ARTICLE
An Undergraduate Course on Publishing in Neuroscience

Leslie Sargent Jones[1,2], L. Codi Black[1], Lauren Bright[1], Catherine Meekins[1], Vivek Thakur[1], and Cade Warren[1]

[1]South Carolina Honors College, [2]Department of Pharmacology, Physiology & Neuroscience, School of Medicine University of South Carolina, Columbia, SC 29208.

While scientific publishing is not typically taught to undergraduate students, we believe that an in-depth exposure to this topic might prove useful to those contemplating careers in neuroscience research or scientific writing and publishing. Here we describe a course designed to introduce students to most aspects of online publishing, from the details of editing to the ethics of scientific communication, from the specifics of how an online website works to the general debate between open-access and for-profit publishing. By having students learn about the theoretical issues in refereeing while actually reviewing submissions for the journal *IMPULSE*, the students gain practical knowledge about scientific publishing, a deeper understanding of the contemporary research environment, and intellectual confidence.

Key words: scientific publishing, peer review, science writing, undergraduate neuroscience journals, teaching publishing syllabus.

Providing research experiences for students has become increasingly important for all undergraduate educational institutions. The so-called Primarily Undergraduate Institutions (PUIs) have taken the lead in this area, but following the Boyer Commission Report (The Boyer Commission on Educating Undergraduates), and with the help of the Reinvention Center (www.sunysb.edu/Reinventioncenter/), the larger, Research I (RI) institutions have also started emphasizing primary scholarship as an important component of undergraduate education. However, for laboratory-based research, the experimental experiences are just part of the whole process of research, and what seems to be missing in the exposure of most undergraduates to authentic research is the opportunity to submit a written report of their results for peer review and the experience of reviewing the submissions of others. The students may write a final report for a grade, they may even be co-authored on a subsequent, published paper, but they rarely are the ones to write the submitted manuscript, respond to referee comments, and see their work through to publication. Undergraduates certainly are not the ones asked to review someone else's manuscript.

This important aspect of what happens after the manuscript is submitted, the processes of peer reviewing, editing, and publishing, is largely invisible to students. However, undergraduates who aspire to careers in research will not only write papers in the future, but they will also be expected to review them. Obviously, learning to review facilitates learning to write, but the opportunity to review scientific submissions is rare for undergraduates. Usually these experiences are limited to "reviewing" papers that are already published, and thus, theoretically at least, are not in need of much revision. While it may seem that reviewing scientific manuscripts genuinely needing revisions is too much to expect from inexperienced undergraduates, the grammatical skills of the highly ambitious, graduate school-bound student are often, in fact, quite sophisticated. Furthermore, their critical thinking skills are also quite good, and learning to review can only improve this ability so essential to advanced scientific pursuits, as evidenced in work by others (Thomas et al., 2002).

The present work describes a course that we have used at the University of South Carolina for the last three years to introduce students interested in careers in neuroscience to the publishing side of research. In our case, the course is coupled to the running of *IMPULSE*, the undergraduate journal for neuroscience hosted at USC (http://impulse.schc.sc.edu); all students wishing to join the review team must take the course. However, the syllabus suggestions reported here could easily be applied to any publication of undergraduate writing, whether created to showcase an institution's own scholars, or in another discipline. Indeed, if no submissions for an existing journal are available, most of the syllabus can still be used to form the framework of such a course, with imaginative use of published papers to fill-in for the sections of our course where "Open for submission review" is listed (Table 1). The point of the course is not to teach the students how to write a scientific paper — such courses already exist in plenty (just do a web search to find a sampling) — but to expose the students to the broader world of scientific publishing, from the practical issues to the philosophical challenges. The course has no prerequisite and is open to students of any year. The class is always very small (4-10), allowing for individualized feedback and training. It is also routinely mixed in make-up by year, providing for useful interactions between students of different levels of college experience. The students may take the course for 1-3 credits; this allows a student with a full schedule to add it so that they may join the review team, but the homework expectations might be modified somewhat (one student could not add the credit, so came to all classes and did all the work for no credit in order to be a reviewer). The course designation lists it as a 300-level course within the interdisciplinary Honors course listings. Other courses directed at somewhat similar questions, though not

