Scientific Writing Training for Academic Physicians of Diverse Language Backgrounds
Carrie Cameron, PhD, Stephanie P. Deming, Beth Notzon, Scott B. Cantor, PhD, Kristine R. Broglio, MS, and Walter Pagel

Abstract

Research articles are the coin of the realm for anyone working in academia, including those working in biomedical research. Success or failure to publish research determines a biomedical researcher’s career path. Of perhaps greater concern, the ability to clearly communicate one’s research findings determines the extent to which those findings can be used as the basis for research by others. Although programs to teach effective writing are offered in some departments and institutions, few have been undertaken at the institutional level. Throwing the need for such training into greater relief is the fact that, at the same time that English is becoming increasingly dominant as the language of science, a rapidly growing number of U.S. trainees and faculty do not speak English as their first language. Indeed, the National Science Foundation reports that the number of foreign scientists and engineers working in academia in the United States has more than doubled in the last 35 years, whereas growth in the publication of internationally coauthored articles rose by more than 100% in the United States from 1988 to 2003. The trend toward globalization of science and engineering is accelerating, the prevalence of English as the language of research publication is expanding, and the need for linguistically sophisticated English-language writing and publishing support is greater than ever. With the current climate of research publication in mind, instruction in the conventions of English-language scientific writing should be an integral part of career development for both native and nonnative English-speaking researchers. A focus-group study of nonnative English speaker (NNES) trainees and their mentors conducted in 2002 by the Department of Scientific Publications at The University of Texas M. D. Anderson Cancer Center revealed that both trainees and mentors were frustrated about a lack of skill in scientific writing. NNES trainees represent a sizeable population at M. D. Anderson. Institutional demographics indicate that 473 of 666 (71%) postdoctoral fellows are of international origin, along with 67 of 307 (22%) clinical residents. (The category “international” is determined by visa status and does not necessarily indicate that the native language is not English.) Study results indicated that trainees were frustrated because they struggled with writing research articles in English, and mentors were frustrated because the articles often seemed unpublishable, requiring laborious revision. Postdoctoral fellows suggested that many principal investigators were not able to provide appropriate guidance in writing, especially to writers who were not fluent in English. Faculty acknowledged that

Writing manuscripts and reading manuscripts are key tasks in academic life. We are, in general, poorly prepared.

—Anonymous participant of a faculty writing workshop

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they often simply rewrote student drafts themselves rather than providing developmental feedback.\textsuperscript{11} To address these expressed concerns, the senior vice president for academic affairs challenged the Department of Scientific Publications to develop a scientific writing education program.

**Development of a Scientific Writing Workshop**

It was clear from the focus groups that both faculty and trainees needed scientific writing support.\textsuperscript{11} Rather than referring the nonnative speakers to general English as a second language (ESL) classes and then developing a writing workshop for native speakers, the Department of Scientific Publications envisioned a workshop that could be useful for all trainees (assuming a basic threshold of English competence). The effort was guided by a steering committee consisting of the director, assistant director, education coordinator of the department, and a senior editor experienced in teaching writing at the undergraduate level. Once the steering committee identified a set of key learning objectives (List 1) with corresponding curriculum features, they organized the features into modules. The steering group outlined the goals of the modules based on needs assessments, and the curriculum development group, consisting of associate and scientific editors and the publications managers, then designed interactive programs for each module. These were reviewed by the steering committee, revised one or more times, and finalized, and a handbook for the students was prepared. To assist with more technical aspects of curriculum development, an expert in scientific writing and science journalism and an expert in adult learning served as external consultants. Finally, the editors who helped create the curriculum needed support in developing the skills required to teach writing—a very different set of capabilities from those they already possessed. The team received start-up and ongoing professional development in presentation and instructional methodology to bridge their transition from editing to teaching.

The result of this intense curriculum and staff development program was an 18-contact-hour workshop, “Writing and Publishing Scientific Articles” (WAPSA).

**List 1**

**Learning Objectives of Writing and Publishing Scientific Articles, Department of Scientific Publications at the University of Texas M. D. Anderson Cancer Center, Houston, Texas**

**Global Objectives**

1. Use verb tenses appropriately in each section.
2. Use consistent terms and phrasing for similar concepts throughout the manuscript.

**Preliminary Steps**

1. Write an effective hypothesis or purpose statement.*
2. Describe when you would use a purpose statement versus a hypothesis statement.
3. Describe the importance of identifying your audience before you write.
4. Describe the advantages of using an outline when writing your article.

