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Journal Clubs and Lab Courses: The Prose and Cons

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Communication skills are often cited as a key component of a successful undergraduate education as well as being a highly coveted skillset for the workplace. Literature-based discussions, known commonly as Journal Clubs (JCs), have been traditionally used as a means to showcase research and scholarship at the undergraduate level. This report will summarize why and how JCs can be modified to include communication skill development for science undergraduates registered in a laboratory course. The effect of JC exercises on undergraduate science communication development can be measured with the help of different assessment tools, as described in this report.

Keywords: Journal Club, Communication, and Assessment

Introduction

A Journal Club (JC) is a round-table discussion of scientific literature wherein an article (usually a peer-reviewed, primary research study) is read in advance by a group of participants (often experts in the field) who then gather together to do a group-based, interactive critique of the publication. The JC is believed to have originated in Europe (as reviewed in Deenadayalan *et al*., 2008) and is still used as a method for evidence-based practice in many different fields (although with mixed efficacy). They are commonplace in graduate and professional schools but have been incorporated in undergraduate curricula as a way to teach the scientific process and science writing (Glazer, 2000; Lee, 2005). That being said, JCs are not normally associated with developing universal communication competencies (e.g. establishing situational context, maintaining a theme, story continuity, tone of speech, etc.). Normally, JC discussions focus primarily on the analysis and evaluation of the science behind the study (e.g. experimental design and analysis) over the writing style and structure of the paper. This strategy may be appropriate at a post-graduate or professional level but, when it comes to the undergraduate learning experience, this focus on the science is too limited and short-sighted.

By contrast to institutional goals for an undergraduate education, students when polled have generally described the main goal of a post-secondary education as a means to net "enhanced careers and greater earning potential" (as reviewed in Chan *et al*., 2014). When examining the list of skills most sought after by employers, the skill most desired involved communication (written, verbal, digital, and listening) (Hansen *et al*., 2015). In fact, many universities include proficiencies in communication as one of the key learning goals of an undergraduate education (Chan *et al*., 2014; Council of Ontario Universities, 2011). In addition, unlike professional or postgraduate-level JC activities, which involve content experts critiquing a discipline-linked study, undergraduates more than likely do not have the pre-requisite expertise to judge fully its scientific merit. This should not be surprising since science papers are read (and evaluated) by "peers" (hence, *peer-reviewed*) who more than likely have advanced degrees in the field.

Despite these limitations, however, undergraduates usually know a "good story" when they read (or hear) one. Unfortunately, the elements of a good story, such as writing style and story structure, are not often emphasized in JC exercises (perhaps because they are viewed as being too subjective or qualitative to quantify). This is despite the fact that the recognition of these elements is a key stepping stone to honing communication skills, a key objective of the undergraduate learning process. When one considers that a minority of undergraduates pursue graduate degrees (let alone a science research degree such as a M.Sc. or Ph.D.) (Allum *et al.*, 2015), one can argue that the traditional emphasis on data analysis over writing style (for example) serves only that minority of students headed for careers in science only. It is the contention of this report that the style, tone, and structure of a research paper complements its scientific merit and should play at least an equal role to data analysis in JC activities, especially in an undergraduate educational setting in which honing (science) communication skills is a critical benchmark of the undergraduate learning experience. As with data

analysis, ALL students are best served by adding a communication component to the JC exercise.

Given the emphasis on data analysis, it is not surprising that there is a paucity of literature that describes how a JC exercise can serve as a teaching aid for developing the students' science communication skills, both written and oral. Less common still are reports that provide readers valuable tools to assess the development of these skills with the help of JCs. This report will differ from the mainstream by including specific details as well as examples of different assessment strategies used to measure student learning of communication skills.

