 Developing the literature review

This document is a resource to support the Stage 6 Science Extension course[[1]](#footnote-1).

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Preface

Stage 6 science students should develop and demonstrate skills in reasoning and argumentation. The ability to analyse information critically is a crucial component of those skill sets. This document provides teachers with guidelines on the essential elements of searching for and analysing information in the scientific, academic literature. The literature review is developed after analysing the information in the literature. The review not only summarises relevant information in the scientific literature but also defines the purpose of the research proposal. It is an essential aspect of the scientific process. The skills required to develop a literature review will develop students’ skills in other areas, such as metacognition, reasoning and argumentation.

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Executive Summary

Conducting literature reviews is a fundamental skill in science. Scholarly scientific communication occurs primarily through platforms such as journal articles and conference proceedings, which are generally peer-reviewed. Before proposing a research project, researchers undertake a review of the literature to determine contemporary knowledge of the research area, as well as cutting-edge ideas and developments that define current thought. While the literature review is the most common approach for summarising critical ideas in a discipline area, the annotated bibliography is also occasionally used.

Literature reviews are produced for specific purposes. Researchers in rapidly expanding scientific fields resort to producing literature reviews to consolidate essential ideas and developments in those areas. Such reviews also identify knowledge gaps in scientific disciplines. Invariably, the literature review forms the basis of new research inquiries.

Science students in high schools should conduct the literature review after developing an initial research question.

The literature review should

* Summarise essential ideas in the literature
* Identify gaps or contradictions in knowledge and understanding
* Develop the research hypothesis
* Justify the research itself

Students should employ a variety of strategies to search the literature, including

* The use of keywords and search strings (Boolean operators)
* Using question matrices
* Controlled vocabularies

In all cases, students should summarise and paraphrase information in the literature.

After collecting the relevant scientific articles for the literature review, students must organise the information in a logical order that highlight the development of key ideas. The information (for example, the research ideas, methodologies, and interpretation of results) must also be critically analysed. Armed with this knowledge, students can then proceed to construct the literature review (using relevant headings, such as introduction, the body of the review, discussion and perspectives). The review will evolve as the students deepen their understanding of the research area.

Annotated bibliographies can be presented in several formats. These serve to provide only summaries of the research papers, rather than critically reviewing them. Annotated bibliographies may be further developed into literature reviews.

Introduction

The literature review is an essential element of scientific research. The scientific literature is vast and is proliferating. It comprises original research articles, reviews, conference proceedings, and other reports. A literature review is a narrative that brings together key ideas from an area of research.

There are two main reasons for reviewing the literature:

* To consolidate information about specific areas of scientific research.
* To develop the foundations for scientific inquiry (research).

Thus, the literature review anchors the proposed research on past developments. In doing so, they provide the significance and justification of the research proposal.

Writing the review is a demanding endeavour and should be undertaken methodically. Literature reviews in science must contain certain elements, including

* the purpose of the review;
* the author(s) analysis of the information in the literature, and
* the author(s) perspectives and conclusions which stem from the analysis.

Besides the literature review, researchers also produce [annotated bibliographies](#annotatedbibliography), which are abbreviated summaries of critical publications in a research field. Sometimes literature reviews are developed from annotated bibliographies.

Research questions and the literature review

Before embarking on the literature review, students must define the research topic. Perusing the literature to identify a research topic is not the same as conducting a literature review (see ‘[developing a literature search strategy](#literaturestrategy)’). Students should define their research topic after consulting their teacher or mentor. As the research question takes shape, students should consider the following issues:

* Is the research topic interesting?
* Why is the research topic worthy of inquiry?
* How will the research benefit the research community and broader community (for example, will it explain some phenomena? Will the research fill a gap in our understanding? Will it provide data to support or refute a hypothesis – for example, help to clarify conflicting information?).

Purpose of the literature review

Scientists produce literature reviews for some specific purpose. These include:

* Summarising critical ideas in the literature about the research topic.
* Indicating the purpose of the scientific inquiry.
* Indicating the novelty of the scientific inquiry.
* Identifying contradictions and gaps in the knowledge base.

After reading the review, the reader should be able to identify:

* the significant achievements in the reviewed field,
* the main areas of debate/contention, and
* the key research questions.

Types of literature reviews

Typically, there are two types of literature reviews in science. These are:

* Narrative review–qualitative reviews that provide a summary of relevant ideas in a topic area.
* Systematic review—provides evidence for the development of scientific hypotheses. It includes a discussion of specific data and methodologies.

In Science Extension, students will generally prepare systematic reviews of the literature. They will use their literature reviews to inform the reader about the key ideas in the topic area, gaps in understanding or conflicting theories, and how that information leads to the development of their research question and hypothesis.

Audience

When writing the literature review, students should assume that the reader is scientifically literate, but is not familiar with the research topic. The reader understands the scientific process but may not know the details of the concepts that form the usual paradigm of the research topic. Therefore, the author’s (student’s) role is to provide relevant information from the literature, including a [critical analysis](#criticalanalysis) of that information so that the reader can contextualise the proposed research.