**Writing the Introduction Section**

1. State the purpose of the introduction.
2. Identify the parts of a good introduction.*
3. Explain how a funnel reflects the structure of a good introduction.
4. Explain the importance of stating the gap in knowledge.

**Ethical Issues in Scientific Publishing**

1. Apply the necessary criteria to be considered an author.*
2. Recognize what must be kept confidential during peer review.
3. Recognize plagiarism.*
4. Recognize what dual submission and duplicate publication are.
5. Recognize what might be considered conflicts of interest as an author, editor, or peer reviewer.

**Writing the Methods and Results Sections**

1. Describe what should and should not be included in the methods section.
2. Describe what should and should not be included in the results section.
3. Relate the results section to the methods section.*

**Navigating the Peer Review Process**

1. Recognize the conventions of the peer review process.
2. Diplomatically and effectively respond to peer review comments.
3. Describe how to work effectively with journal staff.

**Writing the Discussion Section**

1. State the purpose of the discussion.
2. Describe what goes into a good discussion.*
3. State your conclusions as an answer to your research question, hypothesis, or purpose.*
4. Diplomatically explain contradictions between your findings and others’.
5. Summarize others’ data succinctly and accurately.

**Writing the Abstract**

1. State the purpose of the abstract.
2. Recognize what belongs in the abstract.
3. Recognize what does not belong in the abstract.*

**Writing an Effective Title**

1. Describe the purposes of the title.
2. Recognize the features of an effective title.

**Cohesion and Clarity**

1. Identify features of linear scientific writing.
2. Distinguish between clear, strong, and precise writing and that which is vague, weak, or general.
3. Use transitions effectively.*
4. Streamline writing by shortening sentences and eliminating wordiness.

* Indicates an objective that has a corresponding test question on the preworkshop and postworkshop assessments.
First rolled out as a series of 12 weekly 1.5-hour modules, it is now offered as a series of three 6-hour modules offered during three consecutive weeks. Experience has shown that the course is effective for both NNES and native English speaker (NES) postdoctoral fellows, graduate medical education fellows, and residents.

**Workshop Design and Methodology**

Research in applied linguistics has shown that NNES writers can benefit immediately from explicit instruction in the structural and rhetorical requirements of the English-language scientific article regardless of their mastery of English grammar.1–10,13,14 The workshop is designed to explain these requirements. Divided into nine units during three days (Table 1), the workshop follows the widely accepted IMRAD (introduction, methods, results, and discussion) format, covering topics such as what should and should not be included in the various sections of the article, how to build the sections, how much background to use, how to discuss others’ work appropriately, and how to note limitations of a study. The rhetorical expectations of an English-language article are also articulated explicitly, explaining the tendency to employ a linear, unified, instrumental style of writing, which includes explicit hypothesis or purpose statements, structured and discrete paragraphing, a strong authorial voice, limited discourse, open advocacy for the author’s interpretation, restricted amounts of background information, and others.9–10,13 Workshop participants are also introduced to the cultural conventions of biomedical publishing, such as the peer review process and publishing ethics, and they explore questions such as “How should reviewer comments be handled?” “Who qualifies for authorship on a paper?” and “What constitutes plagiarism?” Finally, workshop time is devoted to techniques for writing with clear and cohesive language and to getting started writing and managing the writing process.

Three weeks before each workshop, a registration announcement is e-mailed to all postdoctoral fellows at the institution with an attached registration form. Participants are required to fill out the

