

How to read scientific papers

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PD UofM Spain Program
Wednesday, July 12th, 2023

Driven by
doing.



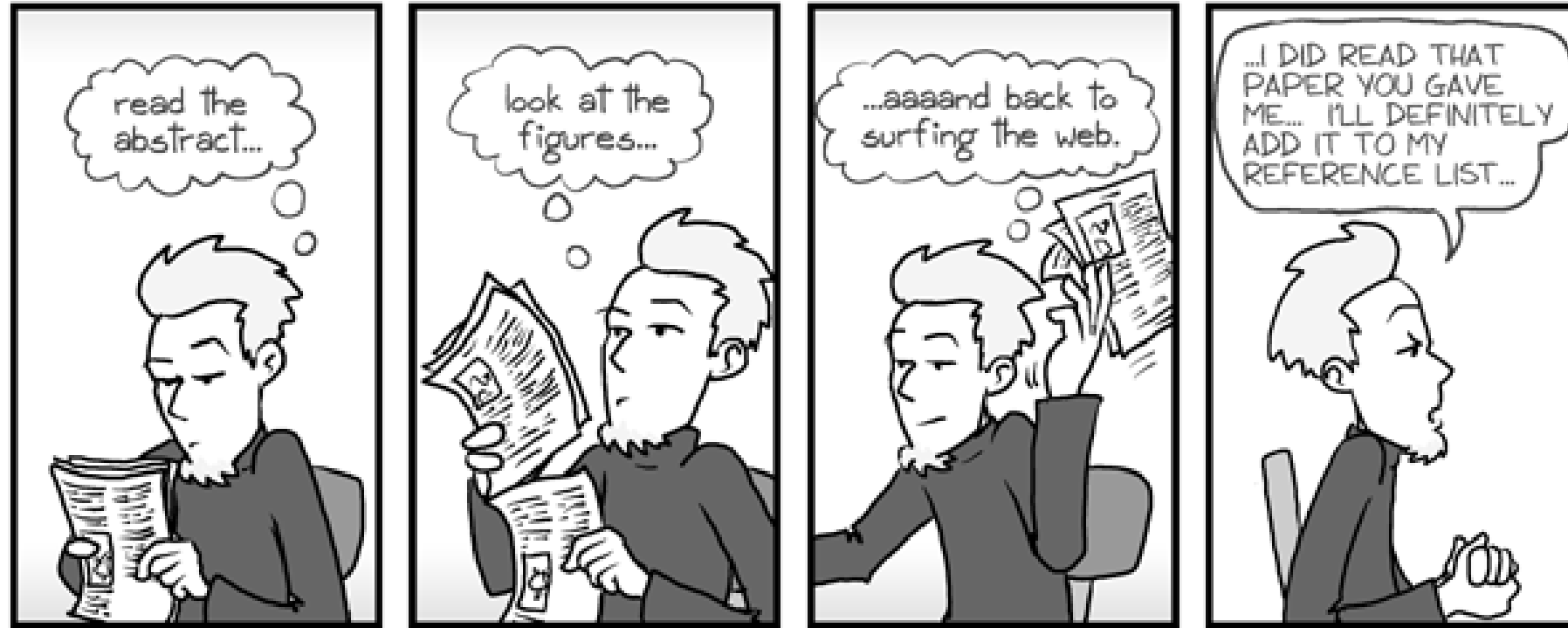
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Objective of the session

At the end of the session, students will be able to

1. Recognize the different sections of a scientific paper
2. Identify the different types of scientific papers
3. Understand the difference between textbooks and journals
4. Understand the structure of a scientific paper and what information it contains

Frustrating things about reading research articles



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The WORST way to go through a research article is to dive right in and read it word for word. This can be a monumental waste of time and it is quite likely that you are not going to find what you're really looking for

