously and then releasing that information to your conscious brain. If you try to cram a lot of writing in at the end without breaks, you won't allow yourself that opportunity for subconscious reflection.
>
> **An essential component of good writing is editing your writing**. Most authors become too close to their own writing to objectively critique it and improve it. An important way to give yourself some distance from your own writing is downtime between drafts. Let your writing sit for at least a day or two so that you approach your writing with (reasonably) fresh eyes. Doing so will allow you to be more critical of your own writing. Alternatively, exchange your essays with your fellow students to read and get comments. Again, this will require time.

A lack of effective time management is highly correlated with receiving a poor mark on an assignment. Failing to manage your time and struggling to meet impending deadlines may also lead to academic misconduct such as plagiarism. If you need guidance about how to improve your time-management skills, we recommend Peter Levin's *Skilful Time Management!* (Levin 2007).

Step 1: Carefully read the instructions for the assignment.

Reading instructions may sound unnecessary to say, but many students fail to understand the assignment because they did not read the instructions. For instance, the instructions often include the length, scope, format, due date, submission instructions, and criteria for marking. Reading the instructions is so important

that we recommend reading the instructions several times before writing, during writing, and before submission of your paper. If the instructions have the criteria for marking, keep those in mind at all times.

Step 2: Set a timeframe for reading and a timeframe for writing.

Prepare a plan of how you will do the reading and research. For example if there are ten weeks until the deadline, give yourself four weeks to do primarily reading and six weeks to do primarily writing. You want the period where you are doing mostly reading to be detached from the period where you are doing mostly writing. Otherwise, you may use searching for more to read and reading as an excuse for not writing.

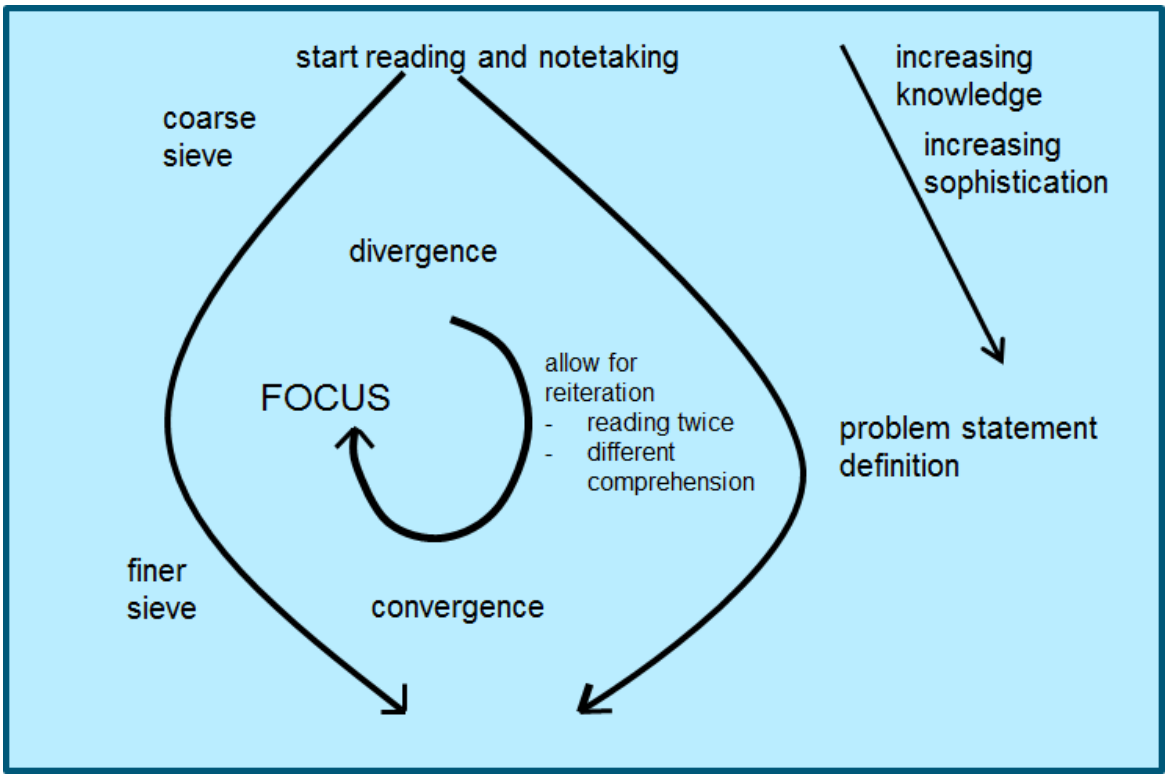

Figure 1: The reading and note-taking process of writing a research paper.