Excerpts will be provided from BPS4127, *Advanced Techniques in Biosciences*, a fourth-year, multi-sectioned undergraduate lab course that integrates JC exercises as a tool to prepare students for a final mock-paper submission and PowerPoint presentation of the results of their semester-long lab project. Each section of lab is comprised of up to 28 students who come together twice a week, working in groups of two at 3 hours per session, over the course of a 12-week semester. In this particular scenario, the students do 2 to 3 JC exercises (depending on the project for that semester). Moreover, each section is normally assigned 2 teaching assistants (TAs) to help the course coordinator moderate the JC exercise. These TAs are normally graduate students with relevant expertise for the lab course and familiar with the concept of Journal Clubs.

Excerpt from the Course Syllabus

Adapted from a Senior-Level (4th-year) Lab Course, Advanced Techniques in Biosciences (BPS4127):

"Recall from the course syllabus the 3rd learning outcome for this lab:

- **To compose in your own manner and words a clear and concise demonstration of your accomplishments in keeping with scientific conventions.**

To this end, we shall be doing a Journal Club (JC) exercise in which you will be expected to read at least 1 possibly 2 scientific papers related to the lab project. The papers selected will be important resources for your final report and oral presentation at the end of the year. In addition to analyzing and evaluating the studies' scientific merits, equal emphasis will be placed on each paper's structure and writing style. It is important that you recognize and apply scientifically-sound and stylistically-appropriate judgement when deciding what data to present and how to present it. These Journal Clubs are set up to develop these skillsets since they involve written, oral, and visual components, each of which is shared in both your end-of-semester oral presentation as well as your final scientific paper. It should be noted as well that elements of the JC exercise will be assessed in your term tests (sample test questions to be provided).

All JC papers will be posted at least 2 weeks prior to the assigned Journal Club date. It is expected that you read the paper (at least twice) in advance of the specified date. This is an open-book exercise although NO ELECTRONIC DEVICES will be permitted; you should print out the article(s) and you are allowed to bring supplemental printed/handwritten material (e.g. your notes, textbooks, other articles, etc.).

When reading the paper(s), it is expected that you apply sound judgement; if there is a term or concept that you find unfamiliar, find the answer by doing the research (e.g. online or at the library). Moreover, as you read each paper, you should come up with your own questions. From these questions, you are required to select 3 (THREE) with your (best-guess) answers per paper. Each student should bring their list of 3 questions (printed or handwritten) to the lab the day of the JC exercise. Special attention should be paid to the Introduction, Results, and Discussion sections as these are the relevant sections for both the end-of-semester oral presentation and the final lab report. That being said, students should be aware of the role of the other sections such as the Abstract and Material and Methods. Resources to help you with understanding how a paper (a study) is written (constructed) will be provided on Blackboard Learn.

The JC exercise will take place in-class during time allotted for the exercise. The *Moderator* of the JC will commence the discussion by jumping straight into the Introduction, followed by the Results, and finishing with the Discussion. Each student will have the opportunity to pose their question(s) or respond to other questions/answers during the discussion. Each student will be afforded at least 3 opportunities to participate in the discussion. From these interactions, the moderator will assign each student a grade based on a simple rubric (see Appendix __). Note that there are two categories (Preparation and Comprehension) that apply to the in-class discussion. These are the most important performance measures for this exercise. A third category will focus on the questions and answers that you have written/printed out.

Questions and Answers

Here are some important points to note when coming up with your list of questions:

- Come up with more than 3 questions with answers for each assigned paper.

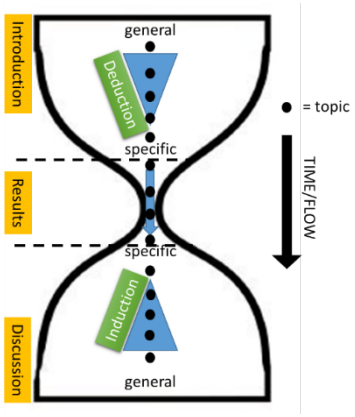

Figure 1. The Hourglass and Science Communication. In undergraduate labs, the key components of a typical presentation or report include at least the *Introduction*, *Results*, and *Discussion* sections. These sections are depicted as different sections of the hourglass. Each section is part of the overall story which should have continuity or flow. This is symbolized by the dots (or topics) that are linked thanks to transitions that lead the reader from one topic to another in a logical manner over time. A topic may be an individual data figure, table, observation or fact.