Week	Topic	Material & Assignments
1	Undergrad, online journals; *IMPULSE*; review team organization	Students each find 2+ online, undergrad journals, then present sites to rest of class (pros/cons of navigation, design). Begin learning to edit with editing guidelines and marks.
2	Editing: methods and exercises	Correct handout of a poorly written, published paper for correction using supplied editing guidelines. Use student written "experiments."
3	Ethics in Scientific Communication	Read "Guidelines: Responsible Conduct Regarding Scientific Communication" from Society for Neuroscience. Each student presents a section of document and class discusses import of major points.
4	Open access publishing	Selected articles on pros & cons of open access vs. for-profit scientific publishing for discussion and debate by class
5	Impact Factor and h-index	Handout from Institute for Scientific Information and articles on role of Impact Factor in science (careers, article evaluation, directions of research).
6	Undergraduate journals	Selected articles on pros and cons of undergraduates publishing for discussion/debate
7	Reaching internationally; role of English on global science	Selected articles on science writing for non-native English speakers; impact of English on non-Anglophone articles (e.g., impact factor, web searches). Discussion of how to improve global reach of English-language science; find examples of journal with abstracts in translation
8	Misconduct in science/role of peer review	Selected readings on scientific misconduct examples, paper withdrawals, with some lecture and lots of discussion. This is updated annually as new, unfortunate examples emerge each year. Articles on role/value of peer review and alternatives.
9	Science lay publishing	Find lay article and then original science citation. Students present to class reliability of lay representation of science
10	Alternative media	Find examples of press releases; scientist web pages for discussion of their role, as well as meetings, poster/platform presentations (examples of SfN posters given; attend local poster event and critique posters)
11	Website design	Lecture by Information Technologist on *IMPULSE* website design. Students expected to learn general features (programs used) of site
12	Best undergrad journal	Find best undergrad journal website, present to class, and make recommendations of improvements to *IMPULSE*
13	Open for submission review	Submitted manuscript reviewed by class
14	Open for submission review	Submitted manuscript reviewed by class
15	Open for submission review	Submitted manuscript reviewed by class

Table 1. Sample Syllabus for a Scientific Publishing Course. This outline illustrates the series of topics covered in this course. Topics may be covered in a single class meeting, or extend over several meetings, depending on the length of each class. The topics take an average of two hours to cover, with some taking as much as four (e.g., Ethics).

necessarily for undergraduates, can be used for additional ideas on course construction (Guildford, 2001; Olds, 2002; Little and Parker, 2004).

General Course Objectives and Rationale for Order of Presentation

The primary objectives of the course Scientific Publishing (Neuroscience) were to have the students learn to: 1) understand the ethical considerations in scientific communication, 2) edit manuscripts, 3) review neuroscience manuscripts, and 4) write cogent and unemotional reviews. Secondary objectives included gaining an understanding of: 1) the international nature of neuroscience publishing, 2) issues in open-access publishing vs. subscription publishing, 3) the role of the impact factor, 4) peer review and dealing with scientific misconduct, 5) considerations in website design, 6) the role of an undergraduate journal, and 7) other forms of scientific communication.

In order to meet the primary objectives of the course, we actually start with an overview of existing, online undergraduate journals, including *IMPULSE*, in order to give the students a context for the course. Then we move to the second item on the Primary Goals list, editing, due to the fact that when we receive an *IMPULSE* submission during the semester the syllabus must be suspended temporarily while we review the paper, and the students need the rudiments of editing, at least, to begin reviewing. In the case of this type of course being taught without a journal to work on, then the order could be changed to put the other general topics first, and leave the nuts and bolts aspects of editing until later. Following the segment on editing skills, we return to the topic of ethics in scientific communication for several classes and proceed with a syllabus as outlined in Table 1.

In general, the course material is set out in an order that starts with practicalities and builds to the more theoretical issues in publishing. But the course topics lend themselves to rapid swings from the esoteric ("why can text be copied, quoted, and cited, but not figures?") to the banal ("why is the comma inside the quote marks?"), and a tidy, hierarchical ordering has not emerged. The following sections flesh out how the classes are designed to accomplish the objectives of the course.