Scholarly journals

For the literature review, students should restrict themselves to scholarly, academic journals. The information contained in such sources are generally peer-reviewed and accepted by the scientific community. While it may be challenging to identify scholarly journals, the [following characteristics of scholarly articles](https://www.lib.sfu.ca/help/research-assistance/format-type/scholarly-journals) may be useful.

Scholarly articles

* are written by and for faculty, researchers or scholars (scientists and researchers)
* Use scholarly and scientific language
* tend to be long and detailed, about research in academic disciplines
* Include full citations for sources
* Are often refereed or peer-reviewed
* Include information about the authors
* Are published by academic organisations

Note: book reviews and editorials are not considered scholarly articles, even when found in scholarly journals

Developing a literature search strategy

Students should receive explicit instruction on developing strategies for literature searches from their teachers. It will allow them to become proficient in constructing literature reviews. Improperly constructed literature reviews will either be too narrow or too broad for the inquiry. Students generally perform a literature review

* To identify a suitable topic of inquiry, or
* To develop a strong literature base to support the inquiry after deciding on the research topic.

Conducting a literature review to identify a research topic is a difficult undertaking, as it requires a comprehensive analysis of the relevant ideas in the literature. To do this, students must analyse the strengths, weaknesses, and gaps in the paradigms of the research area. In their initial stages, it may be preferable for students to identify research topics by consulting their teachers, mentors or other individuals who have experience in research-related matters.

Students should conduct the literature review after they have developed an initial research question. They will refine their research question as they acquire and analyse information in the literature. The initial research question serves as a starting point for students’ exploration of the scientific knowledge base. As their literature search progresses, students may refine their research question numerous times. As a result, the final research question becomes a powerful inquiry tool for further investigation.

Search strategy using keywords

The following literature search strategy assumes that the student has identified a research topic and developed an initial research question or hypothesis. Consider the following example of a student research project:

* General inquiry question: what is the effect of alternative therapies on controlling hypertension?
* Research inquiry question: does meditation help control hypertension by lowering high blood pressure?
	+ Independent variable: blood pressure
	+ Dependent variable: meditation practice.

The general inquiry question is broad and reflects an area for investigation. However, in that current form, the inquiry question is not suitable for scientific investigation. The research inquiry question, which is derived from the general inquiry question, is more focussed. In the research inquiry question, the independent and dependent variables are evident. Both the independent and dependent variables provide starting points for searching the literature. These variables and related terms can be used as keywords to interrogate databases for published papers on the topic.

However, merely using keywords to interrogate databases will return large numbers of ‘hits’ and make it difficult to find relevant papers for the review. Using Boolean operators and complex queries can provide more focused results (see ‘[conducting the literature search](#conductingliteraturesearch)’).

Students who face difficulty generating keywords for their literature search may find the following online tool useful: [keyword generator](https://webapps.library.uow.edu.au/keywords/).

Search strategy using inquiry questions

Another option is to develop (brainstorm) a series of questions around the keywords, as shown in the following table. This approach is derived from the [Question Matrix method developed by Chuck Wiederhold](http://www.knowledgecompass.org/uploads/2/8/4/2/28422343/the_question_matrix.pdf).

| Question Stem | Question | Relevant? |
| --- | --- | --- |
| Who | Who conducted studies into the causes and treatment of hypertension? | ✓ |
| Who | Who else is working in this same area of research? |  |
| Who | Who else is exploring the relationship between alternative therapies and lowering high blood pressure? | ✓ |
| What | What is the relationship between stress and blood pressure? | ✓ |
| What | What is normal blood pressure? | ✓ |
| What | What are the current treatments for high blood pressure? |  |
| What | What causes blood pressure to rise? | ✓ |
| What | What is the relationship between meditation and stress? | ✓ |
| What | What is the effect of prolonged hypertension? | ✓ |
| What | What are the side effects of blood pressure lowering drugs? | ✓ |
| Why | Why does hypertension damage health? |  |
| Why | Why is there no cure for hypertension? | ✓ |
| Why | Why does stress affect blood pressure? |  |
| When | When does blood pressure rise? |  |
| When | When is blood pressure considered to be high? | ✓ |
| When | When is the best time to meditate? |  |
| Where | Where can we obtain information about national health trends concerning blood pressure in Australia? | ✓ |
| Where | Where in the world is high blood pressure a problem? |  |
| Which | In which countries are blood pressures the lowest? |  |
| Which | Which lifestyle factors contribute to high blood pressure? | ✓ |
| Which | Which meditation procedures are the most effective at reducing stress? | ✓ |
| How | How do different medications lower blood pressure? | ✓ |
| How | How is meditation practised? | ✓ |
| How | How does stress raise blood pressure? | ✓ |
| How | How do I know if I have high blood pressure? |  |
| How | For how long is meditation carried out? |  |

Once the student has generated this list of questions (the middle column in the table), the next step is to identify those questions that are relevant for the current research project (right column in the table). Students can now explore the literature to seek answers to specific questions. These questions also form different themes (thematic clusters) for grouping their articles for the literature review (see ‘[developing the literature review](#developingtheliterturereview)’). Students need to be flexible in their approach when searching for relevant articles — they may come across articles in topic areas they had not considered before. Though this occurs often, students need to be judicious about exploring those articles for their literature review.