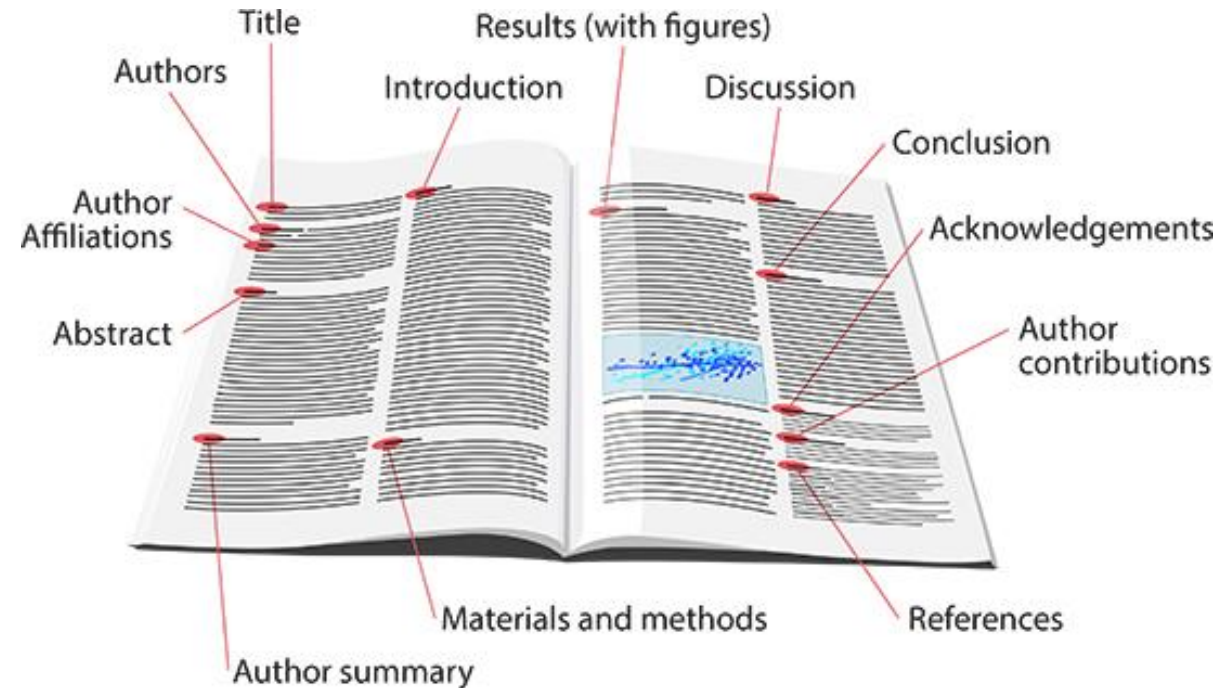
Frustrating things about reading research articles



TIP: Use a highlighter, underline and circle essential words and passages, add comments and questions in the margin. In long term, learn to “dialogue” with the paper that you’re reading. READING SHOULD BE A CONVERSATION!

What are scientific papers?

- ❖ Scientific papers (or articles) are documents presented to **targeted audiences in an area of science**
- ❖ They help the **development of science** by allowing the work of scientists **to be built upon by others in the field**
- ❖ They are used as a **communication method** between scientists and a way to **share their work**
- ❖ Scientific papers are typically published as **journal articles** (peer-review process before publication) and/or **conference proceedings**