Primary Objectives

1. Understand the ethical consideration in scientific communication

While learning to read and edit manuscripts is of the most practical importance, we view learning about the ethical considerations in scientific publishing to be of the greatest overall importance. To this end, we use the extensive document, "Responsible Conduct Regarding Scientific Communication" provided at the Society for Neuroscience website as our guide to this topic (Guidelines: Responsible Conduct, apu.sfn.org/content/AboutSfN1/Guidlines/guidelines.pdf). The students are assigned sections of this 28-page document to present in class, and we go over the entire document thoroughly.

There are a surprising number of topics for which the students do not see the need for guidelines; this usually precipitates the telling of anecdotes from the teacher's repertoire, and this is difficult to codify for another instructor's use. It would appear that a very junior scientist might have trouble relating to some of the issues, but there are always places to find documentation of misbehavior or problems that resulted in the need for specific sections of the guidelines (see examples in Judson, 2004). At the end of the course the students are asked to write a report on what they learned, focusing on what was most surprising. As one student wrote "I was surprised at the fact that the guidelines had to lay out clearly that 'Authors should not make personal attacks on other researchers,' who knew science could be so catty?" They also are surprised at the need for specific statements in the Guidelines, such as: "Accounts of a researcher's publication record should be accurate." They cannot imagine that some scientists would lie about their own record.

2. Learn how to edit manuscripts

In order to teach editing, we start by going over the standard editing marks, which are available at numerous websites (e.g., University of Colorado Publications and Creative Services at www.colorado.edu/Publications/styleguide/symbols.html). These lists and tables of editor's symbols provide a useful starting point for talking about grammar and language, as learning the symbols invites discussion of when they should be used. An assignment is given to the students to read a current submission to *IMPULSE*, if one is in the queue, or a poorly written, badly edited, published paper is given instead. The students are asked to use the symbols they are learning to mark up the manuscripts, and then we discuss their choices and decisions in class. There are usually a few students in the class who have, in fact, very strong backgrounds in style and grammar, and they help to teach the others in the class. Three references are used to clarify knotty points and for useful examples (Shertzer, 1986; Plotnik, 2000; Strunk et al., 2000). Other works are given as suggested readings, such as Truss (2003) but, interestingly, the students do not always find these as amusing as the instructor does.

3. Learn how to review neuroscience manuscripts

Learning to review the articles from a scientific standpoint is a more difficult task than proofing and editing. In this case, the underclass students in particular are intimidated by the idea of commenting on the science in a manuscript. Having upper class students in the course with a science (specifically neuroscience) background is very useful, but even these students can feel uncomfortable initially; they know their comments will be sent to a real person, an undergraduate like them. What appears to work well as a means of bolstering their confidence is to start by asking questions that are not about the science, per se, but about the organization of the manuscript. For example, a submission may have some of the results folded into the discussion section, or methods may be lost in the figure text. Strictly speaking, this is an editing issue, but by letting the students realize that they recognize logical errors in organization, their confidence grows, and they begin to see other logical errors, such as an incomplete description of a technique, or a missing control. Although it feels like a big step for the students, it is not that difficult to get them to apply their general understanding of how a scientific story should be told (for example: observe a phenomenon, generate an idea about it, formulate a hypothesis to explain the idea, design an experiment to test the hypothesis, collect and analyze data, interpret data in light of hypothesis, repeat). Once they make this connection, the lights go on as they grasp that much of what is wrong or right about an article is obvious simply by following the logical flow (or lack of it).

The correctness of the scientific details are checked in several ways: it is the primary role of the Faculty Advisor to serve as the backstop on the fact checking, which is done for all submissions in the same way as for any manuscript submitted to a scientist for review by any other journal. In cases where the work is beyond the expertise of the faculty member, colleagues with the appropriate discipline knowledge are recruited to help. The student reviewers are taught to use the internet extensively for their fact checking. Specifically, all citations are checked through PubMed (www.ncbi.nlm.nih.gov/entrez/query.fcgi) to assure accuracy not only of the bibliography, but also of the match between citation and fact-attributed-to-citation. The students thus learn and check simultaneously. Because the submissions are coming from undergraduates, the scope of the papers is not on the order of full reports to a mainstream journal, such as *Neuron*, so it does not take long for the students to appreciate their own abilities to comment on the work of peers.