Searching the scholarly literature

In the Science Extension course, literature reviews should be based on scholarly publications. The scholarly literature refers to peer-reviewed publications or scholarly works produced by authors from academia or professional organisations. The peer-review process is essential for maintaining the integrity and rigour of the information in scientific journals. All scientific articles, including literature reviews, are subject to peer-review. Thus, researchers can be confident that published scientific papers meet the standards of the scientific community. This [video](https://www.youtube.com/watch?v=rOCQZ7QnoN0) explains the peer review process. This [video](https://www.youtube.com/watch?v=rLmx-G5YINQ&feature=youtu.be) provides tips for selecting scholarly articles.

Conducting the literature search

After developing the literature search strategy, students should embark on collecting relevant literature. Most scientific articles are published in peer-reviewed academic journals. They are available online although they may only be available by subscription.

There are several ways to source academic articles.

* Online searches: [Google Scholar](https://scholar.google.com.au/) allows easy access to academic articles (and sometimes, their pdfs). Students can save the articles for later if they have a Google account. It also provides the citations of selected articles in common referencing styles.
* Libraries: Students can access the [catalogue](https://primo-slnsw.hosted.exlibrisgroup.com/primo-explore/search?vid=SLNSW&tab=default_tab&sortby=rank&_ga=2.127103432.471121113.1527637252-778186176.1493730173) of the State Library of New South Wales with a State Library card or by [registering their card](https://www.sl.nsw.gov.au/eresources-register) from a NSW public library (operated by your local council). The State Library subscribes to a wide range of academic journals that members of the Library may access. Teachers and students should also consult the teacher librarians at their schools, who may provide more information about accessing academic databases for the literature search. The [National Library of Australia](https://www.nla.gov.au/app/eresources/) is another source of databases with access to published scientific articles.





These figures show screen captures about accessing academic databases through the State Library of NSW. In this example, after logging in to the library e-resource portal using their library card number (upper figure), students can access published articles via the EBSCO database (lower figure).

* Consulting academics: It may be possible for teachers or students to contact researchers directly (for example, email) to request for published articles. Those researchers may able to suggest other relevant articles for students to read.

Students will perform online literature searches using various search engines. The following suggestions may be useful approaches for finding published articles.

* In the first instance, students should explore the internet with keywords relevant to the research topic. They should use a variety of databases (for example, Google Scholar, ISI Proceedings, JSTOR Search, Medline, Scopus, Web of Science), as different databases may identify different publications for the same search query. Students may access many of these databases through the State Library of NSW or the National Library of Australia.
* As they progress through their literature research, students should use progressively complex search strings. For example, rather than merely searching for information on ‘hypertension’, searches such as ‘hypertension and treatments’ may provide more specific information. Boolean operators such as ‘and’, ‘or’, ‘not’ and quotation marks (“ ”) will increase the specificity of search results. When using the Google search engine, the ‘[advanced search](https://www.google.com/advanced_search)’ feature allows users to construct complex queries.
* Some databases (for example, Pubmed) use controlled vocabulary to identify research articles. For example, the medical research literature is archived under MeSH (Medical Subject Headings) terms (Baumann, 2016). This system allows researchers to identify key terms that, when combined, increases the specificity of searches:
	+ Search 1: Cancer
	+ Search 2: Clinical trials
	+ Search 3: Gene therapy
	+ Search 4: search 1 + search 2 + search 3

The final search will return a list of all articles that contain information on gene therapy trials to treat cancer.

* Students should check that the articles they are reviewing are recent (generally, published in the past ten years\*, although older articles may still be relevant). To do this, try the following:
	+ Open Google Scholar.
	+ Enter the title of an article.
	+ When the results appear, refer to the entry that is the same as the query (for example–the same article).
	+ Look at the ‘cited by’ entry–this shows if there are more recent articles on the same topic (note: a large number here suggests that the search article is important as many other authors have cited it).



This screenshot shows the output of a query on Google Scholar. This specific article has been cited in 411 other publications, suggesting that there may be newer articles on the same topic. It also suggests that it is a significant paper since many other researchers have cited it.

\* The chronological age of the published articles is not as crucial as the currency of the ideas and concepts. In science, researchers will refer to essential ideas, even if those ideas are ‘old’.