- **Select the 3 (THREE) which you feel best reflect your level of preparation and comprehension of the paper. Write/print out these on 1 (ONE) page.**
  - As an example: if a paper has performed a Western in one of the figures, do not ask "What is a Western?" because the answer to that question does not require extensive reading of the paper. It is better to ask "Why was it necessary to do the Western for … in Figure 3?" This type of question (with your answer) imparts some level of knowledge and understanding of the paper's contents and context.
  - You will have the opportunity to pose any or all of your questions to the moderator of the Journal Club.
  - If your question has already been posed, you cannot ask it again. This does NOT negatively affect your written submission.
  - If you pose a question to the moderator, he/she may do one of three things:
    - Answer the question honestly,
    - Answer the question dishonestly, or
    - Redirect the question back to you or to another student
  - You will be invited on a case-by-case basis to assess the answers provided by either the moderator or by your peers. **Please be respectful especially when disagreeing.**
  - Be prepared to answer questions posed by the moderator.
  - All questions posed and answers given should be related to the papers and/or the theme of the discussion.
  - Your questions and answers must contribute in a meaningful way to the discussion at hand.
    - For example: Name- or fact-dropping for the sake of name- or fact-dropping will not be afforded any credit if it is not warranted (as determined by the moderator and any additional judges).

At the end of the JC exercise, you will submit your list of 3 questions to the moderator for a final assessment (see Appendix). The caliber of the questions with your answers will be assessed in addition to your in-class performance during the Journal Club.

Given that this is the first time you are doing this type of exercise, the first Journal Club will be a TRIAL RUN. Only formative feedback will be provided. Subsequent JCs will include a summative grade which will be counted for your final grade.
Pay attention to the kind of questions asked and you are encouraged to take notes."

Notes for the Instructor

As an Exercise for Science Communication

So as indicated in both the *Introduction* and *Student Outline* of this report, the JC can serve double-duty. In addition to developing critical analytical skills of an article's science methodology (e.g. assessing study design, statistical analyses, and inferences made from the data), the JC can also serve as an important developmental tool for communication. From the standpoint of oral communication, the JC requires students to explain orally their own interpretation of the results to a group consisting of their peers and course personnel. In a sense, the JC becomes a stepping stone for the students' more intensive oral presentation that they would do at the end of the course. Additionally, as an exercise in science writing, the JC allows the facilitator to highlight the role of each component of a paper as well as highlight the quality of dialogue. This last point is completely relevant for both report writing as well as script preparation for an oral presentation since clear and concise dialogue with the

appropriate segues is a key component to quality communication.

An analogy can be drawn between the structure of the JC paper/written report/presentation and an hourglass (see Figure 1). As an hourglass starts with a larger upper compartment which tapers down to a connecting point below, this shape is a good analogy for the role of the **Introduction** section of a paper or presentation. In many studies, deductive reasoning is used to generate a specific prediction from a general observation. Written in another way, a well written introduction using deductive reasoning needs to the set the stage of the study by establishing a clear and concise connection from general principles/observations to specific interpretations or predictions that will be addressed by the study. This is why, after establishing a connection to the wider field of inquiry, the last paragraph in most deductive introductions comment on the specific intentions of the author(s) (e.g. "In this study, we will examine…"). Questions can be posed to the students addressing the rationale behind the study and highlighting the stepwise progression from the broad to the very specific. Like granules of sand in an hourglass, there has to be a logical flow from the general to the specific over time (the logical continuity of the story or *flow*). Students need to recognize the need for flow and determine if it is present in the paper as written. This aspect should then be tied to their lab report and/or presentation so that they see the JC's relevance to other course-related assignments.