Type of scientific paper

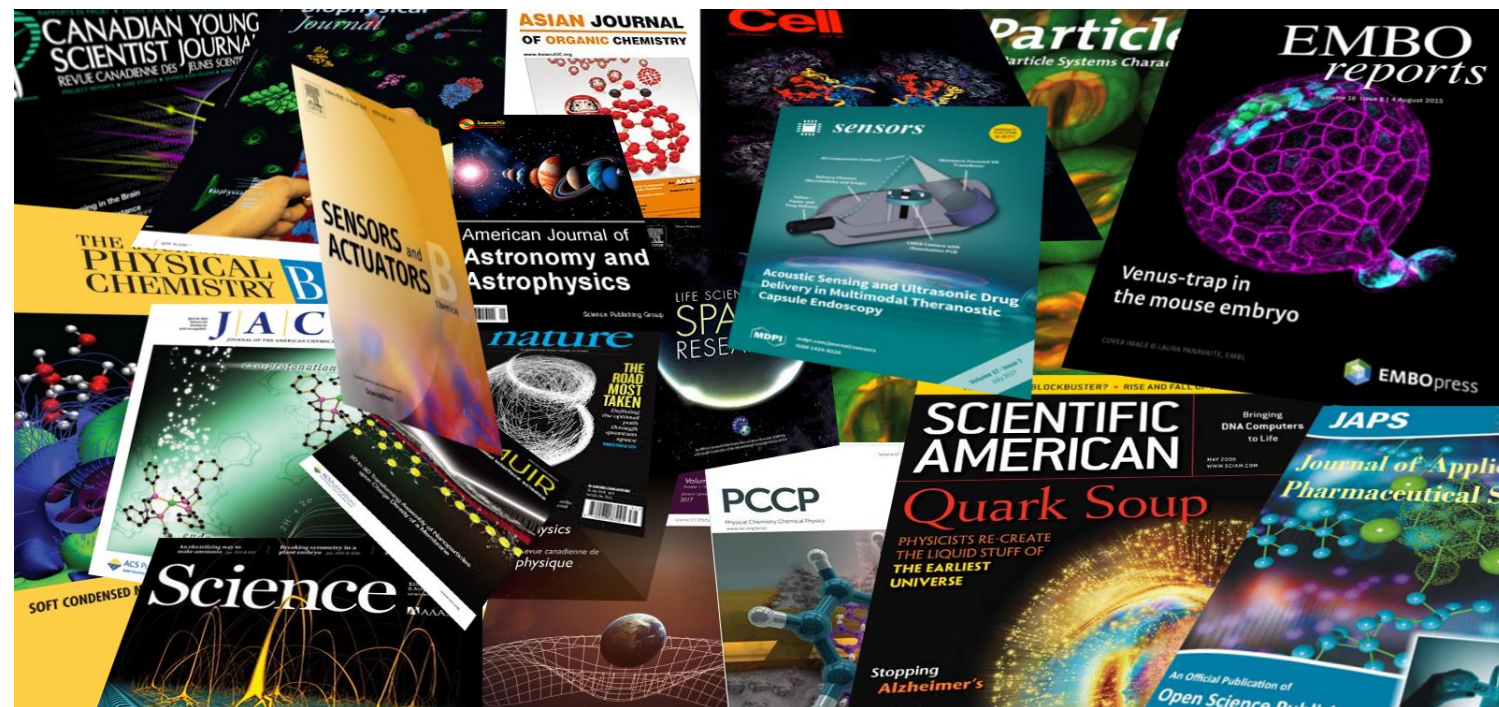
- ❑ **Original (primary) research:** reports on studies carried out by the authors
- ❑ **Review papers:** manuscripts that review and analyze the work of others
- ❑ **Case studies:** report information collected and analyzed from work with individual or groups of real-world cases
- ❑ **Theoretical articles:** make an advance of a theory
- ❑ **Methodological papers:** new or improved methodologies



Why read scientific papers?

It is expected that graduate students read and critically evaluate scientific papers, including original research and systematic reviews.

Commonly, scientific papers are found in peer-reviewed journals



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Papers that have been through a peer-review process. This involves reviewers, who are expert in the field, critiquing the work and providing feedback to the authors, so that any concerns that arise can be addressed before the work is accepted for publication (in theory, at least...)

Example of the peer-reviewed process

-  **Appropriateness for Applied Optics**
Does the subject material fall within the scope of the journal? Will the paper be of interest to the applied optics community?
Rating Options: Very high, High, Moderate, Low, Very low

-  **Quality, Depth, and Completeness of Content**
Does the manuscript provide increased understanding related to the applications of optics, photonics, sensing, or imaging? Is the paper an original and significant contribution to the field? Is the topic covered in depth? Is the topic covered completely, e.g., theory, simulation, experimentation, and analysis? Does the topic provide design guidelines or explain limitations on implementations of theory? Are the conclusions supported by the data presented, and is the work placed in proper context? Is prior or related work adequately referenced? Note that papers considered to be incremental, incomplete, or lacking in scientific or technical relevance are likely to be rejected. Does the work warrant publication in an archival journal?
Rating Options: Very high, High, Moderate, Low, Very low