An additional exercise for reviewing is to have the students perform and write up their own very small experiment on some easily tested hypothesis, such as: "Girls bring more opposite gender guests to their dorm." This can be easily measured in one hour of evening observation, and the study written as a brief report of one to two pages. This gives the student a small experience of organizing and presenting a research story. The reports

Review Form for Research Articles
to be Considered for *IMPULSE*

Article Title: _____
Date of Review:_____
Reviewers: _____ _____

The article is to be scored on the following criteria. There is a total of 100 points. 95 are necessary for publication with each category also having a minimum score. Please make specific notes in each category when points are deducted. The categories are listed in descending order with respect to points

I. ___/20 Correctness and Clarity of Conclusion
MIN 18—The paper must make scientifically sound interpretations of the results. The conclusion should be concise, while fully explicating the interpretation of the results.

II. ___/20 Presentation and Interpretation of Results
MIN 18—Results must be clearly and succinctly presented. Graphics must prove integral to the paper. This section of the paper should include not only the data, but also any statistical analyses performed on the data.

III. ___/16 Scientific Method
MIN 15—The paper will be judged strictly on its adherence to the principles of the scientific method. This includes but is not limited to sufficient background, statement and explanation of hypothesis, explanation of experimental method, presentation and interpretation of results, and clarity and correctness of conclusion.

IV. ___/15 Interest Level and Ability to Read
MIN 12—The article must maintain an appropriate level of scientific inquiry, while remaining accessible and engaging to the reader.

V. ___/10 Grammar, Punctuation, and Spelling
MIN 10—The paper must be *completely* free of any grammatical, punctuation, or spelling errors.

VI. ___/10 General Presentation
MIN 9—The paper must be visually appealing with regular margins, spacing, and text.

VII. ___/9 Thoroughness
MIN 8—The paper must completely explore all relevant aspects of the topic. It is also expected that the author will have included appropriate background sources, as well as references with supporting/opposing results.

TOTAL: ___/100 MIN 95 - ACCEPTANCE AS IS
MIN 70 - ACCEPTANCE PENDING REVISIONS

ACTION: ___ Accepted, as is
___ Accepted, Pending Revisions
___Declined

GENERAL COMMENTS:

Figure 2. Review Form for Research Articles. This form helps guide reviewers in their evaluation of original research articles. This encourages reviewers to comment on more than a few aspects of a manuscript, and to consider the value of each category.

are then exchanged among the classmates for peer review, and the results shared with the entire class, where they usually generate much lively discussion.

4. Learn to compose cogent and unemotional reviews

When a manuscript is received, the students are assigned to read it immediately (the syllabus is suspended). The manuscript is discussed in class and the process of reviewing is explained with the course instructor as the students review the paper and write a draft of a review. In a class where there is no affiliated journal with articles to write reviews for, another tool is needed. The students might be assigned to write reviews of published papers, with their reviews then shared and discussed in class. Alternatively, some generous local faculty members might be induced to submit their own manuscripts for review.

Review Form for Review Articles
to be Considered for *IMPULSE*

Article Title: _____

Date of Review:_____
Reviewers: _____ _____

The article is to be scored on the following criteria. There is a total of 100 points. 95 are necessary for publication with each category also having a minimum score. Please make specific notes in each category when points are deducted. The categories are listed in descending order with respect to points.

I. ___/20 Thesis and Conclusion
MIN 18—The article should have a clearly defined thesis to defend. This thesis should be presented in the Abstract and Introduction of the review. In the same way, the conclusions of the author must logically follow from the existing literature.

II. ___/16 Extent of Literature Review
MIN 14—As a review, the article should be extensive in the literature chosen. Seminal papers and research should be adequately covered, and the findings of this research incorporated into the thesis presented. The review should give a good overview of the current state of research.

III. ___/20 Presentation and Interpretation of Literature
MIN 18—Results must be clearly and succinctly presented. Graphics must prove integral to the paper and the logic of the review. The literature should be presented accurately and cited accordingly, especially considering the logical flow of the review.