Step 3: Read freely and broadly, but with a purpose.

Reading the scientific literature may be a new experience for you, and the unfamiliar scientific terminology and concepts may be offputting. In fact, it may seem like the authors are talking to a small group of insiders, a group that you are not privy to. Indeed, you would be correct! Most of the scientific literature is not directed at novice scientists or students; it is for the other experts in the field. Thus, authors freely use terms that these experts will understand. That makes the literature particularly challenging for someone just starting out. To give you some advice to tackle that barrier, the first thing we recommend is to recognise that this reading was not intended for you. Moreover, many scientists are not good writers, so it may be a challenge for you to read their writing. There, feel better? OK, great. Let's get to work.

How do you unravel the facts and stories within scientific literature that you may not completely understand? One tip is to start with the title and abstract. If you can understand the title and abstract and its relevance to your topic, then that is a good start. You don't need to read the paper from beginning to end (what we call *linear reading*) and understand it completely in order for the paper to be useful to you. In fact, many scientists read the paper nonlinearly (Schultz 2010, p. ES32). After reading the title and abstract, they may read the introduction, then the conclusion, then look at the figures. The last thing they read, if at all, is the body of the text and the tables (Schultz 2010, p. ES32). In this way, scientists are able to get the information they need

from the paper quickly. If more details are required, well, the entire paper is there for the reading. You should do the same. Don't waste time reading irrelevant sections of papers.

More specifically, if the title and abstract are promising and relevant, then try to find the parts in the paper that relate specifically to the knowledge that interests you. Is it the whole paper? Is it just one small part of the results section? If so, then you may not need to spend time understanding the whole paper. Of course, putting that one result in context of the entire paper is necessary to understand the author's motivations, but, for your purposes, it may not be necessary to understand completely all the other parts of the source.

Plan your reading: for roughly the first half of the reading period, allow yourself to read freely of the material. This is the period we call *divergence*. You may not even be reading on carbonate deposition in Saudi Arabia, but carbonate deposition processes in general. Look to gain information that you didn't know before in the broadest sense. Follow the guidance on identifying source material discussed in section 2.

It may help to focus your reading into steps, allowing you to break up the generic task of "reading about carbonate deposition in Saudi Arabia" into "reading about the different types of carbonates", "reading about sedimentary environments where carbonates are deposited", and "reading about the geology of Saudi Arabia". Breaking up the task will also allow you to budget and manage your time more effectively, especially in the face of uncertainty about what you will be reading.

When reading on a topic unfamiliar to you, it often helps to start with introductory textbooks on the subject (secondary and tertiary sources). Reading such material can be a quick and easy way to understand basic concepts about the material. However, because this work is someone else's interpretation of the information, it may not be entirely accurate or up-to-date. As you become more comfortable with the material, it helps to find more advanced books on the subject, those appropriate for upper-level undergraduate courses or postgraduate students, and review articles (secondary sources). Finally, your investigations should take you to the origins of the ideas you have read about: the primary scientific literature. Recall that instructors expect students to be engaging with and citing primary, peer-reviewed literature. Those who demonstrate that they master the material receive higher marks.

Read with a purpose. Take notes with a purpose. Don't just write down anything that looks relevant. As you read, it may be helpful to remember this analogy: are you a bucket or a sieve? **Don't be a bucket, be a sieve** (Fairbairn and Fairbairn 2001, p. 68).