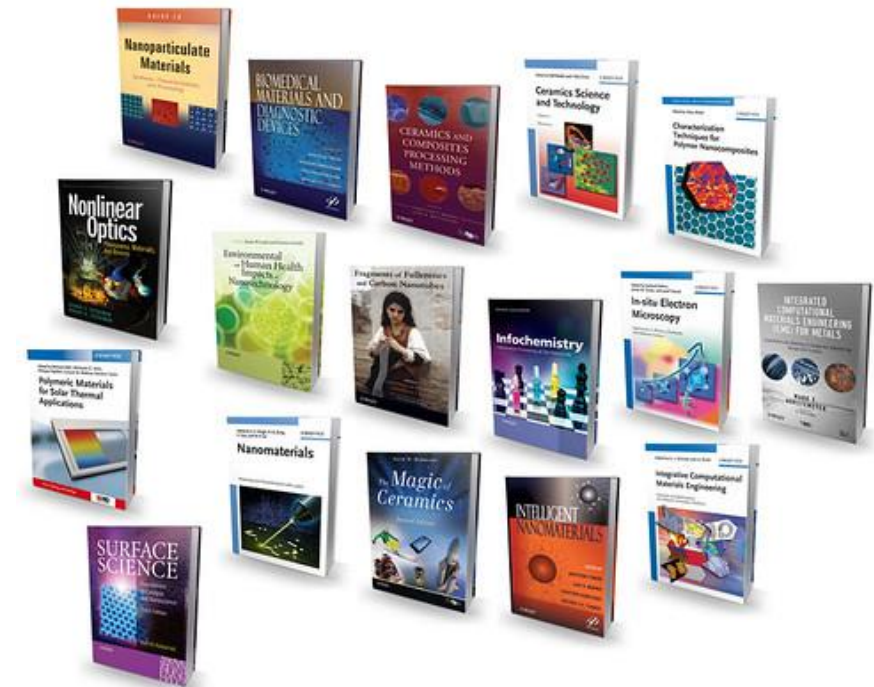
-  **Significance**
Reviewers are asked to rate the significance of submitted papers assuming appropriate revisions are made. What likely impact will the submitted paper have on the research field covered? Significant papers are expected to explore unanswered practical issues. They can make an impact through novel results, in-depth analysis, address important problems, provide new theoretical insights, or present clear methods, procedures, or reviews to help other researchers perform similar work.
Rating Options: High, Moderate, Low

-  **Quality of Presentation**
Is the title accurate and does it clearly identify the subject matter? Is the abstract succinct and comprehensible to a non-specialist? Is the manuscript clearly written and logically organized? Are figures and tables understandable and readable as submitted, including all captions and labels? Is the quality of English language usage and grammar appropriate for an archival journal (note that *Applied Optics* articles are minimally copy-edited)? If there is multimedia content, is it clearly presented and does it contribute to presentation of the research? Is the manuscript formatted according to the journal style guide? Are the OCIS codes selected by the authors appropriate for indexing the article?
Rating Options: Very high, High, Moderate, Low, Very low

Difference between reading peer-reviewed journals versus textbooks

Because of the peer-review process, reading current scientific journals provides more scrutinized and up-to-date information on a topic.

However, to get background knowledge about a topic, it is important to start reading from textbooks.



Reading scientific papers

Understanding the layout – how information is structured – helps you to navigate through the paper

Outline/Structure of a scientific paper (like the approach of the scientific method)

Structural sections of a scientific paper	Scientific method
Introduction	Ask a question
	Background research
	Construct a hypothesis
Methods/ design	Test hypothesis
Results	Analyse data
Discussion (and conclusion)	Draw conclusion
Whole paper	Communicate research

Hypothesis: Idea or proposed explanation for something that you test through scientific method, usually resulting in the collection of information/ data for analysis.

Note. Although this alignment between a scientific paper and scientific method is typically more representative of original research, systematic reviews are presented in a similar format. While systematic reviews are likely to have research questions and aims, they tend not to test a hypothesis.