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Curriculum for Writing and Publishing Scientific Articles, Department of Scientific Publications at the University of Texas M. D. Anderson Cancer Center, Houston, Texas</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit</strong></td>
<td><strong>Questions considered</strong></td>
</tr>
<tr>
<td>Preliminary Steps</td>
<td>• How do I get started writing?</td>
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<tr>
<td></td>
<td>• What does a good hypothesis or purpose statement look like?</td>
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<td></td>
<td>• How do I choose a journal?</td>
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<tr>
<td>Writing the Introduction Section</td>
<td>• What should I include in the introduction?</td>
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<tr>
<td></td>
<td>• What is the right amount of background information?</td>
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<tr>
<td></td>
<td>• How do I effectively structure this section?</td>
</tr>
<tr>
<td>Ethical Issues in Scientific Publishing</td>
<td>• How is authorship decided?</td>
</tr>
<tr>
<td></td>
<td>• What ethical rules must be followed during peer review?</td>
</tr>
<tr>
<td></td>
<td>• What is plagiarism?</td>
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<tr>
<td></td>
<td>• What are dual submission and duplicate publication?</td>
</tr>
<tr>
<td>Writing the Methods and Results Sections</td>
<td>• What should I include and exclude?</td>
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<tr>
<td></td>
<td>• How should I organize these sections?</td>
</tr>
<tr>
<td>Navigating the Peer Review Process</td>
<td>• How do I write a good cover letter?</td>
</tr>
<tr>
<td></td>
<td>• How should I respond to reviewer comments?</td>
</tr>
<tr>
<td></td>
<td>• Can I request or exclude reviewers?</td>
</tr>
<tr>
<td>Writing the Discussion Section</td>
<td>• How do I effectively structure this section?</td>
</tr>
<tr>
<td></td>
<td>• How do I state my conclusions and interpretations?</td>
</tr>
<tr>
<td></td>
<td>• How do I discuss others’ work?</td>
</tr>
<tr>
<td></td>
<td>• How do I deal with limitations or negative findings?</td>
</tr>
<tr>
<td></td>
<td>• What kinds of things might I talk about to explain the significance and implications of my work?</td>
</tr>
<tr>
<td>Writing the Abstract</td>
<td>• How do I limit the amount of information in the abstract but still retain the key elements?</td>
</tr>
<tr>
<td></td>
<td>• How can I make sure my abstract fully and accurately represents my work?</td>
</tr>
<tr>
<td>Writing an Effective Title</td>
<td>• What is the best format for the title?</td>
</tr>
<tr>
<td>Cohesion and Clarity</td>
<td>• What elements of the study should be mentioned in the title?</td>
</tr>
<tr>
<td></td>
<td>• How can the document be structured globally?</td>
</tr>
<tr>
<td></td>
<td>• What can I do to make my paragraph structure well organized?</td>
</tr>
<tr>
<td></td>
<td>• How can I make my words and sentences clear, powerful, and efficient?</td>
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</tbody>
</table>

* For the in-class manuscript-writing exercises, students use templates that list the content and organization principles presented in the workshop and prompt students to fill in blanks to create the outline of a full research paper.
form and indicate their readiness to write a research article, their mentor’s approval, and the participant’s commitment to attend for the duration of the workshop. In the event that more requests for registration are received than there are spaces available, participants are selected on the basis of how close they are to beginning a manuscript. In most instances, approximately two to seven registration requests must be deferred because of space limitations.

Teams of two or three experienced biomedical editors lead the workshops, which are limited to a maximum of 20 participants; a faculty member leads the discussion on the peer review process. During each unit of the workshop that covers a manuscript section, approximately 20 minutes is set aside for participants to draft the corresponding section of their own real article in progress. During this time, they receive immediate one-on-one feedback from the instructors. On completion of the workshop, each participant is paired with an editor—advisor who works with the participant for the duration of his or her time at the institution. The task-based approach (practicing on manuscripts in the workshop) and the basis in genre pedagogy (structure and rhetorical style)13 comprise the essential features of the workshop. Other important instructional features include providing templates and checklists for each section of the manuscript, analysis of effective and mocked-up ineffective examples drawn from the literature, and the individualized support provided by seasoned publication “insiders” (biomedical editors).

Measuring Effectiveness
The first WAPSA workshop was held in March 2003; as of November 2007, more than 300 trainees and GME fellows had participated in 22 WAPSA workshops.

Qualitative feedback from participants has been robustly positive and has included many comments validating the design focus on structure and rhetoric (List 2). The NNES writers in particular often note that they find the discussions of English-language structural and rhetorical preferences particularly illuminating, yet NES authors also report benefiting from these discussions, suggesting that these elements of English expository writing may have been lacking from their previous education. Suggestions for improvement were primarily focused on logistical concerns, with roughly equal numbers of respondents requesting the workshop be extended and requesting the workshop be condensed. The section of the workshop that was most often requested to be condensed was How to Write the Methods and Results Sections, because these sections of the manuscript are composed of objective reporting with little or no interpretive discussion.

Confidence self-assessments were conducted immediately before and after the workshops, separate from the satisfaction-based evaluations. Questions probed respondents’ confidence levels in getting started writing, writing an article that would be accepted for publication, recognizing a well-written research article, writing a good introduction section, writing a good discussion section, and writing a good abstract.