People who read like a bucket walk on the beach and see something interesting and put it in the bucket. They don't discriminate between the sand and the gems, whatever attracts their attention. At the end of the day, they pour the bucket out on the floor, see what they've collected then try to make sense of it. People who read like a bucket have a distant relationship with the literature. They are using the literature to find interesting facts that are isolated from their purpose of the reading. They harvest ideas to put into their essay, rather than read the text to yield understanding, which is then used to write the essay. Buckets will have a much harder time remembering what they read for very long because there is no coherent narrative around which to incorporate the new knowledge into their thinking.

On the other hand, people who read like sieves only pick up the gems, allowing the irrelevant sand to filter through back onto the ground. They critically evaluate information, evaluate the quality of the information, and assimilate the best information in their existing knowledge. By incorporating their reading into their existing knowledge, they learn more effectively and remember information for longer.

When reading as a sieve, ask yourself the following questions:

- What is the author's main point?
- Does the evidence support the argument?
- How good are the assumptions made by the authors?
- Would other arguments explain the same result?
- What is the historical or cultural backdrop in which the research was done?

What you read, therefore, is scaffolding for your own argument where you demonstrate your own ability to think critically about what you read. From this perspective, critical reading and critical writing will help you avoid plagiarism.

As you do more reading and become more knowledgeable about the subject, start considering specific questions left unanswered by the literature, multiple explanations for the same observations, or contradictions in the literature. Is there a storyline that you could tell about the scientific questions your essay is supposed to address? If you can start thinking along these lines, your essay will be much more powerful.

Step 4: Define the problem statement and the purpose of the essay.

As the amount of literature that you have read expands, your breadth of knowledge expands. With an insurmountable amount of literature out there, this process could keep going for a long time. And, for many students, it does. More and more reading is done, which, in turn, is used to procrastinate on writing the paper. Also, you need to strike a balance between choosing too broad a topic so that your essay lacks depth and choosing too narrow a topic so that you have nothing to say. For both of these reasons, that is why focus needs to happen. We need to end the period of divergence and start convergence so that you have enough time to write the essay.

Considering the questions that you started thinking about at the end of the last step, define the problem statement. The problem statement is the hook that will entice the reader to read your paper. Is it a conflict between two groups? Is it a paradox? Has some new observation cast doubt on previous hypotheses? An attractive problem statement gets readers interested.

With the problem defined, write down the purpose sentence, the one sentence that will define your essay. Congratulations! You've just written the first sentence of your essay. We suggest writing an explicit sentence near the end of the introduction section that says specifically, "The purpose of this essay is to…." It may seem a bit mechanical, but such a statement gives the reader something to judge the success of your essay . Make sure your purpose statement is not too broad so that the essay ends up being too shallow. For example, "The purpose of my paper is to describe how subduction zones work" would be an example of a purpose sentence that is too broad.

When writing the rest of the essay, keep focused on your problem statement. Anything that does not contribute to your problem statement needs to be eliminated.

Step 5: Focus your reading around the purpose statement.

The problem statement and purpose of the essay is essential to turning the corner and reaching convergence. Without a strong problem statement, your essay may:

- be a list of facts from your reading;
- lack depth;
- lack focus;
- be incoherent.

Reading the scientific literature can sometimes be like reading a foreign language. Different rules apply.

- The scientific literature is full of academic speak, technical language, and jargon meant to be understood by specialists.
- The scientific literature is not like reading a novel or other pleasure reading. You must read it more slowly to understand it.
- Do not criticise yourself for reading slowly.

- Do allow yourself enough time for reading and writing.

You may have several periods of convergence and divergence on subtopics (Figure 1), but don't allow the time you spend on the literature review to get out of control. You need to keep it limited or you will never get around to writing the paper (section 7).

6. How to cite sources and avoid plagiarism

In the Middle Ages, and as recently as the 18th Century, repeating the work of great thinkers (e.g. Aristotle) without citation was acceptable. Modern science, however, is based on the principle that the author is doing original work or synthesising past work through citation, but in the author's own words. This approach may be drastically different to what you learned in school where exact repetition of information was important. We sympathise with the challenges that this may pose for you and how we are asking you to change your way of delivering information at the university level. Nevertheless, writing in your own words and citing the relevant source material is the foundation of modern science. It is expected of you in the real world.