As we reach the neck of the hourglass, which is very narrow, we now enter the study itself, which, like the neck, is very narrow in scope; the neck in the hourglass symbolizes the **Results** section of their JC paper/final report/presentation. It is important to emphasize as a science communication exercise not just the components of this section (e.g. each figure or table) but also the order in which they appear. Students should recognize the described flow (if any) in the presentation of the data in the JC article. For example, for a paper with 8 figures, why is Figure 1 the first figure? How did we get to the Figure 2? Is this the best ordering? Ideally, a well written paper will provide explanations for each transition from section-to-section/figure-to-figure (*connecting the dots*) but students should not have to agree necessarily with the paper's layout. As before, it is important to relate this learning experience to their lab report/presentation so that they appreciate its significance when they prepare their own **Results** section(s).

Finally, after leaving the neck, the granules of sand enter the lower chamber which tapers wide towards the bottom. This is akin to the **Discussion** section in which inductive reasoning is used to take specific inferences from the study's results in order to make broader connections/extrapolations with the wider field. As with the previous compartments of the hourglass, there is still a flow with time (from the specific to the broad) that students ought to recognize and incorporate into their own communication projects, whether it is for their report or oral presentation.

In the end, the JC exercise can be made to emphasize not only what a paper says but also how it says it. This latter teaching point can be assessed by way of science communication exercises such as lab reports (long or short), oral presentations (long or short), and even test questions focused on science writing. Examples of such test questions are provided in the Appendix of this paper. Different types of JC-related questions can be constructed to measure different cognitive levels as defined by Bloom's taxonomy.

Format of JC Exercise

Below is a short-list of possible scenarios that can be followed depending on the number of sections and teaching assistants (TAs) available.

Scenario 1: One Section with Multiple Teaching Assistants per Section.

a. One *Moderator* who will facilitate the discussion of all papers while remaining TA(s) (ideally 2 or more) act as *Judges* listening to responses and ranking student performances. *Moderator* may also act as judge if capable. (IDEAL).
b. One *Moderator-Judge* per paper. Divide the class in two sections. At least one TA/demonstrator will moderate and assess the discussion of the 1st paper with one group while at least another TA/demonstrator moderates and assesses the discussion of the 2nd paper. At some point, the groups switch such that each group discusses each paper with the other TA (for consistency reasons).

Scenario 2: One Section with One Lab Demonstrator/Teaching AssistantpPer Section
One *Moderator-Judge* for the entire exercise. (POTENTIALLY MOST STRESSFUL; LEAST CONSISTENT)

Moderator's (and Judge's) Role

There should always be a *Moderator*. The *Moderator's* job is to facilitate the discussion within the group and to keep the conversation moving at a reasonable pace. Moreover, especially in the absence of the *Judges*, the *Moderator* will, like the *Judges*, assess each student's performance as per the rubric (see Appendix). To this end, the *Moderator* will pose questions when needed (e.g. when there are no questions concerning the Discussion section, the *Moderator* should

make up some) or respond to questions as described in the *Student Outline* (c.f. in Student Outline).

It is critical that *Moderators* and *Judges* be trained in the use of the rubric and that expectations be clearly laid out to maximize validity and reliability of student performance.

Judge(s) to Student Ratios

A Journal Club typically takes place among small groups (10-15 participants) and ideally there should be a moderator per group. That being said, Scenarios 1a and b have been applied successfully to larger sections of up to 25 students (and conceivably more) provided enough time (c.f. Time constraints) is allotted for multiple interactions per student (c.f. Number of Papers per JC). The one additional caveat for larger groups is the need of additional *Judges* to help the *Moderator*. It becomes more difficult for a single *Moderator* to keep track and assess the performance of larger classes (>30 students) by themselves. At some point, the JC as described in this paper becomes unfeasible without adequate support.

Time Constraints

Journal Clubs can be time-consuming depending on the size of the class, the number *Moderators/Judges* available, and the number and difficulty of the assigned papers. Normally, a JC can be completed in about 1-2 hours with a group of up to 28 students responding at least 3 times to one paper consisting of 5-7 figures and no more than 10 pages in length. Journal Clubs are a great way to fill in those long incubation periods for certain experiments (e.g. PCR, restriction digestions, etc.). Larger groups will require more time to have their 3-4 opportunities to pose/answer questions but this could be accommodated over different time intervals.

