

Curran, L.M. handout
How to Read a Scientific Research Paper: A Few Techniques

Scientific research papers are not presented how they are conceived or conducted. Sections are often disconnected (at least in the document) and you must weave and re-connect the links to assess and to critique the work effectively. The convoluted form of presentation often baffles non-scientists or those relatively new to the field. Reading such work effectively is a skill to be developed and to be perfected just as writing or presenting your work.

This brief overview will assist you in evaluating published scientific research, producing and publishing your own research and especially in the recall of the hundreds of papers you read during your graduate years. Also, you can evaluate the merits and weaknesses of scientific publications with this approach. In addition, it is a time-efficient way to review and to process extensive technical material for your examinations or during a short-term consultancy. Please let me know what works, what was confusing and send me any suggestions or any improvements in approach and effectiveness that you have discovered or applied with success.

Approach

First, read the **ABSTRACT**.

Then piece through the paper following this game plan. After following these steps, go back and read the entire paper. Why? You are often lost in the details, background and other aspects of the paper especially if it contains information encountered for the first time. Good writers with bad data or poor analytical thinking may fool you; bad writers with strong results or interesting work may not convince you of their arguments.

Read the paper over generally with this framework. You then have questions (hypotheses or objectives if it is a review or synthesis), major results and approach.

Find the Question (s) – Underline it/them.

Think carefully about assumptions and methods you would employ *before* reading further.

- Is the question important, intriguing or re-defining an old problem or classic issue in the field?
- What may be the non-mutually exclusive questions and/or methodological problems?
- Do the questions contain both an applied and theoretical basis? Look for ambiguous terms, ill-defined issues or vague definitions.
- What assumptions are inherent in the question (s)?

Go to the DISCUSSION and/or CONCLUSIONS

See if the questions (s) answered is/are the one(s) proposed. Often conclusions are based on general objectives, desired outcomes or answer/address a different question. This provides you with a road map – starting point and end of the publication journey.

If the conclusions diverge from original objectives/questions/hypotheses, ask yourself why this might be so: design, change in experimental design, agenda, or insights gained during the experimental process. Think now; read again later.

METHODS

Keep the questions in mind – link them to methods- Q1:M1:R1:C1;
Q2:M2:R2:C2...and so on.

Well-written scientific papers retain a tight parallel construction throughout.

- Carefully review the sampling design. Most important, should I believe these data?
- Was it the appropriate system to test the question?
- Was this question or hypothesis the proper one to ask of this system?
- What site bias or sample bias occurred?
- Did the treatment conditions lead to a select, subjective loss of subjects?
- Any sampling bias from equipment failure, lost exclosures, overlooked factors?
- Replicates, controls, Pseudo-replication- Examine if there are any major constraints to site, samples, seasonality etc.
- Does the spatial scale of the question and conclusions correspond with the sampling design?
- How did they choose sites, samples, numbers and techniques?
- Was the length of the study sufficient to warrant conclusions?
- Was the length of the study sufficient to incorporate natural variation, extreme weather events (e.g., ENSO) or conducted during unusual conditions?
- Were the specific conditions considering in the analyses and conclusions?
- Are any questions not really tested?

Specifics to the general conclusions-

- What are the qualifications of the researchers?
- Who financed the study?
- Are there any biases, perspectives different views or institutional lens that may cloud honest evaluations of results?
- Do they have a particular view, "axe to grind" or long-standing argument (a.k.a. career) to defend?

RESULTS

Presentation of Data

- Critically examine results and presentation
- Check graph axis/es – start at zero; % rather than samples, present sample sizes and variance, lump or split samples, assume normality but do not treat data or test for homoscedasticity (equal variability around each conditional mean); include mean and standard error – with sample size; sd; variance.
- Was this a balanced design? Did the design become unbalanced because of sample loss?
- Does presentation enhance results or hide ambiguous results?
- When reporting inferential statistics (e.g., t-tests, F-tests, chi Sq. etc.) the magnitude or value of the test, the direction of the effect, the degrees of freedom and the significance or probability level should be given. What is missing?
- Are there critical tests or assumptions overlooked from the questions that you wish you knew more about before the tests were conducted?
- How convincing are the results?
- What other samples, multiple years, additional treatments would you require to be convinced of the general conclusions?

Keep a notebook/computer file with tests and their applications — invaluable later when deciding on your own tests and application – Best way to learn statistical methods is from empirical datasets applied to research problems in your own field.