6.1. Citing sources: an example

To start this section, let's consider how scientists determine what information in their papers needs citation. The example below is from the journal *Geology* (Bastow et al., 2011, p. 91). The text contains five sentences from two places within the text.

> Much of the geological record on Earth can be interpreted in the context of active processes occurring at the plate boundaries. For Phanerozoic (younger than 570 Ma) rocks this is well established, but during the Precambrian (older than 570 Ma), when the oldest rocks were forming, Earth conditions were likely very different, so analogies with modern-day tectonics are less certain. For example, 40 yr after the advent of plate tectonic theory, the precise onset of continental drift remains ambiguous: in the past 5 yr its onset has been estimated as early as ca. 4.1 Ga (e.g., Hopkins et al., 2008), or as late as ca. 1 Ga (Stern, 2005). Gathering geological evidence preserved deep within the plates in stable Precambrian regions (shields) is thus essential to improve our understanding of the early Earth.
>
> Our results support the view that significant lithospheric deformation occurred during the Paleoproterozoic and that modern-day plate tectonic processes were thus in operation by at least ca. 1.8 Ga.

The first two sentences do not have any citations associated with them because this material is largely common knowledge among geologists and no single citation, or group of citations, would be able to make the unambiguous claim of originating the ideas contained in these two sentences. The third sentence contains very specific dates for the onset of continental drift. For the claim that plate tectonics has been active since 4.1 Ga, Bastow et al. (2011) cite "(e.g., Hopkins et al., 2008)". The "e.g." indicates that Hopkins et al. (2008) is one of a number of citations that could have been cited here, but to offer a complete list would be burdensome or irrelevant. *Burdensome* because there could be tens of references relevant to this claim. *Irrelevant* because the point of this sentence is not to provide a complete listing of all sources, but merely to provide at least one example; some publications suggest plate tectonics started as early as 4.1 Ga, this is one of them. The citation to Stern (2005) for dates as late as 1 Ga without the "e.g." indicates that the authors understand that only Stern (2005) has suggested that the onset of plate tectonics came as late as 1 Ga.

The final sentence in the first paragraph is a statement by the authors. They suggest that looking for geologic evidence in Precambrian shields should help narrow the range of dates over which the onset could have occurred. The second paragraph is the authors' own results. They say that their data suggest plate tectonics had started by around 1.8 Ga. Because both of these sentences are their own views, no citations are needed.

6.2. Using other's sources: how to avoid plagiarism

Similar to many other universities, the University of Manchester (2014, p. 1) defines plagiarism as "presenting the ideas, work or words of other people without proper, clear and unambiguous acknowledgement". Our experience is that plagiarism results from one of two reasons. First, students are aware that they should not plagiarise, but they don't know what plagiarism looks like and how to avoid it. In some cultures, plagiarism is perfectly acceptable. In the UK and other western countries, however, plagiarism is unacceptable. The approach to reading and understanding the literature provided in section 5 can help students vulnerable to this reason. Second, students leave things until the very last minute, panic and produce an essay by copying and pasting other sources. Better time management, including adopting the writing approach presented in section 7, can help avoid this excuse.

The purpose of this section is to guide you through a hierarchy of examples based on the example from Bastow et al. (2011) above to discuss what is and what isn't plagiarism.

Example 1:

> Gathering geological evidence preserved deep within the plates in stable Precambrian regions (shields) is thus essential to improve our understanding of the early Earth.

Plagiarism. It is copied verbatim from the original source without attribution.

Example 2:

> Gathering geological evidence preserved deep within the plates in stable Precambrian regions (shields) is thus essential to improve our understanding of the early Earth (Bastow et al., 2011).

Plagiarism. It is copied verbatim from the original source. Citing the source at the end of the sentence does not excuse the blatant copying.

Example 3:

> "Gathering geological evidence preserved deep within the plates in stable Precambrian regions (shields) is thus essential to improve our understanding of the early Earth" (Bastow et al., 2011, p. 91).