* A reference manager (for example Endnote, Mendeley or Zotero) is recommended to keep track of the articles of interest. Those programs also save the PDFs of the published articles if they are available. Reference manager software also allows students to annotate the articles for writing the literature review.
* Students should refer to different types of articles:
	+ Research articles–these contain primary research information, including research data.
	+ Review articles–these are good starting points for the literature search, as they contain summaries of other published research papers.
* When reading the articles, students should note the following features of the papers (they will be useful when synthesising the review, and for critically analysing the articles):
	+ What was the research question?
	+ What were the assumptions made by the researchers?
	+ What were the methodologies used?
	+ What were the hypotheses tested?
	+ What were the conclusions of the study?
	+ Were the research questions answered?
	+ Do the findings support or refute others’ conclusions?
	+ What were the limitations of the methodologies or conclusions?
	+ How does the research demonstrate an evolution of ideas and paradigms?
	+ Are the articles (you are reading) referred to by other authors?

Paraphrasing and Summarising

Summarising and paraphrasing information in the literature are two essential skills for preparing the literature review. They indicate different ways of presenting information to readers.

In paraphrasing, statements from various sources are re-phrased in the author’s own words. When paraphrasing, other researchers’ ideas are referenced, but not quoted. Therefore, students should not use quotation marks when paraphrasing information in published articles. To ensure proper paraphrasing, students should avoid using phrases from the original text, and avoid replicating the sentence and paragraph structures of the original article. The following example from [Davidson Biology](http://www.bio.davidson.edu/dept/plagiarism.html) illustrates paraphrased texts of varying quality.

| Criteria | Text | Comment |
| --- | --- | --- |
| Original text | Few laboratory creatures have had such a spectacularly successful and productive history as Drosophila. It first entered laboratories about 1900, revealed its talent for experimental genetics to Thomas Hunt Morgan and his students at Columbia University in the early 1910s, and after some ups and downs in status is still going strong almost a century later.(from Kohler, R.E. 1994. The Lords of the Fly. The University of Chicago Press, 321 pages.) | No comment. |
| Paraphrase 1 | Despite some ups and downs in status, nearly a century after the fly revealed its talent to Thomas Hunt Morgan and his students. Drosophila genetics research continues its spectacularly successful history (Kohler, 1994). | This is not a good paraphrase, as the author has reproduced phrases from the original text. |
| Paraphrase 2 | No model organism has been so amazingly useful and effective as the fruit fly. The fly came on the scene as an experimental tool at the beginning of the 20th century, was adopted by Thomas Hunt Morgan and his Columbia pupils at Columbia University around 1910, and (despite some fluctuations in attention paid to it) is still a widely used experimental system (Kohler 1994). | This is not a good paraphrase. The sentences in this paraphrase are structurally similar to those in the original text. |
| Paraphrase 3 | Drosophila is a model organism with a rich and useful legacy. Upon arriving on the scene at the turn of the century, the fruit fly soon became the organism of choice for Thomas Hunt Morgan and his Columbia University pupils. Despite fluctuations in status, fly research is still central to the progress of genetics (Kohler, 1994). | This is not a good paraphrase. The sequencing of ideas in this paraphrase is similar to those in the original text. |
| Paraphrase 4 | Thomas Hunt Morgan and colleagues at Columbia University were among the first to use the fruit fly Drosophila as a model organism, adopting it as an experimental system around 1910. Since then, the popularity of the fly has waxed and waned somewhat, but the breadth and depth of current research indicate that Drosophila continues its legacy as an incredibly important research tool (Kohler, 1994). | This paraphrase is acceptable as it expresses the ideas in the original text in the author’s perspective. |

An online tool, the [paraphrase self-test](http://handymandanonline.com/Paraphrasing-tool.html), can demonstrate the similarity between original and paraphrased text to students. It is important to note that the algorithm of this tool indicates the similarity between the two texts, but not the quality of the paraphrasing.

When summarising information in articles, the author attempts to condense essential information to present it succinctly. Only the essential information is kept, and all extraneous information is left out. As with paraphrasing, students must express information in their own words. The following example from [Monash University](https://www.monash.edu/rlo/research-writing-assignments/writing/paraphrasing-summarising-and-quoting#summarising) shows an example of effective summarising:

Original text

With respect to daily intakes of specific micronutrients, 40% of adolescent girls and 8% of adolescent boys were at risk for inadequate intakes of iron. While protein intakes were adequate in these subpopulations, the top two sources of iron were from plant-based, iron fortified sources (breakfast cereals and breads and bread rolls). With regard to higher iron bioavailability and density, animal-based protein sources may be another strategy to address iron intake, particularly among females, as it has been previously shown to be a less popular food choice among Australian children and adolescents and avoided by young female adults (Fayet-Moore et al., 2017).

Summary

Fayet-Moore et al. (2017) found that 40% of adolescent girls, compared to 8% of boys, are likely to have an inadequate amount of iron in their diets, in spite of a sufficient protein intake. They attribute this to a tendency to avoid foods derived from animals.