IV. ___/15 Interest Level and Ability to Read
MIN 13—The article must maintain an appropriate level of scientific inquiry, while remaining accessible and engaging to the reader.

V. ___/10 Grammar, Punctuation, and Spelling
MIN 10—The paper must be *completely* free of any grammatical, punctuation, or spelling errors.

VI. ___/10 General Presentation
MIN 9—The paper must be visually appealing with regular margins, spacing, and text.

VII. ___/9 Thoroughness
MIN 8—The paper must completely explore all relevant aspects of the review topic. It is also expected that the author will have included appropriate background sources, as well as references with supporting/opposing results.

TOTAL: ___/100 MIN 95 - ACCEPTANCE AS IS
MIN 70 - ACCEPTANCE PENDING REVISIONS

ACTION: ___ Accepted, as is
___ Accepted, Pending Revisions
___Declined

GENERAL COMMENTS:

Figure 3. Review Form for Review Articles. This form helps guide reviewers in their evaluation of review articles. This encourages reviewers to consider more than just whether they liked it, and focus on whether the literature was sufficiently surveyed, for example.

After the in-class review, the students are divided up and assigned to one of the existing review sub-teams. These teams are made up of three or more students who took the class earlier, and are now senior members of the

IMPULSE review board. Each team member writes a guided review based on a series of questions with numeric ratings attached to help them weight the value of their comments in different categories (See Figures 2 and 3). An Associate Editor leads each group, and the students currently in the course meet with their assigned team to go over each group member's review of the manuscript; the Associate Editor is responsible for mentoring the new students during this process. Subsequently, the entire local team meets with the Faculty Advisor to discuss the manuscript and their combined comments further. Thus, the new members participate in three levels of reviewing: in class with instruction, with their sub-team under the guidance of an experienced Associate Editor, and with the whole team. Each sub-team comes up with a set of review comments that are forwarded to the Editor, who integrates the groups' comments for the final review. Despite having the multiple level of reviewing, the comments on submitted manuscripts are returned to the authors within one month. If the authors return their revisions rapidly, a manuscript could be posted in as little as two months from submission.

Secondary objectives

1. Appreciate the international nature of neuroscience publishing

Many undergraduates are fairly unaware of the international extent of research; they see papers are in English and assume most of it is produced by Anglophones. Recognizing that neuroscience is published in every continent (save Antarctica), and research pursued in most countries, even developing nations, is an important part of the students' growth as scholars. To introduce this concept they are assigned readings on the challenges to non-Anglophone authors (e.g., Ancker et al., 2002; Simpson, 2002), the bias inherent in impact factor calculations for non-Anglophone work (van Leeuwen et al., 2001), the challenges for browser searches in non-Anglophone languages (e.g., Bar-Ilan and Gutman, 2003), and the role of translation in globalizing science. While simple solutions to the polyglot problem are not obvious, discussing the issues faced by non-Anglophone scientists promotes thinking of ways to improve global intellectual access.

2. Examine the issues in open-access vs. subscription journals

The debate on the topic of open-access publishing has grown along with the web's increasing contribution to public awareness of and access to primary research. The controversy, well documented through lay reports and articles in sources such as National Public Radio, *Science*, and *The Chronicle of Higher Education*, strikes the students as curious at first; they are instinctively in favor of open-access, all the time. But through reading articles presenting both sides of the issue (e.g., Ewing, 2004; Gass and Doyle, 2005; Koonen et al., 2006), they come to appreciate that the problem is more complex than it first appears, and that our own journal is not run for free, but is subsidized. This epiphany about the cost of publishing comes with the recognition of their own efforts, and that the burden must be borne by someone; if not the readers, who else? This prompts a more interesting and thoughtful exploration of possible answers than was possible before the readings and their own time spent working with their journal.

3. Learn about the impact factor and h-index

The role of the impact factor in the career advancement of scientists is well known to the faculty. However, the existence of this magic number is essentially invisible to undergraduates. It is a revelation to them to learn that such a thing exists, and then how it is calculated and what a powerful role it plays in their professors' lives. They are incredulous initially, but with the help of various readings (e.g., Monastersky, 2005a) and some time spent with Science Citations Index through the ISI Thomson website (www.isinet.com), they begin to understand how and why this is calculated.