Understanding the structure and what elements one should evaluate as one go along

Section	Purpose	Relevance for critical evaluation
Title	Identifies what the paper is about.	Provides information on the paper's relevance to your purposes. If uncertain, see the abstract.
Authors	Identifies who did the work, their affiliation/s and who the contact is for the work.	Who the individuals are may not be particularly important. Knowing if the paper has been peer-reviewed and if there is any potential conflict of interest with the authors who did the research (for example, sources of funding from those with a vested interest in the results)).
Abstract	Summarises the paper, particularly the key findings and often the methodology.	Allows you to determine relevance and identify key findings. Note: you should read the full paper to critically evaluate the work.
Introduction	Sets the framework for the paper, identifying gaps in previous research, justifies why the current research is important and outlines aims, research questions and / or hypotheses.	Contributes to the credibility of the paper in terms of providing a sound background and justification for the research.
Method/ Design	Outlines the design of the study and method used in the experiment. Usually includes information on the population (subjects/ cohort) studied.	Highly important. You need to critically evaluate the methods to identify if the experiment is well conducted to control for things (biases) that might influence the results of the study that are not the things in the experiment being tested. Well-designed studies that have minimal sources of bias and use tools to measure outcomes that are reliable and valid, allow you to believe the findings are due to the experiment itself, rather than other influences.
Results	Report what the research has found. Results may be quantitative (data expressed numerical) or qualitative (descriptive observations) depending on the study design and type of data collected.	Highly important. Look at the results to determine the answer to the study's research questions (Do the results support or go against the hypothesis? Are the results inconclusive?) The results provide you with the findings of the research rather than the authors' interpretation of these findings.
Discussion	Provides the authors' interpretation of the results in the context of the research question and other research in the field. Relevance of the results suggested in a practical or 'real world' context. Reports on limitations and areas for further research.	Helps you to understand the results and the 'real world' applications of these findings. As you become more experienced and skilled in studying science, ideally, you should try to draw your own conclusions from the data in the results section. As the authors critique their own work here, this can help inform your critical evaluation of the paper.
Conclusion	<u>Often included in the discussion section</u> , but may be separate. Provides a take home message based on the aims and findings.	Ideally, the reader should try to draw their own conclusions from the results section. However, as beginning scientists this section can be very helpful for relevance.
References	Lists other sources cited in the paper (these are mainly cited in the introduction and discussion).	Evaluate to determine if the relevance and currency of the literature. This can also be a helpful source for finding other relevant literature in the area.

Best procedure to read a paper

Phase I: Screening the article

1. Read the title
2. Look through the authors
3. Look at the date.
4. Some articles have a brief list of key words

QUESTION TO ASK: Is this paper significant for your purpose?