Number of JCs and Number of Papers per JC

It is possible to assign only 1 paper of sufficient length for discussion in a class of up to 30 students but no more than 2 papers should be assigned. It is recommended that the articles have sufficient material in order for each student to have at least 3-4 opportunities to demonstrate the performance measures in the rubric (see Appendix). Moreover, it is recommended to have more than one JC exercise and to use the first JC as a trial run.

Rubrics

Rubrics are great tools to provide both formative and summative feedback back to the student. Given the nature of this exercise, it is a good idea to keep the rubric simple as it makes grading of each student simple and easy to track. This is especially true if there is only one *Judge* (namely the *Moderator*) for each group/class of students. Again, the main emphasis of the grading is on the in-class portion. The assessment of the written questions should not have any summative value since students can share questions/answers. Consequently, they do not reflect necessarily their true preparation and comprehension of the entire paper.

Final Thoughts (and Student Feedback)

Often students in their upper years can recognize and describe the individual trees (the experiments) but not the order explaining the placement of the trees in the forest. It is this *Big Picture* (or coherent story) that is understated in science education, which often emphasizes the quantitative elements (statistical analyses, data interpretation, etc.) over the qualitative (Were you able to follow their reasoning? Was there a consistent flow in the story? Explain.). What is described in this report is a rationale and means to emphasize the science communication along with the science analysis. Overall, student rankings have been positive to very positive for recognizing the importance of Journal Clubs as tools to meet the learning outcomes (>85%, n=40, personal communication for 2015) but this is accomplished in large part thanks to repeated reminders to the students as to how and why the JC exercises are important and relevant to the course learning outcomes. By tying the JC activities to other course assessment tools like the test, the final lab report, and oral presentation, the student buy-in becomes very high and the feedback remains generally positive. Most negative feedback is often associated with the perceived subjective grading of JC activity but this cannot be avoided. Ideally, the instructor should take steps to minimize grading discrepancies to mitigate this perception.

About the Author

Dr. Alp Oran is a lab course coordinator in the Department of Biology at the University of Ottawa teaching lab, lecture, and seminar courses in both English and French. In addition to a M.Sc. and a Ph.D. in medical research, he is currently completing a M.Ed. part-time with emphasis on teaching, learning, and evaluation.

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Appendix
Rubric

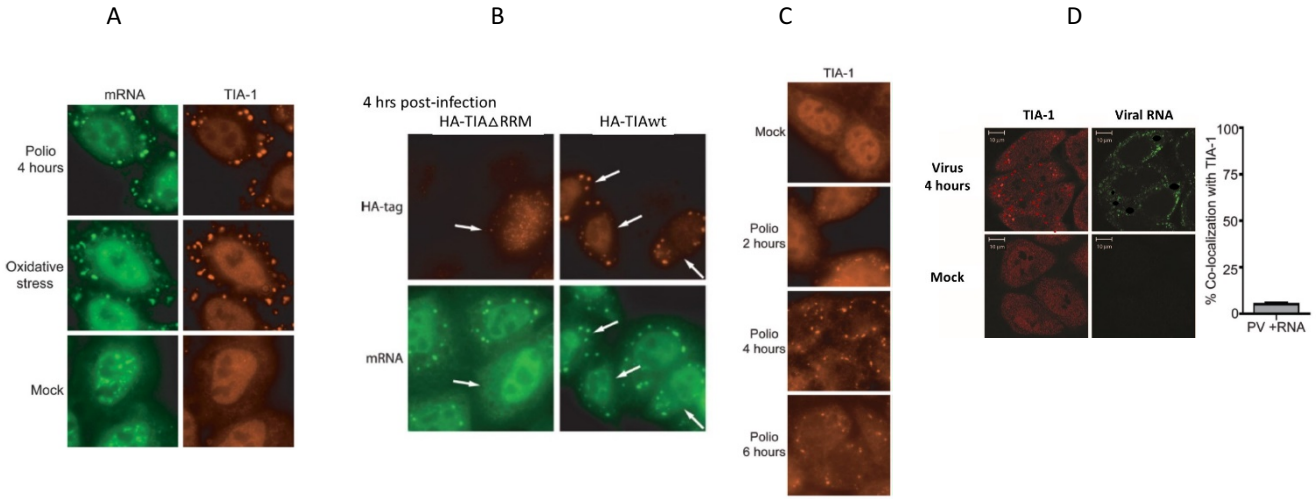
Table 1. Sample Rubric for JC Assessment.