The students are assigned the task of calculating the h-index (see Monastersky, 2005b) for a specific researcher, and that also is an eye-opener. This segment of the course usually generates a great deal of "but why…?" questions that result in unresolved debate on just how one *should* measure contribution, productivity, and value in the sciences. For this portion of the course the students must look up the impact factor for a particular journal. They are asked to pick a journal where a faculty member they know has published. This information, combined with finding the h-index data on that faculty member, is a sobering lesson for them; grading for scientists does not stop when they leave school.

4. Peer review and dealing with scientific misconduct

While peer review is largely the gold standard for manuscript assessment in the sciences, there are disciplines that are moving away from it, and others that are exploring interesting alternatives (Vastag, 2006). There is also some debate each time a new, dramatic case of scientific misconduct emerges as to whether peer review is "broken" and should be replaced. Using articles such is a recent review by McCook (2006) exploring this exact question, the students are interested to learn that their assumptions about the role of and necessity for peer review may be incorrect. Certainly they have had no experience of doing it, and having the opportunity to study peer review through the prism of their own responsibility as a reviewer for *IMPULSE* is very educational. But even if the students in a course are not actively reviewing, thinking about the process specifically and what it is intended to accomplish for journals and for granting organizations is very useful.

5. Learn about journal website design

The website used by *IMPULSE* was designed by the founding student team in collaboration with the Information Technology Director at the Honors College, William Morris. Subsequently, the site went through a redesign in the spring of 2005 to accommodate the switch to immediate posting of accepted articles (see Fig. 4). The students are encouraged to learn as much as possible about the

website design and programs used to support it. To that end, one week of the course is devoted to studying the web architecture and appreciating why certain functions exist, while others may not be feasible. The students often have interesting suggestions about the site, and the advantage of an online journal is that it is flexible and the team can make modifications to the site as they see a need. If the course were to be offered without a journal, the rest of the segment could still be pursued: the students are given the assignment of selecting several other online

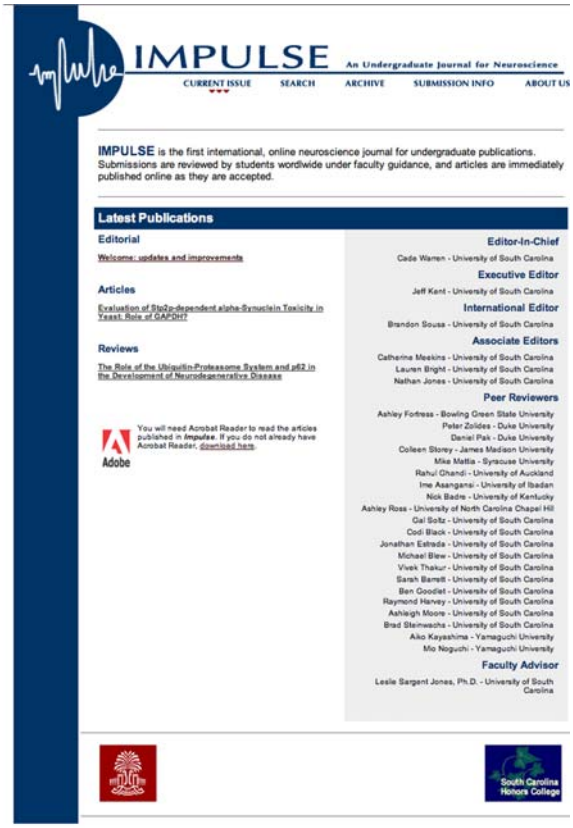

Figure 4. *IMPULSE* cover Spring 2006. The cover is dynamic, with articles added to the cover as they are posted to the site. The issue will be moved to the archive at the end of the calendar year. All of the editorial team is listed on the cover to emphasize the inter-institutional character of the journal.

journal websites, both undergraduate and mainstream, to compare website options, features, and bugs. While the students in this course are assigned to make suggestions on ways to improve our existing site, a useful assignment would be to have the students design a mock-up of a journal website of their own design. Presenting these in class and comparing their different choices in website appearance and function would be an excellent teaching tool both specifically for journal website design, and website structure generally.