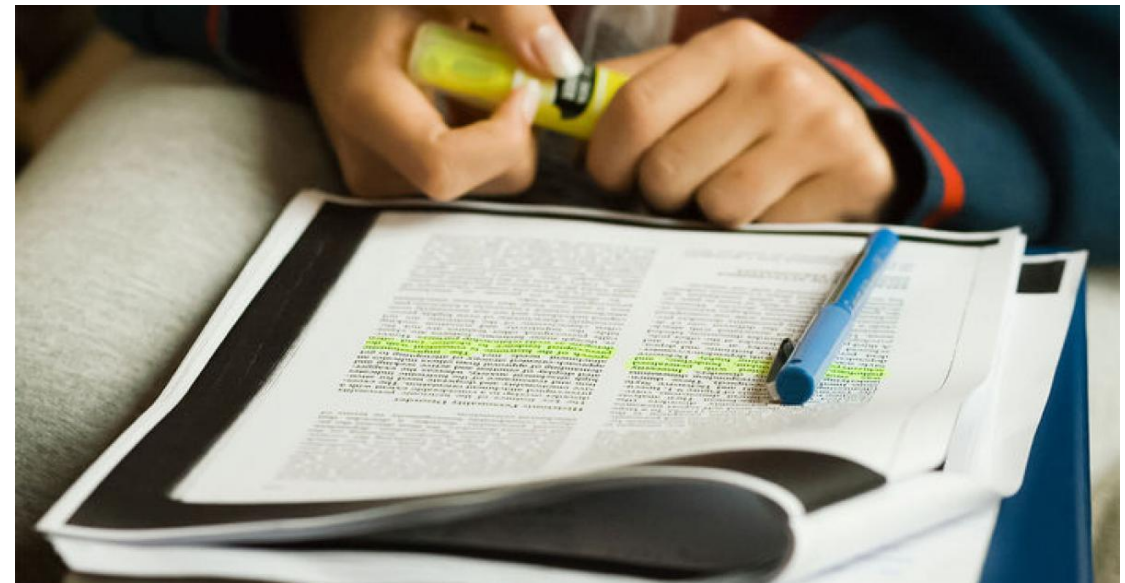


Best procedure to read a paper

Phase II: Getting the main points

1. Read the abstract
2. Read the introduction
3. The introduction will often cite many of the relevant references

QUESTION TO ASK: Is the purpose clear and justified from the background information provided in the introduction?

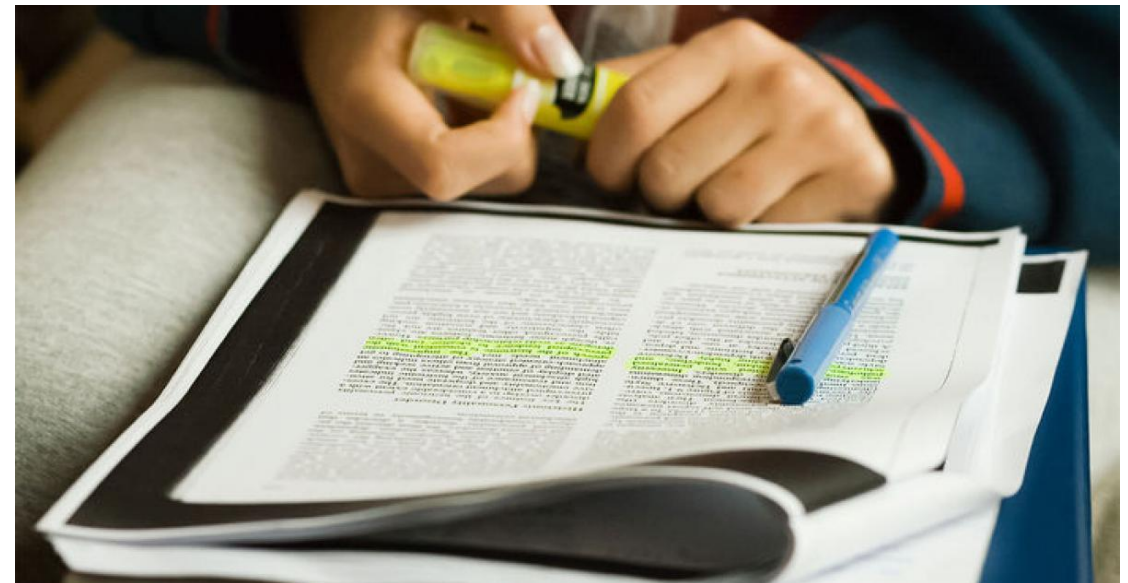


How to go about it

Phase III: Understanding the approach

1. Peruse the figures and tables
2. Skim the discussion

QUESTION TO ASK: Do the results answer the research questions/aims proposed in the introduction? Which conclusions can I get from their results?