Not plagiarism, but unnecessary quotation. Although the text is copied verbatim from the original source, it is enclosed in quotation marks with attribution, so it is not plagiarism. However, it doesn't demonstrate that the student has understood the ideas – they are just parroting a piece of text from the paper. For this reason, such quotations do not attract high marks. In fact, we would recommend to you to rarely, if ever, use direct quotations in your assignments.

A better way to present this information in the words of the student would be the next example.

Example 4:

> By studying the rocks in Precambrian continental shields, geologists hope to date the onset of plate tectonics more precisely.

Not plagiarism. Although meaning nearly the same as the original text, the words and structure of the sentence are those of the student. Reusing scientific terms such as "Precambrian shields" but in different contexts is generally not considered plagiarism because scientists require the precision that such scientific terms provide.

Example 5:

> The precise onset of plate tectonics remains uncertain. Its onset has been estimated between ca. 4.1 Ga (e.g., Hopkins et al., 2008) and ca. 1 Ga (Stern, 2005). New results by Bastow et al. (2011) support the view that plate tectonics were in operation by at least ca. 1.8 Ga.

Plagiarism. Although some words have been changed or replaced by synonyms, some of the original text still remains and the structure of parts of the original text can still be identified. Even citing Bastow et al.

(2011) does not excuse the imitation of the original text. Compare with the original text, where highlighting indicates parts that were imitated or copied.

> For example, 40 yr after the advent of plate tectonic theory, the precise onset of continental drift remains ambiguous: in the past 5 yr its onset has been estimated as early as ca. 4.1 Ga (e.g., Hopkins et al., 2008), or as late as ca. 1 Ga (Stern, 2005). … Our results support the view that significant lithospheric deformation occurred during the Paleoproterozoic and that modern-day plate tectonic processes were thus in operation by at least ca. 1.8 Ga.

Example 6:

> Stern (2005) concludes that plate tectonics began operating as late as ca. 1 Ga, whereas Hopkins et al. (2008), among others, argue for a much older onset (ca. 4.1 Ga). More recently, Bastow et al. (2011) working in northern Hudson Bay, Canada, find evidence for a collision between two plates ca. 1.8 Ga, thereby better constraining the more recent end of the range.

Not plagiarism, but no interpretation. Although the information is derived from the original source, the words and structures of the text are those of the student, so it is not plagiarism. The content is largely similar to that of the original text, so the student's text does not show insight beyond comprehension of the original material.

Example 7:

> The following text is based on Bastow et al. (2011). Different authors have proposed various starting dates for plate tectonics, ranging from as late as ca. 1 Ga to a much older onset of ca. 4.1 Ga. More recent research finds evidence for a collision between two plates ca. 1.8 Ga, thereby better constraining the more recent end of the range.

Not plagiarism, but a crude way to summarise a source. Although the information is derived from the original source, the words and structures of the text are those of the student, so it is not plagiarism. The first sentence is rather crude, but at least cites the source for the material to follow. Bastow et al. (2011) are not responsible for the other dates, so omitting their sources is inappropriate.

Citing inappropriate sources is particularly a problem when using a textbook as your sole source. Textbooks are typically collections of facts from other sources, and so are not the original sources. Where possible, always cite the primary sources, which are largely from peer-reviewed journal articles.

Example 8:

> The time at which modern plate tectonics were first operating on the Earth contains huge uncertainty. Stern (2005) concluded that plate tectonics began operating as late as ca. 1 Ga, whereas Hopkins et al. (2008), among others, argued for a much older onset (ca. 4.1 Ga). More recently, Bastow et al. (2011) working in northern Hudson Bay, Canada, found evidence for a collision between two plates ca. 1.8 Ga, thereby better constraining the more recent end of the range. Exploration of other cratons in Tanzania (ca. 2 Ga), and Pilbara, Australia, and Kaapvaal, South Africa (ca. 3 Ga), would be logical places to look for evidence of plate tectonic processes in older rocks to better define these dates.

Not plagiarism, and insightful. Although the information in the second and third sentences is derived from the original source, the words and structures of the text are those of the student. The first sentence serves as a topic sentence that places the rest of the paragraph into context. The last sentence demonstrates that the next logical step occurred to the student to further refine the ages of onset of plate tectonics: would slightly older cratons (ca. 2 and 3 Ga) also show evidence for plate tectonics? This example demonstrates a well-constructed paragraph that is coherent, informative, and not plagiarised, but contains the student's own insight and interpretation of the original text, drawing upon his or her own knowledge of geology.