Paraphrased and summarised texts must be accompanied by in-text citations so that the sources are correctly attributed. The following steps may be useful for paraphrasing and summarising published texts:

* Read the original article so that the context of the information is clearly understood.
* Identify the key points, including any relevant data.
* Without referring to the original paper, paraphrase and summarise those key points.
* Redraft the summary and align the paraphrased and summarised text with the literature review (or annotated bibliography).

It is acceptable to reproduce properly attributed technical phrases when describing certain types of information (for example, the procedures, reagents or equipment used in investigations).

The U.S. Office of Research Integrity has produced a list of [guidelines to avoid plagiarism](https://ori.hhs.gov/plagiarism-0).

Developing the literature review

Once the literature search is complete or is well underway, students can proceed to the next stage of their literature review. Here, students will construct the structure or layout of their review. To do this, students may use the following strategies:

* Use mind mapping or other visualisation tools to organise the key ideas from the literature search (see figure below).
* Create groups or thematic clusters of articles based on some reasonable criteria. For example:
	+ Articles that contain similar vs. different ideas - for example, there are two competing ideas about coral atoll formation: debris-topped mountain and Island subsidence. When organising articles from the literature on this topic, students may classify them as those that support the first or the second hypothesis.
	+ Articles that describe different trends or aspects of the research topic - for example, when conducting a literature review on treatments for hypertension, students may group articles according to the different treatments: pharmaceutical treatments versus lifestyle changes versus alternative medicines.
	+ Student-generated categories. If there are no obvious categories for grouping the articles, students should generate suitable headings. For example, for a literature review on microplastics pollution, students may group articles under the following headings:
		- Types of plastics
		- Breakdown of plastics and scale of microplastics pollution
		- Ingestion of microplastics by marine animals
		- Damage to animals caused by microplastics
		- Recent developments that address the problem of microplastics pollution
		- Gaps in the understanding of microplastics pollution.



This figure shows an example of organising literature using different themes. The author has identified four themes (leftmost column) for the review and has compared the articles around those core ideas (Mewburn, 2013).

Critical analysis

Literature reviews should describe not only the information in the literature but also the analysis and evaluation of that information. Critical thinking incorporates analysis (the relationship between the individual components of a complex idea), evaluation (evidence-based reasoning) and creation (combining particular ideas to create a new concept). Readers need to understand the author’s (student’s) interpretation of the facts, as that interpretation will form the rationale (scientific basis) of the inquiry. All good reviews contain independent analyses by the author. In a nutshell, critical analyses investigate the strengths and weaknesses of the reviewed articles. For example, students may critically evaluate a study’s research approach, methodology, experimental design, as well as the analysis and interpretation of results. Critical analyses allow evidence-based conclusions to be formed about a research topic area so that those conclusions can be used to develop the research question and hypothesis. Thus, the information presented in the literature review should contain a common thread that not only links the key ideas but also direct the reader to the research question.

The University of New South Wales [website](https://student.unsw.edu.au/critical-thinking) on critical thinking provides an example of a student essay that illustrates the elements of critical thinking. The [Appendix](#appendix) to this document provides further examples of literature reviews that critically analyse information.

Students must evaluate the reliability and validity of the information used for a literature review. One useful model for evaluation is the CRAAP (Currency, Purpose, Authority, Accuracy, Purpose) test (shown in the table below).

| Acronym | Term | Meaning |
| --- | --- | --- |
| C | Currency | How recent is the information? |
| R | Purpose | Is the information related to the research topic? |
| A | Authority | Who published the information? |
| A | Accuracy | Is the information accurate and reliable? |
| P | Purpose | What is the intention of the information? |

This table shows the criteria used to evaluate information in the literature. Such an evaluation contributes to the critical analysis of the literature. This table is adapted from [The CRAAP Test: Critically evaluating information sources](https://www.library.qut.edu.au/transcripts/craaptest.jsp).

Writing the literature review

The final stage of the literature review process is its construction. Although students can start the writing process at any stage during the literature research, they should be advised to put it off until all relevant resources have been assembled and analysed.

Before commencing on the writing, students should have installed a reference manager software (for example, Mendeley, Zotero or Endnote) on their computer. All articles for the review should be stored in the reference manager software (including pdf files). The reference manager software should be integrated into the word processor software that the student is using. For example, Mendeley, Zotero and Endnote contain Word add-ins, which appear in the ‘References’ tab of Word.

If the literature review is a stand-alone piece of work (for example, an assessment task), then the student may start by creating the structural outline of their review. As a starting point, they may consider the following headings:

* Abstract
* Introduction
* Body
* Discussion/Conclusion
* References

They may then add content to each of the sections. Under the body section, students should add sub-sections comprising the headings they developed earlier.