Now go back and read the entire paper- start to finish. You have a solid framework to assess the approach, interpretation and presentation of the work. Keep in mind the quality of the journal, the readership, and the general objectives of the author(s).

- Does this paper fit the journal?
- Do they properly cite previous work?
- Is there good scholarship? Often – especially senior authors – (unfortunately) do not cite others' work that contradicts or even contributes to the issues presented.
- Citations may be old (dated), secondary literature (gray reports), improperly cited or unavailable works.

Remember, however, time to publishing in a journal such as *Ecological Monographs* is two full years! Reviewers require a few months, then revisions within three months then even after acceptance there is another 18 months before we receive the paper in print. Wow, eh. So timely citations may be need to be in print for at least 2-3 years for some works. *Science* and *Nature* are within 6-9 months, but most journals are on the unfortunate publishing schedule of at least a year to two years lag time from acceptance. Check dates received, revisions submitted and acceptance along with when an article is published.

- Is much unpublished or the authors work?
- Do any assumptions depend on unpublished or obscure research results?

Only primary, published literature should be cited. However, some gray literature and websites with some "in press" articles are allowed.

Presentation

- Are the assumptions clearly stated and tested or are they disregarded, glossed over or given unequal weight with their importance?

For example, if a key assumption was distribution of land area or forest type but it was not measured is this addressed or dismissed? Often key unexamined variables are not noted.

- Does the prose ramble?
- Are other tangential/peripheral issues to the main argument included?

These may be issues they sought to address but did or could not answer but included as a filler to attract or engage a broad audience or receive high impact.

DISCUSSION- *specific to general*

- Do the author(s) address contradictions or at least different outcomes with other published results?
- Do the author(s) state their interpretation of their results in a balanced, yet assertive way, or boldly state a particular view?
- Similarly, do the authors cautiously extend their results to other studies or similar systems or make broad sweeping generalizations about the general importance of their research?

The best papers will stress what is known and widely accepted, highlight how this may apply to other systems/regions/sites and provide new questions/hypotheses to be developed from their research. Note the introduction goes from general to specific while the discussion begins with the specific results to the general.

ACKNOWLEDGEMENTS

- Do you want to really assess a researchers' character? Check out the acknowledgements.
- Do they thank those – especially nationals – who assisted with the research in-country (best yet included them as co-authors), provided key insights or corrections on drafts?
- Do they attribute major conceptual advances to discussions with colleagues?

Some journals limit the acknowledgments section (which is a major shame, if you ask me) while others forget those who assisted along the way. Remember, this is a very, very³ small 'club' and your scientific/professional reputation is the major asset. Unless you are brilliant and publish outstanding work often and continually throughout your career, you cannot afford to be a major ^\$^*&\$@#%. If this becomes your life's work, you must become a responsible researcher ASAP and maintain the integrity in the field.

Organizing Your Scientific Exploration

A few additional life lessons to pass on or "do as I say not as I did" (with many regrets late in graduate school during the dissertation/publication crunch)

Begin entering your references in Endnote or similar database reference program *early*. File hardcopies – alphabetically by author – learn authors and their works. Save a set of PDF files in folders. Save additional PDF copies by subject (if necessary) but realize this system becomes far too unwieldy with time and amassed projects when using a hardcopy set. Put notes from seminars/discussions and lectures within the same folder as the authors' paper (electronic or hardcopy) allowing a recall of those heated discussions or lectures long ago.

See also the handout from *Ecology, Ecological Monographs and Ecological Applications* re Reviewer's Instructions for Submissions to ESA journals.

This will provide a baseline of what reviewers' are instructed to do in the peer-review process and how your papers will be evaluated for publication.

For Discussion Sections:

- 1) Write in the margins of your papers or notes prepared;
- 2) Ask questions about what you **do not** understand as well as trying to prove points in debate;
- 3) Outline your arguments, thoughts, and questions before coming to section;
- 4) Think about positive aspects of the work;
- 5) Discuss how this relates to lectures and explore why it was assigned;
- 6) Debate why this particular paper may advance our knowledge in the field;
- 7) Compare and contrast combinations of readings; and
- 8) Speak up! Develop your scientific voice.

You will require several skills in a successful career- critiquing papers and reading much, developing a conceptual foundation of the field, debating works, producing your own and presenting the results to a diversity of audiences.

Respect everyone's opinion and enjoy the communal process of discovery.

Most importantly, have fun! Please send me any insights into your own approaches and what works for you.