How to Read a Scientific Paper you Don't Understand

HarvardU/MIT REU Workshop

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June 23, 2022

What is a Research Publication?

A written piece of work that generally undergoes a peer review process before being put into a journal

Why are they so difficult to read?

Most publications have strict figure and word limits. This makes the text incredibly compact. Scientific articles are not meant to read directly; they must be decompressed first.

What are research publications good for?

Learning the SOA, repeating research work, validating statements and observations, determining the interest of other researchers.

What does the State of the Art (SOA) mean?

This is the way things are currently being done in active work by the research community, this does not imply that it is BEST way to do things. SOA is used to justifying the novelty of your work by showing that your work is either progressing or changing the SOA.

How many paper do I need to read to understand the State of the Art?

In my opinion, it takes a paper per day in order to catch up to the SOA and at least 2-3 papers a week to stay caught up.

Where do you find Research Articles?

There are many places to find articles, Google Scholar is a great resource for peer reviewed research. ArVix is a great place to get non-peer reviewed publications.

Attributes of a Publication

- **Publication Type:** Each Type has different purpose

  - Articles: Full Scope Research

  - Letters: Highlight a particular research finding

  - Reviews: Covers a topic area with recent advances in the field

  - Thesis: A compilation of a person's entire PhD work, including published and unpublished work

  - Books: Includes a comprehensive discussion of the background science and past/present/future work in the field

- **Publication Date:** < 10 years implies current, < 3 years implies cutting edge, < 1 year implies active work

- **Number of Citations:** Correlated to the general popularity and broader impact of the paper

- **Journal Impact Factor:** Quality Journal doesn't always imply quality paper, >2 impact factor implies quality journal

Anatomy of a Research Publication

- **Abstract** – Summary of the work

- **Introduction** – first two paragraphs which provide background and state of the art. Where you find the best references for similar published works

- **Work / Research Statement** – A few sentences which explains the What and Why? General starts with something like, "In this paper we will…" or "Here we propose…"

- **Figures and Captions** – Visual Data and Results, this is where most of the research is spent.

- **Results and Discussion** – Dense language that makes up the bulk of the publication, hardest part to read and write. Often used as a roadmap to explain the figures.

- **Conclusion** – Summary of Results and Discussion, includes author's perspective of the research outcomes. Generally, this part is located at the end of the publication.

- **Methods** – Explains how the work was preformed, ie specific theory, equipment, and important calculations

- **Reference** – Support publications which helps explain and justify the work

- **Supplemental Section** – Sometimes contains extra data and details, usually much easier to read the main text

How to Read and Understand a Research Paper: Steps to Success

1. **Understand the What and Why**
   - Always start with the Abstract and the Work Statement
   - Use references in the introduction to help explain important concepts and SOA
   - Use Wiki and other online sources to better understand introduction and define key terms
2. **Analyze the Figures First**
   - Use Figures and Captions to understand the results of the work
   - For most papers, the figures can tell the whole story
3. **Determine the Outcome, pass judgment**
   - The outcome is somewhat subjective, use the conclusion statement to get Author's perspective of the outcome
   - Develop your own perspective of the work, at this point you should know if this work is relevant and quality for your needs
4. **Read the Supplemental Section and Methods**
   - The supplemental section will contain much more detail than the main text, read this carefully. It will likely explain more than the main text.
   - The methods section can give you clues as to how to repeat this work, ie "the specific type of laser used"
5. **Reanalyze the figures and Refer back to Main text**
   - Once you have a grasp of the paper, try to reanalyze the figures with more detail.
   - Use the results and discussion section as a reference to explain the data in the figures
   - Many times the main text is a road map to identify observations and explain the figures in more detail
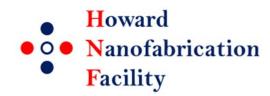
Do …
- Take your time when reading
- Make a list of key terms you don't know
- Use external resources (ie Wiki) to help understand concepts
- Read other papers from the reference section
- Pay extra attention to the figures

Don't …
- Read the scientific paper in order like a book chapter
- Try to understand everything in the paper
- Trust the author's observations as truth
- Dismiss a paper because it has some poor attributes
- Give Up because it doesn't make any sense

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Thank You!!!