* Abstract\*
	+ Write this last
	+ A summary of the main ideas in the review
* Introduction
	+ Introduce the research topic.
	+ Provide an outline of the content of the review.
	+ Show why the research topic is important.
* Body
	+ Form sub-sections (use the headings developed earlier).
	+ Organise the sub-sections logically.
	+ Write succinctly, using concise sentences.
	+ Use the past tense and passive voice.
	+ Include critical analyses of the reviewed literature.
* Discussion/Conclusion
	+ State evidence-based conclusions (for example, based on the articles mentioned in the review).
	+ Highlight the need for further research to clarify inferences or to fill in the gaps in understanding\*\*.
* References
	+ Cite while writing (in-text citations).
	+ Prepare the reference list in the appropriate format.

\* The abstract is not required if the literature review is part of the research report.

\*\*For literature reviews that are part of the research report, link the content of the review to the proposed research.

Revising and editing the literature review

The literature review must be developed over time, during which the original product matures into the final product. Students must allow for sufficient time to proofread their draft before completing the literature review.

* Review the work (ask one or more critical friends to read the review to see if it makes sense to them).
* Check that all the citations and references in the review are in the right format.
* Check for plagiarism - paraphrase all ideas obtained from the articles in the literature and ensure correct attribution (in-text citations).
* Use concise sentences.
* Correct all spelling and grammatical errors.

Resources

The [Appendix](#appendix) contains examples of literature reviews. They illustrate that there is not a single, universal format for a literature review. These examples have in common some essential features of literature reviews, such as an introduction to the research topic, reviews and critical analyses of the references, as well as concluding statements that form the basis of subsequent research.

Writing an annotated bibliography

An annotated bibliography is an alternative to a literature review. Annotated bibliographies are abbreviated literature reviews, although these two forms of literature analyses are different from each other. Unlike literature reviews, annotated bibliographies summarise critical publications in an area of study ('How does a literature review differ from an annotated bibliography?' 2018).

Preparing an annotated bibliography follows the same approaches used to prepare literature reviews. However, the structure of the annotated bibliography differs from that of the literature review. The structure of an annotated bibliography should include:

* A formatted reference for the article
* A summary description of the paper
* A critical analysis of the research
* A concluding statement.

This structure is applied to each article in the annotated bibliography. Here are some examples of annotated bibliographies.

Example 1: summarising the research outcomes

The following annotated bibliography does not include research data and methodology, but only summarises the research outcomes.

(Fox, 2018)

Kletou, D., Hall-Spencer, J. M., & Kleitou, P. (2016). A lionfish (Pterois miles) invasion has begun in the Mediterranean Sea. Marine Biodiversity Records 9(46), 1-7

1This article discusses the recent invasion of the lionfish in the Mediterranean Sea and offers reasons for the sudden increase in the species' presence. 2The study concludes that growth of the lionfish population can be controlled by encouraging commercial fishermen and divers to capture the lionfish to be sold on the market. 3While the article provides data and graphs that forecast the decline of the lionfish with a commercial fishing intervention, the methodology is incomplete. 4The researchers do not fully explain how they obtained these results. 5The article does not address external factors that may derail the fishing plan proposed by the authors; for example, the researchers do not consider the population growth rate of the lionfish or how aggressive the fishing rate needs to be to control the population in a timely manner. 6Although the introduction is helpful in providing a framework for why the lionfish invasion is a concerning issue, the discussion lacks depth in addressing other issues that may arise.

Analysis

Sentences 1-2 provide a summary of the paper. Sentences 3-5 represent a critical analysis of the research. Sentence 6 is a concluding statement.

Example 2: summarising the research methodology

This annotated bibliography includes research data and methodology.

('The annotated bibliography,' 2017)

Randler C, Braun M, Lintker S (2010) Foot preferences in wild-living ring-necked parakeets (Psittacula krameri, Psittacidae). Laterality: Asymmetries of Body, Brain and Cognition 16 201-206.

1Many species display handedness (preference to use one side of the body for a specific purpose) at both individual and population levels. 2Randler et al. (2010) investigated this concept in 184 wild ring-necked parakeets (Psittacula krameri) in Germany. 3The researchers used binoculars to count the number of birds using a specific foot to hold their food, finding left-footedness to be more common (102 vs 82). 4A follow-up study at a feeding station also showed a footedness preference (24 birds showed left-footedness, while 11 were right-footed). 5The statistically significant results showed a preponderance of left-footedness within this flock, and that individually the wild parrots demonstrated specific handedness. 6This paper looked at a reasonably sized sample and included repeated observations (taken over two months) allowing observation under different conditions. 7The trait was identified within a specific, geographically located flock; observations of other flocks, and in other locations, would be needed before the results can be generalised. 8Follow up studies with offspring to see if the footedness trait is learned, inherited or inherent would be an interesting contribution to the subject. 9The findings presented are consistent with laterality preferences found in other vertebrates.

Analysis

Sentence 1 is a general introduction to the research topic. Sentences 2-5 summarise research findings. Sentences 6-7 are critical analyses of the research. Sentences 8-9 are concluding statements, with the author’s opinions included.

Example 3: Annotating multiple references in groups

It is possible to combine articles on the same theme or topic into a single annotation group. In the example below, two separate articles on the same topic are annotated together.

