ACADEMIC RESOURCES AND AI TOOLS

Handout Sessions 18 and 19

How to plan the time?

When making a literature review, the planning of the time is of key importance. Consider, e.g., a a discipline with 6 ECTS, the total time the students are expected to dedicate to complete is 150 working hours. If the number of hours spent in the classes for that discipline is 50 hours, then the student will have another 100 hours to work alone (studying the theory and doing homework). The time allocation is proportional to the number of ECTS, so for a discipline with 3 ECTS just divide these times by 2.

Ask your professors how you should divide your time between studying theory and doing the reports. Once the time for doing the report has been estimated consider dividing the time like this:

1) Do the literature review and read the downloaded documents. This should take about 1/3 of the total time;

2) If the report involves the processing of data and making of figures (images, graphs, diagrams, etc.), then dedicate about 1/3 of the time doing these tasks;

3) Writing the report should take about 1/3 of the time, or 2/3 if step 2 is not necessary. Leave some time to review and correct the final document.

How to do the literature search?

In the methodology of scientific research, the steps indicated below are typically involved (see Figure 1).

1. Identify research objectives, and define which questions or problems are being addressed.

   The Objective of the work should be stated in a short, clear, sentence. It is where the purpose of the work is identified. Use active voice and specific language rather than vague terms. Use keywords related to the topic of your work. The objective should preferably be only one. There can be sub-objectives, if relevant for the work. Do not confuse objectives with methods. So, do not mention methods in the objective (unless the work is about the development of methods).

   Examples of objective statements:

   "This study aims to establish baseline contamination in marine organisms across five trophic levels for regulatory purposes"

   "The objective is to assess changes in deep-water circulation patterns in the North Atlantic to evaluate implications for global climate system."

2. Literature search, which involves:

   a. Select a set of relevant terms (keywords) to use in searching databases;

   If the objective is well stated, then a good set of fundamental keywords were already identified – see the underlined terms above.

   b. Using the set of keywords, search scientific repositories like the Web of Science, Scopus, or library archives, and using general-purpose search engines like Google, Bing, or more technical ones, such as Google Schoolar.

   To improve the quality of the results of an online search:

   - Use keywords and phrases that closely match what you are looking for;
   - Use quotation marks for specific terms;
   - Enclose specific sentences in quotation marks to narrow results;
   - Utilize search operators, such as AND and OR:

Operator	**Result**
AND “coliform” AND “microplastic”	Includes documents referring to both terms.
OR ““coliform” AND “microplastic”	Includes documents referring to any of the terms.
- “coliform” - “microplastic”	Includes documents referring to the first term, but not the second.

   - Explore synonyms and related terms: e.g., “faecal coliform” instead of “coliform”.
   - Frequently clear the search history in the browser, or use incognito mode (this will overcome the search history bubble effect caused by the search algorithm, which restricts the search domain to pages that are similar to the ones you visited before- see Figure 2).

   c. Eventually, employing AI for advanced searches, summarization, or trend analysis to help identify search lines and related topics.

   Note: AI tools should be used exclusively with the purpose of helping in the development of the study, not replace the author. As such, it is not admissible to transcribe directly the texts produced by such tools, without direct and substantial contribution from the author. AI tools can be used to explore large datasets, and to produce new visualizations. Mentioning outputs produced with AI tools is mandatory.

   There are a few techniques that can improve the quality of the experience with AI tools. Large language models (LLM) work best when provided with:

   Context – i.e., provide a background when writing: e.g., type in “What are the latest findings on microplastic accumulation in commercially important

fish species and their potential impacts on human health through seafood consumption?" This gives more context than just "microplastics" AND "fish" and "human health".

Instruction – i.e., be specific about what you need. For instance, ask for bibliographic information by writing "provide list of key publications about ..."; or ask for an explanation by writing "explain how .... in two paragraphs. Use formal technical language. Use a diagram. "

Content – The former example contains three complementary required elements: length of the response, the tone (formal, casual), and format (paragraph, bullet points, image).

Detailing – Explore more information by including in the input the How, Who, What, Where, When, and Why. For instance, write: "Explain the transport of antibiotic-resistant genes (WHAT) in microplastics (HOW and WHY) in the ocean (WHERE) in three paragraphs. Make a historic summary of evidence (WHEN). Use formal technical language (HOW). Include references (WHO)."

Rewording – Try writing the same question in different words. This may lead to different and richer results.

Combine searches – To do this start by asking specific details about several subjects and then make one single more complex question joining them. This can be used to promote chain of thought when studying complex, less-known matters. For instance, to study the impacts of deep-sea mining in specific organisms, start by asking: "which methods are used in deep sea mining?", then "which chemical elements are released into the water when deep-sea mining and on-site processing polymetallic nodules, seafloor massive sulfides, cobalt-rich ferromanganese crusts? Include references", and then "what measurable biochemical effects have been observed on marine organisms exposed to Cd, Hg, and As under very high pressure?", and so on until you are satisfied with the level of detail.