How to go about it

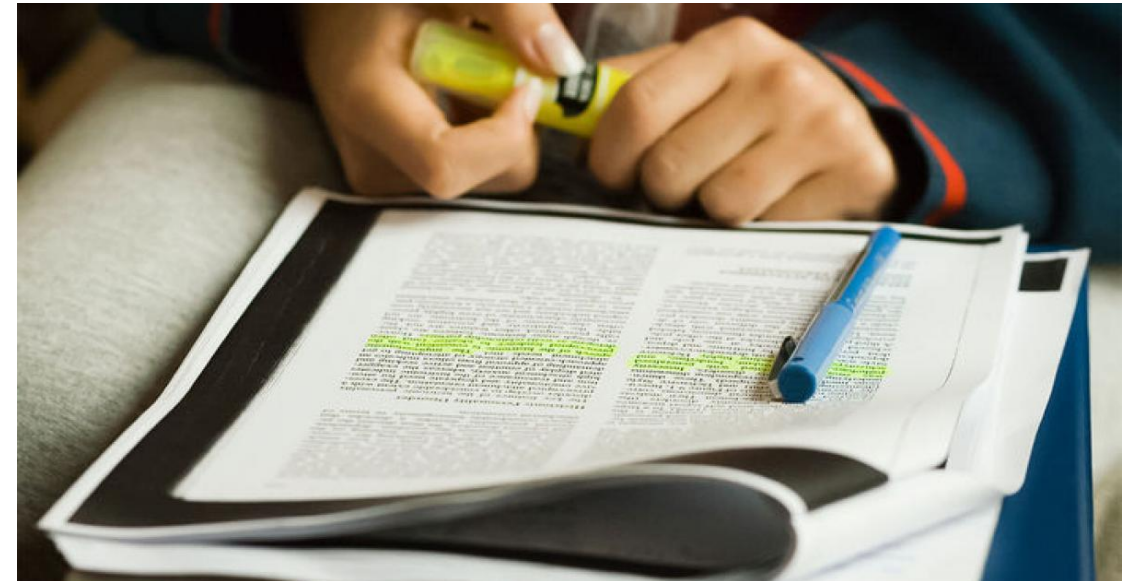
Phase IV: First reading

1. Save or print
2. Skim the **abstract** and the **introduction** again
3. Read relevant parts of the **methods** section
4. Read the **results** section
5. Study the **figures** and **tables**
6. Read **conclusions**

Phase V: Increasing understanding

1. Reread the article several times
2. Make notes
3. Consult the references
4. Reread the abstract
5. **Synthesize the paper**

Note that when reading scientific papers, you will often come across research terminology that you are not familiar with. It is a good idea to look these terms up so you can understand what you are reading. Use a browser to help your understanding of new terms



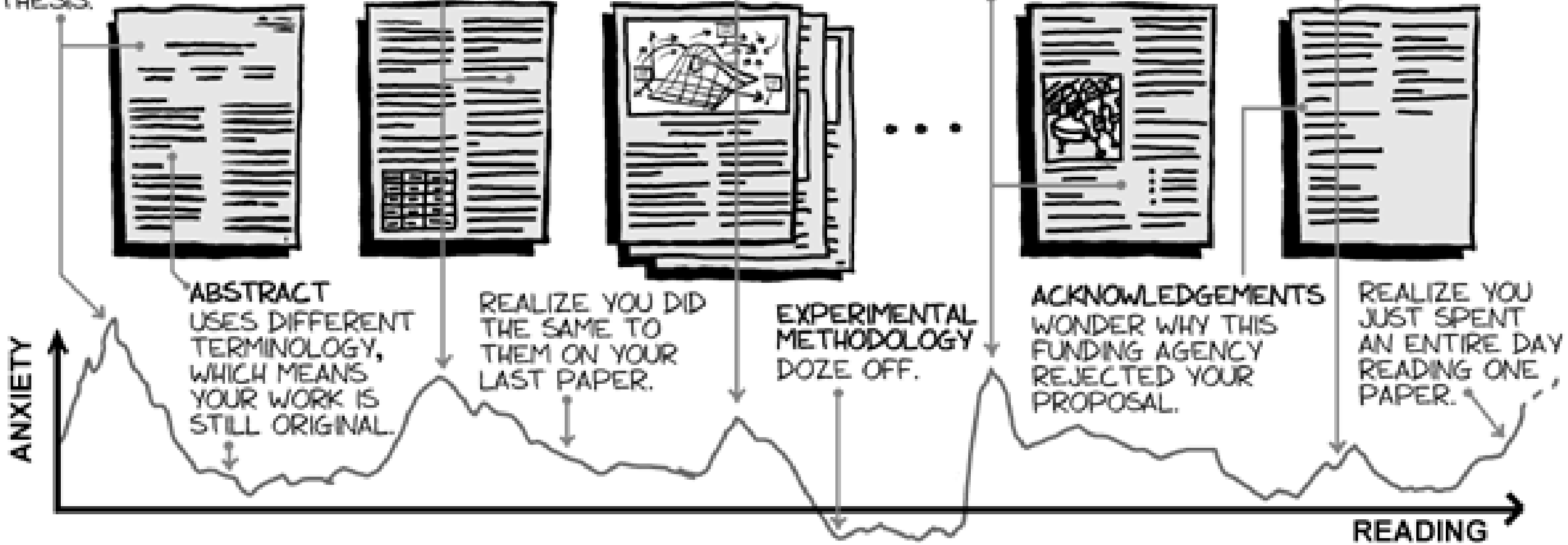
TITLE
SCRATCH THAT
AS A POSSIBLE
TITLE FOR YOUR
THESIS.