Results indicated increases in participants’ confidence levels on these measures of 1.12 to 1.44 points each on a five-point Likert scale (1 = very confident, 2 = confident, 3 = slightly confident, 4 = unconfident, 5 = very unconfident). Although the qualitative results based on immediate in-class evaluations and confidence assessments before and after the workshop were encouraging, we sought to address the problematic issue of obtaining more objective and longitudinal data on the effectiveness of the course material. Measuring the effectiveness of writing interventions is notoriously difficult. Because an article can be perfectly written but lack an interesting problem or be based on unsound methodology, acceptance for publication cannot be used as a meaningful metric unless one has access to all reviewer comments. Measuring the improvement rate of an individual author (by increase in rate of acceptance to peer-reviewed journals) also has many complications, such as whether the author has had a study to publish, whether he or she was the primary author, etc. For these reasons, we devised a survey method that, although not based on purely objective criteria, would give us more reliable information than that of the in-class evaluations. The survey was offered at least six months after the participants’ experience with WAPSA and directly questioned their experience with writing and publication after taking the workshop. The survey questions are outlined in Table 2.

Surveys were sent in November 2005 and May 2006 to 116 former WAPSA participants who had finished the

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List 2
Feedback From Trainee and Faculty Participants in Writing and Publishing Scientific Articles, Department of Scientific Publications at the University of Texas M. D. Anderson Cancer Center, Houston, Texas, 2005–2007

Feedback from trainees workshop:

- The manuscript outlines clarified a lot of prior misperceptions.
- The discussion section is extremely useful; the results section was well organized as well.
- [I liked] the difference I got to know between results and discussion.
- [I liked] discussing how to structure a hypothesis sentence.
- [I liked] linear writing; discussing examples of poor intros.
- [I liked] very concrete guidelines—illuminating the underlying structure of the papers.
- [I liked that we] interview each other and make own introduction.

Feedback from the faculty workshop:

- Overall an excellent workshop—very good at reducing fear of writing.
- It is a very good opportunity to learn how to think and write according to the “logic structure” (Chinese speaker).
- I learned a lot. Now I have confidence to finish my paper.
- This should be required for every student, postdoc, and/or trainee. My dissertation would have been so much easier and better if I had had this workshop.
- Highly needed and strongly recommended for everybody.
- Amazingly useful; make it mandatory for all faculty/students.
workshop from 6 months to 2.5 years before receiving the survey. Forty-six former WAPSA participants, 24 from the November 2005 survey group and 22 from the May 2006 group, completed a survey, for an overall response rate of 39.7%. Respondents included 30 NNES, 12 NES, and 4 respondents who declined to identify their native language.

Table 2 illustrates the survey results. Participants from 10 language backgrounds, including 12 native speakers of English and 17 native speakers of Chinese, plus others including speakers of Turkish, Spanish, Arabic, Hindi, Portuguese, and Japanese, believed the course had improved their writing, made it easier to start writing, and helped them get an article published.

Table 2
Results of Follow-up Survey in 2005–2006 of Scientific Writing Workshop Participants 6 Months to 2.5 Years After Completing the Workshop, Department of Scientific Publications at the University of Texas M. D. Anderson Cancer Center, Houston, Texas

<table>
<thead>
<tr>
<th>Survey item</th>
<th>No. (%) agreeing or strongly agreeing</th>
<th>Overall</th>
<th>Native English speakers</th>
<th>Nonnative English speakers</th>
</tr>
</thead>
<tbody>
<tr>
<td>The course helped me improve my writing.</td>
<td>45/46 (97.8)</td>
<td>12/12 (100)</td>
<td>29/30 (97.0)</td>
<td></td>
</tr>
<tr>
<td>The course made it easier to get started writing.*</td>
<td>37/46 (80.4)</td>
<td>7/12 (58.3)</td>
<td>27/30 (90.0)</td>
<td></td>
</tr>
<tr>
<td>The course helped me get my article published.*</td>
<td>25/44 (56.8)</td>
<td>4/12 (33.3)</td>
<td>20/29 (68.9)</td>
<td></td>
</tr>
<tr>
<td>My principal investigator makes fewer corrections to my manuscripts.</td>
<td>28/45 (62.2)</td>
<td>8/12 (66.7)</td>
<td>19/30 (63.3)</td>
<td></td>
</tr>
</tbody>
</table>

* Numbers of native English speakers and nonnative English speakers do not add up to 42 because of nonresponse on some survey items.

Participants were also asked about their success in completing manuscripts and in publishing manuscripts. In response to the question, “How many manuscripts have you finished writing since the workshop?” 3 participants (7%) said two or more, 19 participants (42%) said one, and 23 participants (51%) said none. These data are limited by the fact that there is no previous basis for comparison, and again by the fact that manuscript completion and publication depend on a wide range of factors.