Sadd, B.M. and Schmid-Hempel, P. (2006) Insect immunity shows specificity in protection upon secondary pathogen exposure. Curr. Biol. 16, 1206–1210

Dong, Y., Taylor, H.E. and Dimopoulos, G., 2006. AgDscam, a hypervariable immunoglobulin domain-containing receptor of the Anopheles gambiae innate immune system. PLoS biology, 4(7), e229.

Although it is known that immunological memory is an important aspect of vertebrate immune systems, invertebrates were thought to lack immunological memory. The papers by Sadd and Schmid-Hempel (2006) and Dong et al. (2006) provide evidence to the contrary. Sadd and Schmid-Hempel show that bees, previously exposed to bacteria, can survive a lethal dose of the same bacteria later. Dong et al. (2006) demonstrate that mosquitoes also survive subsequent lethal challenge with bacteria if the insects have been pre-exposed to the same bacteria. In both studies, the protective effect is specific to the bacteria that the animals were pre-exposed. While Sadd and Schmid-Hempel do not provide any mechanism to explain their observation, Dong et al. show that an immunological protein called Dscam mediates protection against infection. Both these papers provide new evidence that invertebrates are capable of immunological memory, thus overturning a decades-old idea that that trait is specific to the vertebrates.

Teaching resources

[Video: Conducting a systematic literature review](https://www.youtube.com/watch?v=WUErib-fXV0) (an animated video that summarises the literature review process)

[Video: What is a literature review?](https://www.youtube.com/watch?v=Ry_54WleO7Y) (an animated video on how to approach a literature review)

[Systematic quantitative literature review](https://www.youtube.com/watch?v=0bmn92XoBX0) (this is a series of 4 videos from Griffiths University)

[Literature review](https://www.uow.edu.au/student/services/ld/students/resources/UOW142916). Accessed 5 November 2018

[Writing a literature review](https://www.monash.edu/rlo/graduate-research-writing/write-the-thesis/writing-a-literature-review) Accessed 5 November 2018 (an online tutorial on developing literature reviews)

General References

These resources provide general information about conducting and writing a literature review.

Pautasso, M (2013) Ten Simple Rules for Writing a Literature Review. PLoS Comput Biol 9(7): e1003149.

[Writing a literature review](https://www.lib.uoguelph.ca/get-assistance/writing/specific-types-papers/writing-literature-review) (accessed 5 November 2018).

[Writing a literature review](https://www.monash.edu/rlo/graduate-research-writing/write-the-thesis/writing-a-literature-review) (accessed 5 November 2018)

[Writing a literature review](https://www.citewrite.qut.edu.au/write/litreview.jsp) (accessed 5 November 2018)

[In other words](https://uwf.edu/offices/cutla/teaching-tips/spring-2018-teaching-tips/in-other-words----teach-students-the-art-and-craft-of-paraphrasing-to-improve-ethical-authorship-practices.html). (accessed 5 November 2018)

[Avoid plagiarism!](https://www.mesacc.edu/~paoih30491/ArgumentsQuoteSummarizeParaphr.html) (accessed 5 November 2018)

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Baumann, N. (2016). How to use the medical subject headings (MeSH). *International Journal of Clinical Practice*, *70*(2), 171–174.

Creswell, J. W. (2002). *Educational research: Planning, conducting, and evaluating quantitative*. Prentice Hall Upper Saddle River, NJ.

Fox, H., (2018). [LibGuides: EVR 2001: Introduction to Environmental Science: Introduction](https://libguides.uwf.edu/evr2001). Retrieved December 7, 2018,

[How does a literature review differ from an annotated bibliography?](https://www.uow.edu.au/student/learningcoop/assessments/litreview/index.html) (2018). Retrieved December 7, 2018

[Literature reviews\_example from biology](https://www.uow.edu.au/content/groups/public/%40web/%40stsv/%40ld/documents/doc/uow195693.pdf). (2000). Retrieved December 7, 2018

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[The annotated bibliography](https://www.monash.edu/rlo/assignment-samples/science/the-annotated-bibliography). (2017). Retrieved December 7, 2018

Appendix: Examples of literature reviews

The following examples illustrate different features of literature reviews. Teachers may use the structure and outlines of these reviews to guide the layout of students’ literature reviews in the science extension course.

Example 1

In the following example, section headers have been inserted to highlight the different parts of a literature review.

Reference: Exploring the Conceptions and Misconceptions of Teen Smoking in High Schools: A Multiple Case Analysis (Creswell, 2002)

Topic: Tobacco use is a leading cause of cancer in American society (McGinnis & Foefe, 1993).

Research: Although smoking among adults has declined in recent years, it has actually increased for adolescents. The Center for Disease Control and Prevention reported that smoking among high school students had risen from 27.5 percent in 1991 to 34.8 percent in 1995 (USDHHS 1996). Unless this trend is dramatically reversed, an estimated 5 million of our nation’s children will ultimately die a premature death (Center for Disease Control, 1996).