Note: These techniques can help improve the search, but do not solve the issues of reliability found in these IA tools - see the section "Can I use chatbots?" below.

d. Organize files by systematically storing and categorizing documents and data (if you use a dedicated bibliographic software then this step is not necessary – see below).

Download the ones you find interesting. Save the documents in a dedicated folder (e.g., BIBLIO). Use a standard format for the title of the document when saving. This will avoid duplications and makes easier to find the documents.

For instance, for journal articles:

Surname_of_first_author et al ACRONYM_of_journal Date

"Zheng et al STOTEN 2019.pdf" or "Sruthy & Ramasamy EP 2017.pdf"

For reports of agencies:

ACRONYM_of_agency Date - Title

"OSPAR 2024 - CEMP Guidelines for the monitoring of microliter in seafloor sediments for the OSPAR maritime area.pdf"

For thesis:

Name_of_author Date - Thesis_title

"Manthopoulos 2022 - Presence of microplastic in commercial bivalves along the Portuguese coast - comparing different aquaculture systems.pdf"

For web pages (of internationally recognized agencies only):

ACRONYM_of_agency Date of visit – Title of the web page

"OSPAR 2025 - Action 46: Primary micro plastics.pdf"

3. Use of bibliographic software to organize the bibliography, manage citations and references (e.g., Mendeley, EndNote or Zotero).

   One of the main difficulties found by students when writing the reports is with the correct citation and reference of bibliographic sources. Fortunately, this task can easily be done with the help of specific software to store, organize, do in-text citation, and make the reference list at the end of the report. They are fast to learn and save many hours of fastidious work cross-checking every citation. We will learn how to use them in practice.

4. Read the documents briefly online, or at the library, then do:

   a. Identify the documents that you consider interesting to read and download, or request a copy, to read later;
   b. Read the documents now downloaded.
   c. Identify other keywords that are relevant and iterate back to 2b.
   d. If your time for doing the search has ended, or you cannot find new information, stop the literature search.

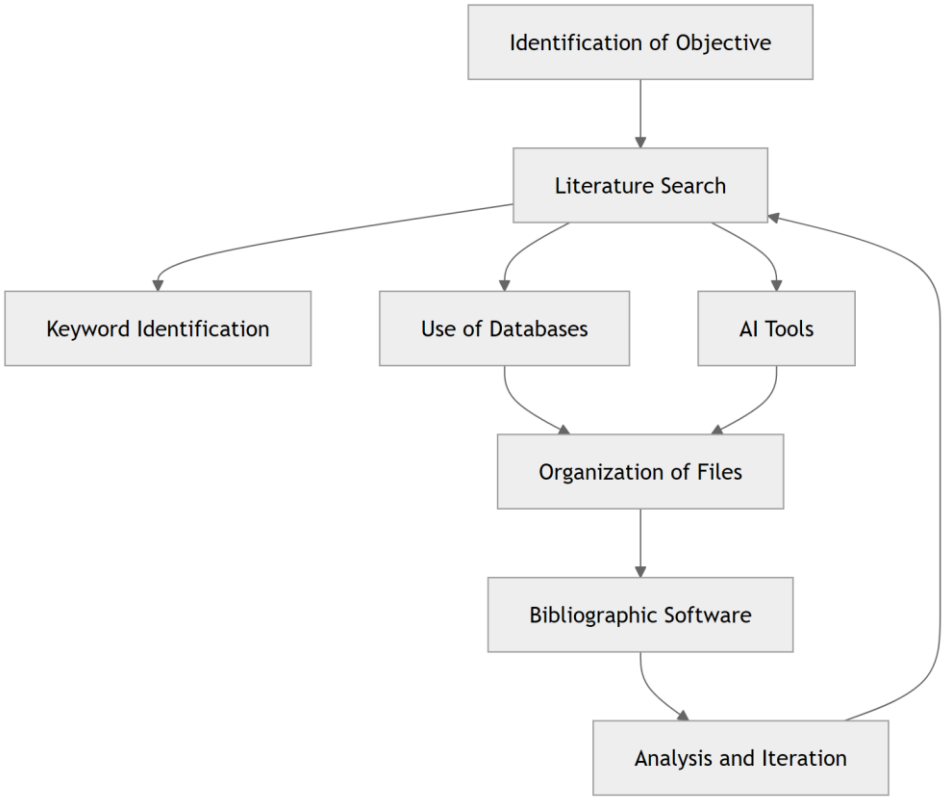

Figure 1.Flow chart for literature search and organization

Figure 2.Search history bubble effect (image produced with Claude.ia (Anthropic, 2024)

We will now discuss each of these steps illustrating them with examples (see Table *1*).