Although just more than half (51.1%) of the respondents reported not having had a manuscript accepted for publication after attending the workshop, the reasons they gave for not completing or publishing more manuscripts frequently indicated external issues as the cause of the delay. For example, 37% reported that they “delay or procrastinate for reasons not related to writing,” 26.1% reported that they “haven’t had enough data to complete a manuscript,” and 23.9% reported that “because of general conditions in [their] work environment it’s difficult to proceed sometimes,” a category that was deliberately left vague as an option for respondents who were reluctant to report problems with coworkers or principal investigators in the lab. Respondents were allowed to check more than one reason. By contrast to the delays not related to writing, delays related to writing problems were minimal: 2.2% (1) reported that the “class did not cover the things [they] most needed help with,” 0 respondents reported that “they forgot what [they] learned in the workshop,” 2.2% (1) reported that they “thought [they] understood the material in class but when [they] tried to write it down [they] weren’t sure what to do,” and 10.9% (5) reported that they “still delay because [they’re] unsure about writing.”

Interestingly, although little accommodation was made for ESL-specific issues, such as grammar and vocabulary, the NNES group reported greater benefit from the workshop on these survey items than the NES group in the areas of “getting started writing” and “getting published.”

Extending the Program

Our subsequent work indicates that this approach to scientific writing training is useful to experienced faculty as well. Although initially we were unsure whether faculty would devote time to a writing workshop, we were sufficiently encouraged by the success of the trainee writing program to develop a condensed version of the workshop for faculty, first offered in October 2005. This program is exclusively devoted to writing the parts of the manuscript and uses the same pedagogical methods as in the longer trainee program. Response has been vigorous and enthusiastic. As of early October 2007, 109 faculty members had participated in seven workshops. Participant evaluation of the workshop was favorable, with the item asking whether the intensive workshop was worth the time spent returning an average positive rating of 4.71 on a 5-point Likert scale. Faculty comments are shown in List 2.

Both the trainee and faculty versions of the course have experienced a consistently high level of demand from both native and nonnative speakers of English. Since the first trainee workshop in 2003, registration requests have exceeded spaces available for nearly every workshop offered, even though five to seven workshops have been offered every year. Demand for the faculty workshop has also been robust—at times exceeding that for the trainee workshop. The intense interest in the workshops is not surprising in light of the pressure to publish and the concomitant lack of training and support for this critical skill, even among experienced writers.

Lessons Learned

Because we were obliged to use a selection process to keep class size
manageable, selection criteria needed to be developed. In our experience, the status of the registrant’s current research writing has emerged as one of the top selection criteria. Only those registrants who are ready to begin or have begun writing a manuscript are accepted into the workshop, and those who are still finishing research are asked to register for a subsequent section. Because a fair amount of workshop time is spent working on manuscripts, this practice ensures that there are no participants sitting idly while others are writing. The result has been a workshop population that is highly motivated and attentive because they can apply the learning principles immediately.

As the workshop has matured over time, we have come to realize the social value that the workshop has for the participants. The workshops include participants from a wide variety of disciplines conducting a wide variety of research, and as the participants interact, they are able to discover more and better ways of conveying their ideas to others who are not already familiar with their work. One exercise during the unit Writing the Introduction Section consists of giving a very brief and structured synopsis of one’s research to a partner, who has been deliberately selected from another discipline. Thus, a radiation oncologist writing up a retrospective study, an anesthesiologist writing up a translational study, and an epidemiologist writing up a population-based study must quickly familiarize one another with their gaps in knowledge, hypothesis or purpose, findings, and significance. Not only do the participants find these interviews instructive in expressing their ideas clearly, but they also say that they enjoy the contact with others who work in a different part of the “pipeline” and have perspectives different from theirs.

Finally, the affective value of the workshop has become apparent over time as well. As participants have shared their reactions, thoughts, and suggestions with us, we have developed an appreciation for the considerable amount of stress, worry, and self-doubt that many writers feel about beginning and managing the writing process and about their linguistic self-expression. A native speaker may struggle a great deal with writing and language; a nonnative speaker may struggle four or five times as much. To provide support, we have expanded sections of the workshop that address how to get started writing and avoid procrastination, how to organize thoughts and ideas into an outline, and how to improve grammar and style. The editor–advisor assigned to each participant also plays a significant role in coaching and supporting the writer.

Our experience and survey results suggest that a carefully designed writing curriculum can be effective in improving researchers’ ability to write and their chances to publish English-language scientific articles regardless of their linguistic background or career stage. Although a role for additional language training for nonnative English speakers remains, the model for scientific writing presented here provides valuable support to writers and eases the burden on the advisors who review their work. In light of the pressure to publish and the high number of nonnative speakers who must publish in English, effective training in scientific writing represents a valuable investment in career development. As Schrödinger15 noted, “If you cannot, in the long run, tell everyone who you have been doing, your doing has been worthless.”

Acknowledgments

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