We hope these examples illustrate how to use and how not to use source material in your own writing.

6.3. Summary: when to cite and when to quote

There are only two times when you do not need to cite a source. The first is if the information is common knowledge or information that your friends would know. The second is if the information originates with you. All other situations require citations of where you received that information.

If you wish to provide source material verbatim (i.e. exactly as it appears in the source), then you need to appropriately acknowledge the source material by quotation marks or, for a longer piece of text, indentation, italicised text or other means of identifying that the material comes directly from the source. Then, follow the direct quote with a citation, as in example 3 above. In practice, however, quotations are frowned upon in science writing. Most papers that you write for science classes should not be using direct quotations. Scientific writing uses citations rather than quotations. Only use quotations from the original source that are particularly eloquent, poignant, precisely worded, or of historical importance.

6.4. Tips for avoiding plagiarism

Understand what you read
If you fully and completely understand what you read, then summarising your knowledge in your own words (not those of the original authors) is much easier.

When taking notes (either by hand or electronically), clearly distinguish your own words and interpretation from direct quotations that you copy
If you cut-and-paste pieces of text into your notes, then place quotation marks around the text, and identify the source and the page number of the quotation in your notes. That way, source material from elsewhere will not end up verbatim in your own essay.

Don't wait until the last minute to write your paper
Reading the scientific literature takes time. Understanding what you read often requires reflection and further reading. Planning your paper takes time and clear thought. Writing and editing certainly require a lot of time. Budget your time accordingly, and start early. Writing a high-quality paper almost always takes more time than you think it will.

Cite as you write
Don't wait until after the paper is written to go back and insert citations.

Remember that the internet is another source of information
The internet should be treated like any book, journal article or technical report (or worse, if the material is a secondary or tertiary source). Taking material from a website and putting it in your paper without citation or direct quotation as in examples 1, 2, and 5 above is also plagiarism.

7. Onward: how to write a first-class essay

Having followed the guidance up to this point on finding, reading, and understanding your source material, the time has come to start writing. Writing serves two purposes: to help the author to think, and to present the author's ideas to others. Many writers find that the process of writing opens up new ways to thinking about their material, producing new insights and synthesising the previous literature with their own contributions. In this way, writing is part of the thinking process. However, don't try to do both at the same time. Your notes for the purpose of helping you to think are for your eyes only, and there is no need to ensure that they are grammatically correct or coherent. Your notes for the purpose of presenting your ideas to others will help you structure your writing. Both sets of notes have different purposes.

Once you sit down and start writing for your audience (usually your instructor and the markers), think of your essay like telling a story. Use the flow of a story to reveal the information that you want to convey to the readers. Scientific readers generally like a good mystery story. For many of us, discovering something new about the way nature works is why we got into science. By conveying your information in the form of a story, starting with the literature and then expanding beyond that, you tap into what drives us as scientists. And, if you make such a deep emotional connection with your audience, you will have their sympathies when they mark your work.

At this stage, you will have done most of the reading, you will have focused the topic of the essay, and you will have defined the purpose of the essay (the five steps in section 5). Now is time to begin to structure the content of your essay. We will provide a brief overview below, but there are many sources available for a more detailed look at how to write an essay or scientific report. We recommend *How to do your Essays, Exams & Coursework in Geography and Related Disciplines* (Knight & Parsons 2003), *Eloquent Science: A Practical Guide to Becoming a Better Writer, Speaker, and Atmospheric Scientist* (Schultz 2009), Science *Research Writing for Non-Native Speakers of English* (Glasman-Deal 2009), and *The Ultimate Study Skills Handbook* (Moore et al. 2010).