Table 1. The objective, research questions and keywords of a study

Item	Definition	Example
Study objective	The research objectives are specific goals that the researchers aim to achieve through their study. They outline what the researcher intends to accomplish.	"Quantify and map the spatial distribution of microplastics in the water column and sediment in Brazilian mangroves."
Research questions	Research questions are specific queries that the researcher seeks to answer through their investigation. They identify the focus of the study and frame the inquiry. Typically phrased as clear, focused, and researchable, questions.	"What is the concentration of microplastics in the water column, and sediments in Brazilian mangroves"; "How does microplastic abundance vary with water depth, distance from shore, and proximity to human settlements?"; "What seasonal variations exist in microplastic distribution patterns?"
Keywords	Specific terms that capture the essential topics, concepts, or themes addressed in the study. The most obvious are always included in the title of the document (or in the text of the homework).	"Microplastic"; "Mangrove"; "Sediment"; "Water"; "Brazil"; "Distribution"; "Variability"; "Source" (or "Origin"); + "Review".

Which documents can be included in the bibliography?

The purpose of the literature search is to find reliable scientific sources to support our statements. So, they should be reputable, easy to find and validated, and permanent.

For these reasons, web pages and social media are usually not accepted, except for those from national and international institutions, and only if no publication is available with the same information. The same applies to newspapers and non-scientific journals, unless the information there contained is particularly relevant, such as in some sociological studies.

In conclusion, the cited references should contain only:

a) Reports published by reputable institutions;
b) Data published by reputable institutions;
c) Articles published in scientific journals;
d) Web pages of reputable institutions, when the same information is not published as a report.

Note that only the documents cited in the report should be included in the list of references. This means that documents read, but not cited, are not listed. The list of references is included at the end of the report and identified with the heading "REFERENCES" (not numbered), before the appendices, when they exist.

What are search engines?

Literature search can be done by three methods, preferably in conjunction: a) using web search engines; b) searching in physical libraries (e.g., the one at the university); c) using artificial intelligence tools.

Web search engines include general search engines like Google and Bing, and scientific search engines such as Google Schoolar (https://scholar.google.com/), Scopus search (https://www.scopus.com/search/form.uri#basic), and Web of Science (https://www.webofscience.com/wos/woscc/basic-search). The latter two are only available through subscription, so may not be reachable outside the academic environment.

Are chatbots useful?

Nowadays, AI-powered chatbots can support the search using a language closer to natural speech, instead of using only keywords. But always double check the AI results alternative methods and making sure to read the cited publications! – results from chats can be incomplete or plainly wrong! One common issue is the incorrect indication of bibliographic sources. So, always check the references provided by the chatbot – as they are in some cases invented!

For instance, consider we want to validate our observation: "microplastics denser than seawater will accumulate in the sediment, whereas those less dense will remain in the water column". See Table 2 for a comparison of the results of the search using a traditional tool (Google Schoolar) and an AI-powered chatbot (supposedly more scientifically correct, www.perplexity.ai).

In this case, the chatbot provided a partially correct response: It is generally correct and includes some of the uncertainties mentioned in scientific literature. However, it used and referred articles that either do not study the analyzed effect (microplastic density) or are for freshwater. Both are incorrectly included in the response.

In conclusion, the use of chatbots, though apparently fast, demands a posterior time-consuming reconfirmation that must be counterbalanced against the more traditional literature search.

Note that incorrections such as these make the detection of chatbot-produced texts very easy to spot!

Table 2. Comparison of literature search methods: search engines using keywords against chatbot

	Literature search method	
	Search engine	**Chatbot**
Input	"microplastics"; "division "water "; "sediment"	"Microplastics denser than seawater will accumulate in the sediment, whereas those less dense will remain in the water column. Include the references"
Tool response	List of hundreds of documents, supporting partially the sentence, and emphasizing the many factors that may affect microplastic distribution, including the ones mentioned in the last paragraph of the chatbot response.	"Microplastics denser than seawater tend to settle and accumulate in marine sediments, while less dense microplastics remain suspended in the water column. This behavior is influenced by the density and buoyancy of the microplastic particles. Denser materials, such as polyethylene terephthalate (PET), sink and integrate into sediment layers, whereas lighter materials, like polyethylene (PE) and polypropylene (PP), persist in the water column or float on the surface (Kane and Clare, 2019; Woodall et al., 2014).

	Literature search method	
	Search engine	**Chatbot**
		Additionally, biological and physical processes, such as aggregation with organic matter or biofilm formation, can alter the vertical distribution of microplastics. These processes may cause even less dense microplastics to sink over time (Long et al., 2015; Rochman et al., 2025)."
Comment	The reading of the documents is time consuming. Choose the relevant documents by making a first search inside the documents by one or two keywords – in this case "density" would be an appropriate one. For supporting a single statement in a report only one or two references are usually needed.	Woodall et al (2014) does not discuss the impact of microplastic density; Rochman et al. (2025) is a text about microplastics in a freshwater lake, not in seawater...

References:

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