How to read a scientific paper critically

It is important that you develop the ability to read scientific articles critically. Although scientific articles represent a specialized form of writing, the critical faculties that you develop in reading the scientific literature will be useful to you in many areas of life. We expect that through careful reading, deconstructing and reconstructing selected research articles, you will enhance your critical reading skills considerably during the remainder of this course.

“Critical” does not necessarily mean negative. What critical reading does mean is that you will see beyond the “advertising” or “promotion” of one point of view to the central issues raised. You will also assess the data independently. It means that you will evaluate what has been presented and decide for yourself whether you agree with what has been asserted and to what extent.

NOT EVERYTHING YOU SEE IN PRINT IS NECESSARILY CORRECT OR TRUE.

Often when students start to read primary research papers they get frustrated because they try to understand all of the facts. And then they may get bogged down without seeing the main point of the paper. It is easy to get trapped in the detail especially when many of the terms are still new to you and the techniques are unfamiliar. In this document, we are presenting a more effective way for you to approach reading primary research papers. We believe that it will help you be a more critical reader faster. After all, you can't critically evaluate results if you do not see the main point of the work or the context within which it is written.

Let’s first start with a checklist of questions we can apply to the article that you’ll be reading for the first discussion. These are general questions that you can then apply to all other papers we read. As you read, write down your comments.

1. Is there a major (big picture) question being addressed? If so, what is it?

2. Is there an hypothesis being tested? If so, what is it?

3. What (experimental) approaches are being taken to address the questions posed?

4. How should we interpret the results?

5. How are the results interpreted (by the authors) and how do they relate to the initial hypotheses and predictions?

6. What further experiments could be undertaken to answer questions only partly answered by the paper or new ones that arise because of the paper?

You might think that, in order to answer these questions, you should start reading at the

beginning of the article and work straight through to the end. Few of us actually do this. Each scientist develops his or her own best way(s) to approach an article. These ways will depend, in part, on your purpose in reading it. For example, if you are primarily interested in a method used because you wish to use it yourself, you might only be interested in the parts of the paper that relate to that method. For purposes of this course, you will have to understand the entire paper in detail, but it may be best to start with the Abstract or Summary to get a perspective on the paper.

- A good Abstract will touch on all of the first 5 questions above, but depending on your familiarity with the subject, it may not be completely intelligible. It should certainly tell you whether the research reported in the article is likely to relevant to a subject about which you are trying to gain knowledge.

- The Introduction section will elaborate on the context mentioned in the Abstract and give you a better idea "where the paper is going". Sometimes, at the end, it will even summarize the Results to be presented and the authors' conclusions, but be aware that this summary is really just advertising.

- If, after reading the Introduction, you still aren't sure what chief points are being addressed, you may want to go through the Discussion before reading the Results section. However doing so may cause you to restrict your thinking about the paper to the context that the authors are directing you towards. So, do this with caution.

- Move on to reading the Results section. You should definitely be skeptical of the authors' claims and conclusions until you are persuaded by the data presented in this section. One test of your abilities (and the authors' too) is whether you can reconstruct the paper solely from the data tables and figures.

- If you aren't familiar with the techniques used to obtain the data reported in the Results section, you should look carefully at the descriptions provided in the Materials and Methods section. This means that you may read by moving back and forth between these two sections, one set of experiments at a time. You might even have to consult some of the literature cited in the References section

- Finally you should read the Discussion and then the Conclusions sections, or reread them if you have already read them. Now is a good time to revisit the questions in greater detail:

1. Is there a major (big picture) question being addressed? If so, what is it?

    a. Are they trying to describe a phenomenon or provide a mechanistic explanation?

    b. Are there hypotheses relating to this question?

c. Is this a seminal article in the area? (Does it provide synthesis, break new scientific ground or persuade you to change the way you think about the subject?)

d. Is it a well-written paper or is it poorly put together? Did the authors make their work intelligible?

2. Is there a hypothesis being tested? If so, what is it?

   a. Does the hypothesis address the major question?

   b. What are the implicit or explicit assumptions underlying the hypothesis?

   c. What are the specific predictions made and do these predictions lead to tests of the hypothesis?

3. What (experimental) approaches are being taken to address the questions posed?

   a. What are the experiments?

   b. What is the rationale for each experiment?

   c. Should I go to another source (textbook, review article, other literature cited in the article, the web, or the TA [consult the TA after you try other sources, you'll at least be able to refine your questions]) to get a better grasp of the methodology?

   d. Do the experiments really test the predictions?

4. How should I interpret the results?

   a. What are the controls and how do the experimental results differ from them?

   b. Do the results from each experiment make sense, that is, are they consistent?

   c. Are results from different experiments consistent with each other in providing support for the predictions they were designed to test?

   d. Are the results consistent with one or several hypotheses? Do they allow you to reject alternative hypotheses?

5. How are the results interpreted and how do they relate to the initia lhypotheses and predictions?

a. In the discussion,do you agree with the authors' interpretation of results? Why or why not?

b. Are the limitations of the study and unresolved problems dealt with adequately?

c. What does the article tell us that we didn't know before?

6. What experiments should be done for future follow-up? Do the authors suggest the same ones?

Adapted from "How to read a scientific paper critically " by E. Larsen, I. Dworkin, A. Cordon and P. Romans, University of Toronto