Evidence that justifies the problem: Previous research on adolescent tobacco use has focused on four primary topics. Several studies have examined the question of the initiation of smoking by young the people, noting that tobacco use initiation begins as early as junior high school (for example, Heishman et al., 1997). Other studies have focused on the prevention of smoking and tobacco use in schools. This research has led to numerous school-based prevention programs and intervention (for example, Sussman, Dent, Burton, Stacy, & Flay, 1995). Fewer studies have examined “quit attempts” or cessation of smoking behaviours among adolescents, a distinct contrast to the extensive investigations into adult cessation attempts (Heishman et al., 1997). Of interest as well to researchers studying adolescent tobacco use has been the social context and social influence of smoking (Fearnow, Chassin, & Presson, 1998). For example, adolescent smoking may occur in work-related situations, at home where one or more parents or caretakers smoke, at teen social events or at areas designated as “safe” smoking places near high schools (McVea et al., in press).

Deficiencies in the evidence: Minimal research attention has been directed toward the social context of high schools as a site for examining adolescent tobacco use. During high school, students form peer groups which may contribute to adolescent smoking. Often peers become a strong social influence for behaviour in general and belonging to an athletic team, a music group, or the “grunge” crowd can impact thinking about smoking (McVea et al., in press). Schools are also places where adolescents spend most of their day (Fibkins, 1993) and are available research subjects. Schools provide a setting for teachers and administrators to be role models for abstaining from tobacco use and enforcing policies about tobacco use (O’Hara et al., 1999). Existing studies of adolescent tobacco use are primarily quantitative with a focus on outcomes and transtheoretical models (Pallonen, 1998). Qualitative investigations, however, provide detailed views of students in their own words, complex analyses of multiple perspectives, and specific school contexts of different high schools that shape student experiences with tobacco (Creswell, in press). Moreover, qualitative inquiry offers the opportunity to involve high school students as co-researchers, a data collection procedure that can enhance the validity of student views uncontaminated by adult perspectives.

The audience: By examining these multiple school contexts, using qualitative approaches and involving students as co-researchers, we can better understand the conceptions and misconceptions adolescents hold about tobacco use in high schools. With this understanding, researchers can better isolate variables and develop models about smoking behaviour. Administrators and teachers can plan interventions to prevent or change attitudes toward smoking, and school officials can assist with smoking cessation or intervention programs.

Example 2

Literature review, the University of Wollongong (‘How does a literature review differ from an annotated bibliography?’ 2018)

| Literature review | Comments |
| --- | --- |
| Although studies have shown that diet has an important influence on a mammal's overall biology (for example – McNab 1983), little is known about the feeding ecology of many Australian species. One species, the yellow-bellied glider (Petaurus australis), which weighs up to approximately 700g, is the largest of the arthropod and exudate-feeding marsupial gliders (see Smith & Lee 1984). It has a widespread but patchy distribution in eastern Australia and is characterized by low population densities (Henry & Craig 1984; Kavanagh 1984). Relatively little research has been centred on the feeding behaviour of this species because of difficulty in its detection and capture (Craig & Belcher 1980). | Introduces the subject of the study & identifies the gaps in previous research |
| One study (Wakefield, 1970) concluded that while yellow-bellied gliders obtain sap from the 'V'-shaped incisions they make in the trunks of various species of eucalypt, arthropods comprise the bulk of their diet. This conclusion, however, was based on limited feeding observations and the irregular occurrence of these 'sap-site' trees. | Summarises the conclusions of the earliest relevant study and identifies limitations in method |
| Other studies conducted analyses on faecal samples from north Queensland and Victoria respectively (Smith & Russell 1982; Henry & Craig 1984; Craig 1985) to determine feeding behaviour. These studies found the presence of arthropods, eucalypt sap, nectar and honeydew. However, as insect and plant exudates are almost totally digested and leave little trace in the faeces, other indicators must be used to infer their use (Smith & Russell 1982). Bark, for example, is used as an indicator of eucalypt sap. Faecal analysis, therefore, does not allow a precise determination of the relative importance of each of the separate dietary items. | Groups another set of studies according to the method, summarises findings and identifies limitations |
| Qualitative observations of feeding behaviour in gliders have also been carried out (Henry and Craig 1984; Craig 1985; Kavanagh and Rohan-Jones 1982; Kavanagh 1987a,b). In these studies each observation is scored equal, regardless of duration. Thus these data indicate only the presence or absence of food items in the diet, not their relative use. | Groups another set of studies according to the method, summarises and identifies limitations |
| A study employing the use of timed (for example – quantitative) feeding observations is necessary to give a better resolution of the species' dietary requirements. This study was aimed at achieving this by addressing the following question: are different food resources exploited in different proportions throughout the year? | Identifies gapStates aims of the research – shows how this research will fill the gap. |

Example 3

Self-Directed Learning resource, the University of Wollongong (“Literature reviews\_example from biology,” 2000).



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