PREVIOUS WORK
PUTS DOWN AP-
PROACH PROPOSED
IN YOUR PAPER.

FIGURES
REALIZE YOUR GRAPHS
WILL NEVER LOOK THIS
COOL.

CONCLUSIONS
HAVE NO IDEA HOW
THEY DID THIS.
READ PAPER AGAIN.

REFERENCES
MAKE NOTE: DON'T
REFERENCE THEIR
PAPER EITHER.



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Reading Literature Reviews

Review papers can be 'narrative' or 'quantitative' in nature

Narrative: authors read, interpret and summarize for us what it is that the literature tells them about a particular topic

Phase I: Background. *Who are the authors?/ Why are they saying what is being said?/ What are their credentials? What is their reputation? Is there a 'review board' or is it an article published by invitation?*

Phase II: Reading Process. *Read title, abstract, and body of the paper. Basis of the organization of the review? Chronology/ Around the dependent variables. Around the independent variables/ Around problems with the area of research. What suggestions are offered on needed future work and how might it be done? Read discussion and conclusions.*

Reading Literature Reviews

Review papers can be ‘narrative’ or ‘quantitative’ in nature

Quantitative: Based on more objective summarization of existing empirically based research findings. Use of statistics (“meta-analysis”).

The reading process is the same as that for an original research paper.

Typically, there is a table that summarizes all the discussed works.



<https://www.youtube.com/watch?v=nAu06cB7Ufk>

https://cbgs.k12.va.us/wp-content/uploads/bsk-pdf-manager/Tutorial,_How_to_Read_Paper__13.pdf

Final check to read a paper

1. Screen the title to see if the paper is relevant for your purposes.
If uncertain, check the abstract for more detail to determine relevance.
 2. Once you have determined that the paper is likely to be relevant, read the abstract in detail to get an idea of the key findings and how the research was approached.
 3. Apply your knowledge on the structure and relevance of each section to interpret and evaluate the paper
- Read through the introduction to get an understanding of what is known in the area and the reason or purpose of the research (or paper). **Ask yourself if the purpose is clear and justified from the information provided in the introduction**
 - Read the methods section in detail to understand and critically evaluate the design of the study. **Ask yourself: is the study well designed? Have authors considered all variables that may influence their results? Are the results likely to be reliable and can they be reproduced?**
 - Read the results section in detail, including figures and tables. **Ask yourself: do the results answer the research questions/aims proposed in the introduction? Which conclusions can I get from their results?**
 - Read the discussion in order to get the authors' interpretation of their results. There may be also information about limitations of the work and directions for further research
 - Read the conclusion. **Ask yourself: are the key findings enclosed in this section? (usually, it is a rephrased version of the abstract but with more details)**



External Links

https://www.youtube.com/watch?v=2frJsC_Q3I0





<https://www.youtube.com/watch?v=EXALl6jFu6E>

<https://www.youtube.com/watch?v=mii3R00SVfo>



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Your turn

Find a research paper from your hosting professor at UofM and read it. Be able to synthesize it in 10-20 sentences.

Important: Identify the knowledge gap, research question(s) and the main conclusions.

Basically: What is known now that this paper has been published, that was not known before?