Domains with Criteria	Needs Improvement (50-69%)	Satisfactory (70-79%)	Good (80-89%)	Exemplary (90-100%)	Not able to measure
Evidence of Preparation = notes, questions, knowledge of fundamental background material; clarity of responses	E.g. Little to no notes/questions, Most to all fundamental questions not answered at all or sufficiently quick	Mixed bag. E.g. Some nebulous/slow answers while others were better; responses not always clear	Eg. Extensive notes, questions, rapid, clear responses to fundamental questions but some gaps	Eg. Extensive notes, questions, rapid, clear responses to ALL question types, evidence of extra effort (e.g. other relevant sources mentioned)	Eg. Did not read
Evidence of Comprehension = The Why; Big Picture analysis; Assessment of interpretations of data; clarity of responses	Minimal or superficial understanding; many inaccuracies in explanations of experimental rationale; too trusting of author's interpretation	Some gaps in understanding; able to accurately explain some but not all; Big Picture is a little hazy.	Complete understanding of what they did and why; minor unexplained issues noted; Big Picture mostly there.	Complete understanding of what they did and why; noted major issues not addressed in the paper; Strong grasp of the Big Picture	Eg. Did not read
Caliber of Questions and Answers submitted; relevance; scope; well-argued and supported by lit	Questions extremely simple as were the answers (no evidence of having read the paper in depth)	Mixed bag of questions (some higher- minded than others)	Good questions related to the study with good in-depth answers	ALL questions and answers were relevant AND went beyond the scope of the study; all relevant/provocative/higher-minded; refs to support answers	Eg. No questions provided

Lower Order Bloom (Recall) Question:
This tests primarily their recall of what was discussed during the JC exercise.
Q: JC2 paper: I want you to write a clear and concise transition statement from Fig. 2 to Fig. 3. I will get you started but remember to keep to the theme of the paper. Up to 2 sentences max (2 points).

"Given that from Fig. 2 we can say that… (YOU FILL IN) …which brings us to the next figure, Fig. 3."

Higher Order Bloom (Synthesis) Question:
This tests their science analysis AND writing style.
Q: Here are some more figures from a paper related to JC1 but that you never read. Based on the results shown, synthesize a logical story using the figures. Rearrange the figures as you will but remember to setup, summarize, and then transition (where applicable) from one to another! (5 points)



A = HeLa cells were either infected with polio virus for 4 h, exposed to 0.5 mM sodium arsenite for 30 min, or mock (uninfected) prior to in situ hybridization to visualize mRNA (green fluorescence) and TIA-1 (red fluorescence), respectively.

B = HeLa cells were transfected with HA-tagged TIA mutant (ΔRRM) or wildtype and 48 hours later infected with polio virus for 4 hours before doing in situ for mRNA (green) and HA-tagged proteins (red). Arrows indicate transfected cells with HA-tagged proteins.

C = Hela cells were uninfected (mock) or infected for 2, 4, or 6 hours before staining for TIA-1 (red fluorescence).

D = HeLa cells were mock (uninfected) or infected with polio virus for 4 hours. Cells were stained for polio virus-specific RNA using in situ hybridization (green fluorescence) or TIA-1 using antibody (red fluorescence). The % of TIA-1^+ SGs having polio virus (PV) RNA were graphed from 3 independent experiments.