Step 1: Brainstorm the evidence to support your purpose statement

Given the purpose statement, brainstorm or build a mind map of the information that will go to support this statement. Such brainstorming can be a very personal process, so we are reluctant to suggest a single method. Nevertheless, you might try 30–90 minutes of quiet time in the library or your room to just sit and think about your topic and what you want to say about it, specifically as it relates to the purpose statement. Avoid referring to source material, it will only tempt you to waste time and not do any independent thinking. Your notes need no order, just a wide-ranging, stream-of-consciousness, whatever-pops-into-your-mind-on-the-topic braindump. You may even wish to have a brainstorming session like this before defining the purpose, too, to help you determine your problem statement.

Step 2: Organise your notes

Sort, focus, arrange, and organise your brainstorming notes in a logical order. Identify key groupings and relevant ideas. Reject irrelevant material that does not pertain to the purpose statement, even if you think it is interesting. Were you to include irrelevant material in your essay, you will only distract the reader, showing that you cannot write coherently on a focused topic.

Be strict with yourself on this point. If you have great anecdotes to fill your essay, but those do not pertain to your topic, eliminate them. Remain focused.

Step 3: Outline your paper

Build an outline as sparse or as detailed as you like. The outline should start from basics: introduction, body of the text, and conclusion. If you plan a more detailed outline, develop it into a progressively more developed outline with more levels before getting to the completed paper. If you plan a sparse outline, then roll up your sleeves and write within a broader context. Beware that a sparse outline will require lots of editing before getting to the completed paper.

Step 4: Produce the first draft

The writing and editing steps are separated in time. At this stage, it's more important to get text written down on paper or on the computer. Don't feel compelled to edit for grammar or punctuation too much at this point. Fix typos and grammar later.

Step 5: Edit the first draft in multiple passes

Editing is an essential part of writing that most people ignore. They finish their first draft and think they are done. Do not submit a first draft for marking! Always edit your work before submission. Use your friends to tell you if the draft makes sense.

Editing is time consuming, as time consuming as the writing phase in some cases. You need to look outside of yourself to be a successful editor. Let the manuscript sit for a day or two. Then, make multiple passes through the manuscript, focused on only one aspect at a time. If you feel you need some structure to your editing, here is one five-step approach that may be helpful to you.

Make sure the essay is organised on the sentence and paragraph level. Does each transition logically flow from one to another? Rearrange for better flow. Use marginal notes to ensure that themes raised in your text have flow.

Ensure that the text is relevant to the purpose statement. If not, delete it (or retain it in a file called outtakes.doc).

Make the text as concise as possible. Look for sentences that repeat content in slightly different words, either in different parts of the text or right next to one another. Delete unnecessary words and phrases. Google "Words and Phrases to Avoid" and see examples of text that can be made more concise, as well as Tables 10.1 and 10.2 in Schultz (2009).

Make sure that each word you used has the proper meaning. Sometimes we use words that may sound right, but may be not be the exact word with the most precise meaning. Is each word the best one? Does it mean what you think it means? Look it up! Make sure that you use consistent scientific terminology throughout, which will help the reader follow your argument more easily. Don't feel that you have to think up new synonyms for scientific terminology.

In the final pass through, mind the little things: spelling, grammar, and punctuation. Check for spelling mistakes (the red underlined words in Microsoft Word are potentially misspelled words), and check for grammatical mistakes (the green underlined phrases are potential grammatical errors). Finally, check your essay against the instructions before submission. Have you used correct formatting? Does the essay meet the length requirements? How should the essay be submitted?

Throughout the writing and editing process, recognise your own writing weaknesses. Keep a list of your weaknesses handy when writing and editing. Refer to them before completing assignments.

Step 6: Edit the second draft

Don't be content with just a few passes through the manuscript. Let the draft sit for a while. Then, pick it up again and start editing yet again. Use your peers. Trade drafts with them. Get feedback. You should desire feedback! Responding to feedback from others will help deliver you a higher mark. Don't be embarrassed by sharing incomplete work among friends if you get feedback that helps you to improve your writing.

Step 7: Edit the third draft

We hope you are seeing the pattern. Editing is as an important step as the writing is. You need time to write and time to edit, especially because you are too close to the material to see its flaws, lack of coherence, and typos. You will probably need tens of drafts, if you are taking editing seriously, before all the problems with the text are worked out.

Step 8: Submit the final draft.

Then, celebrate!

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