6. Study the debate on the role of undergraduate journals

It is still not widely seen that there is a place for undergraduate journals in the sciences, whether the journal is for reviews or primary research. There have been articles debating the point (Gilbert, 2004; Jungck et al., 2004; Siegel, 2004), but we concur with Seymour et al. (2004) that the final step of research, "the dispersing/sharing a new scholar's discoveries with his or her peers" is, sadly, "—a specific step traditionally missing in most undergraduate educational programs." The students spend time reviewing other undergraduate journals in several different disciplines, and then discussing the pros and cons of offering this outlet for undergraduate work. While we are clearly coming to the discussion with a bias for this means of publishing for undergraduate students, it is important for the incoming students to be familiar with the concerns of those who do not see this type of journal as playing a useful role for the students, for their faculty, or even for their discipline. Most students do understand some of the potential problems with undergraduate journals, and it helps us focus the role and goals of *IMPULSE* (see Table 2) to have these discussions. For students not allied with a journal, they can examine the subject more dispassionately, and perhaps conclude that publishing in a mainstream journal is the only acceptable mechanism for reporting findings; the corollary being that findings not acceptable to such a journal are therefore not worthy of publishing.

Primary Goals of *IMPULSE*
▪ Provide an outlet for undergraduate-age students (17-23) to publish the results of their original research and literature reviews. ▪ Offer undergraduates the opportunity to learn about manuscript reviewing by being peer reviewers. ▪ Serve as a training opportunity for students interested in careers in science or science writing.

Table 2. The three primary goals initially identified when *IMPULSE* was created.

7. Compare other forms of scientific communication (lay articles, websites, radio)

Because scientific information is presented in formats other than scientific publications, it is useful to spend a little time during the course to study examples of some other means to relay scientific findings. One assignment involves the students finding a lay article about a result, and then finding the scientific report the article is describing, and determining how accurately the lay article reflects the original report. In some cases, the lay article may be a very good rendition of the science, but often it misses the mark, usually through oversimplification. In some cases the results are so simplified as to be no longer entirely true. This can be seen occasionally even in the most highly recognized newspapers and magazines, and other venues one might overlook, such as museums, "informative" websites, and radio programs. In addition, if there is a meeting on campus during the course, the students are assigned to review a number of posters, and this method of presentation is also usefully examined. Some of the students may be considering careers in science writing, and this portion of the course is of particular interest to them.

CONCLUSIONS

It is our opinion that learning about the process of scientific publishing is a valuable addition to the training of a future neuroscientist, science writer, or clinician. Five co-authors on the paper are students who took the course and wrote drafts of this manuscript, detailing their experience, and the value of it, in their report. Each semester the students are asked to write an evaluation of the course, and all of the students have found that they ended up valuing the course more highly than they had imagined they would. One poignant comment was "It seems rather foolish now, but one of the things I was excited to discover was the fact that undergraduates could be so involved in the scientific publishing process." Another commented that "Through this class I knew that I would learn a lot about the 'ins and outs' of the development of publishing a paper…I did not realize how complex the process was…the class syllabus did an excellent job focusing on some really interesting issues…I took great pleasure in taking this class and look forward to continued participation as a peer reviewer." The recurring theme was that students did not know how much there was to learn.

Understanding how manuscripts are handled after they are written is not something most students see. Through this course, they gain an appreciation for what happens once a paper is written, which is usually as much as students experience (and they are not usually the ones writing). The students see the manuscripts come in, how reviewing is accomplished, and learn about the myriad considerations involved in reviewing. Examples of these run from grammar to style, from citation correctness to novelty of material, from ethical treatment of subjects to fair attribution of authors. The students help put together the comments written up as a review that are returned to authors. They learn about how impact factor and peer review influence the careers of scientists, as well as how choosing a publication language, open versus paid access, and online versus paper affect the likelihood of acceptance, the visibility, and eventual citation count of a submission. These practical topics may be viewed by some as better taught at the graduate level; in fact, we believe it would be useful if they were covered there as well. However, we also think that, as more schools encourage their undergraduates into primary research experiences, the students should have access to the full dimensions of that exposure, including learning how to write a manuscript, peer review a manuscript, and participate in the publication of an accepted work. Many schools now offer courses on scientific writing, which is a wonderful advantage for students considering science careers. We conclude that offering a course on the next step in the scientific process, that is, learning about peer review, revision, and publishing, is an enriching experience in the development of nascent neuroscientists.

REFERENCES

Ancker, J, Nylenna, M, Cann, CI, Bloom, M, Mlyniec, W, Simpson, C (2002) Publication issues for non-anglophone scientists. Science Editor 25:5-6.

Bar-Ilan J, Gutman T (2003) How do search engines handle non-English queries? – A case study, WWW Alternate Paper Tracks www2003.org/cdrom/papers/alternate/P415/BARILAN.HTM.

The Boyer Commission on Educating Undergraduates in the Research University Reinventing Undergraduate Education: *A Blueprint for America's Research Universities* 1998 naples.cc.sunysb.edu/Pres/boyer.nsf.

Ewing JH (2004) Open access to journals won't lower prices. Chron Higher Ed 51:B20.

Gass A, Doyle H (2005) The Reality of open-access journal articles. Chron Higher Ed 51:B13.

Gilbert SF (2004) A case against undergraduate-only journal publications. Cell Biol Ed 3:22-23.

Guilford W (2001) Teaching peer review and the process of scientific writing. Adv Physiol Ed 25:167-175.

Judson HF (2004) The Great Betrayal: Fraud in Science, Harcourt, Inc. Orlando, FL.

Jungck JR, Harris M, Marcuri R, Tusin J (2004) Undergraduates: Do research, publish! Cell Biol Ed 3:24-26.

Koonin EV, Landweber LF, Lipman DJ (2006) A community experiment with fully open and published peer review. Biol Direct. 1:1.

Little JW, Parker R (2004) How to Read a Scientific Paper, course notes. University of Arizona, AZ, 85721, www.biochem.arizona.edu/classes/bioc568/papers.htm#evaluate.

McCook A (2006) Is peer review broken? The Scientist Feb:26-34.

Monastersky R (2005a) The number that's devouring science. Chron Higher Ed 52:A12.

Monastersky R (2005b) Impact factors run into competition. The Chron Higher Ed 52:A17.

Olds B (2002) Academic Publishing Seminar course syllabus. Colorado School of Mines, CO 80401. www.mines.edu/Academic/courses/lais/licm598/licm598.html.

Plotnik A (2000) The Elements of Editing. New York, USA: Macmillan.

Responsible Conduct Regarding Scientific Communication, provided at the Society for Neuroscience website, http://apu.sfn.org/content/Publications/Guidelines2/index.html.

Seymour E, Hunter A-B, Larsen S, DeAntoni T (2004) Establishing the benefits of research experiences for undergraduates: First findings from a three-year study. Sci Ed 88:493-531.

Shertzer M (1986) The elements of grammar. New York, USA: Macmillan.

Siegel V (2004) Weighing the pros and cons of undergraduate-only journal publications. Cell Biol Ed 3:27.

Simpson C (2002) Publication issuer for non-Anglophone scientists. Science Editor 25:5-6.

Strunk Jr. W, White EB, Angell R (2000) The elements of style, Fourth Edition. New York, USA: Macmillan.

Thomas J, Rewer KL, Davis SF (2002) Professional development benefits of publishing in the Psi Chi Journal of Undergraduate Research. Eye on Psy Chi 6:30-35.

Truss L (2003) Eats, shoots & leaves. New York, USA: Penguin Group.

Van Leeuwen TN, Moed HF, Tussen RJW, Visser MS, van Raan, AFJ (2001) Language biases in the coverage of the Science Citation Index and its consequences for international comparison of national research performance. Scientometrics 51:333-346.

Vastag B (2006) Cancer fraud case stuns research community, prompts reflection on peer review process. J Natl Cancer Inst 98:374-376.

Received April 03, 2006; revised May 19, 2006; accepted May 25, 2006.

We wish to acknowledge the generous support of the South Carolina Honors College of the University of South Carolina. We also thank William Morris for his continuous support of both the journal and the course.

Address correspondence to: Dr. Leslie Sargent Jones, South Carolina Honors College, University of South Carolina, Columbia, SC 29208. Email: leslie@schc.sc.edu.