Quality of Graphs in Scientific Journals: An Exploratory Study

Eileen K Schofield

A graph can be the best way to present scientific data but only if it is simple, clear, and readily understandable. Over my 18 years as a scientific editor at Kansas State University, I noticed a decline in the quality of graphs in manuscripts and reports that crossed my desk. It seemed to correlate with the increased use of computers and the availability of numerous graphics programs. I knew that instead of seeking help from the qualified designer on our staff, scientists were making their own graphs. However, many of the programs they used produced overcomplicated graphs or full-color graphs that did not print well in black and white. Also, most of the scientists did not have the expertise to manipulate the programs and design successful graphs.

To address the situation, I participated in a workshop on improving presentations and research publications and prepared a checklist for designing good-quality graphs. The checklist was based on the most common problems (related to format and clarity of presentation) that I had observed. It was later published in a newsletter[1] distributed to agricultural research and extension personnel at the university; this group included my editing clients.

Then I decided to find out how widespread the quality problems were by conducting a survey. I used my checklist to develop an evaluation sheet for rating published graphs. Then I chose 25 journals that regularly printed a lot of graphs and covered over 20 subjects that I edited (in such disciplines as agronomy, animal sciences, ecology, food science, and veterinary medicine). They included journals with regional, national, and international distributions and weekly, monthly, and quarterly publication schedules. For each journal, I looked through several issues published over at least 2 years in 1998-2000 and rated the quality of graphs on an evaluation sheet. I also copied the instructions to authors for preparing graphs and recorded the name and address of the editor.

I composed a one-page questionnaire based on my checklist, the common quality problems observed in the journals, and

Table 1
Quality of Graphs:
Procedures and Problems Reported by Editors of 25 Scientific Journals
(shown as numbers of editors answering each question)

1. Is quality of graphs a criterion for acceptance of manuscripts by your journal?
   16 Yes 9 No

2. Do your instructions to authors include details about preparation of graphs?
   18 Yes 7 No

3. Do you check graphs in submitted manuscripts to ensure that authors have followed the instructions?
   16 Yes 2 No (Includes only those who answered yes to Question 2.)

4. How frequently do manuscripts submitted to your journal include poor-quality graphs?
   3 Often 16 Sometimes 6 Seldom 0 Never

5. Have you noticed a decline in the quality of graphs received by (or published in) your journal over the past 5 years?
   2 Yes 21 No 2 N/A

6. How do you handle poor-quality graphs?
   22 Return them to authors with instructions for corrections
   7 Make corrections in your office
   2 Publish them without corrections

7. What quality problems have you noticed on graphs submitted to your journal?
   20 Lines too thin (or thick)
   19 Symbols too small or difficult to distinguish
   18 Lettering too small
   17 Too many shades of gray on bars
   14 Use of gray symbols or lines
   13 Font difficult to read
   11 Too many patterns on bars
   10 Use of both different symbols and different lines
   8 Redundant title printed on graph
   8 Use of three-dimensional bars for only two variables
   6 Key outside the graph

EILEEN K SCHOFIELD *is former senior editor at Kansas State University, author of several books and numerous journal and magazine articles, and currently a freelance scientific editor.*

the journals' instructions. In October 2000, I mailed the questionnaire, a cover letter, and a stamped return envelope to each of the 25 editors. Nonrespondents received postcard reminders followed by second sets of questionnaires and envelopes and additional reminders until 100% response was achieved.

Table 2
Quality Problems Observed by Author of This Article in Graphs Printed in 25 Scientific Journals (ranked from most frequent to least frequent)

1. Too many patterns on bars
2. Use of both different symbols and different lines
3. Too many shades of gray on bars
4. Lines too thin (or thick)
5. Use of three-dimensional bars for only two variables
6. Lettering too small and font difficult to read
7. Symbols too small or difficult to distinguish
8. Redundant title printed on graph
9. Use of gray symbols or lines
10. Key outside the graph

Results and Interpretation

My evaluation rated the quality of graphs in 25 scientific journals as follows: one consistently excellent, six consistently good, six consistently fair, and 12 variable. The categories were based on the number of problems per issue and the total number. Overall, line graphs were better than bar graphs. The frequency of publication did not seem to affect quality. More frequent publication could limit the time available to critique graphs and make improvements. Guidelines for authors varied from none to very specific; some were available in a separate publication or on a Web site rather than in the journal. Some of the journals still required graphs to be submitted on paper, some required electronic submission, and others accepted both. More graphs submitted in diverse computer programs could lead to delays or difficulties in improving quality. The number of quality problems identified by the editors ranged from one to 11 (all those listed on the questionnaire); the mean was six (Table 1). My evaluation found all 11 problems in published graphs among the 25 journals; the number of problems per journal ranged from zero to eight, and the mean was five. My ranking of frequency (Table 2) differed from that given by the editors (Table 1).

In most cases, at least some of the problems identified by the editors were not obvious in published graphs. I assume that they had been corrected before printing, inasmuch as most editors indicated that they had procedures for making corrections (Table 1). In contrast, my evaluation often identified problems not mentioned by the editors. In the most extreme case, an editor checked only one problem on the questionnaire, whereas I noticed eight others in the journal.

Generally, the journals that provided specific instructions published better graphs. However, graphs in several journals did not meet some of the guidelines. Two journals in which I could not find instructions not only printed poor graphs but also showed the least correlation between the problems identified by the editors and those identified by me.

In two instances, pairs of journals were published by the same society and had the same instructions. In the first case, the quality of graphs was slightly better in one journal, but graphs in the two journals had different problems, some of which were not mentioned by the editors. The difference was dramatic in the second case. One journal had the best graphs of any in the survey; all the problems identified by the editors had been corrected, and the specific guidelines generally had been followed. Quality in the other journal was variable, particularly for bar graphs. The discrepancies can be attributed partly to the fact that the journals had different editorial and production staffs.

A few answers by editors indicated that they were not familiar with their journals' instructions. One editor added a comment that the final version of graphs had to meet the journal's standards, but I noticed several quality problems in published graphs.

Discussion

Any discussion of quality is somewhat subjective. My study began by identifying specific factors that contributed to my perception of a "poor-quality" graph. My initial goal was to provide guidelines that would help my editing clients to produce better graphs. When I decided to expand the study, I consulted several style manuals and found very similar guidelines. Some of these are mentioned below. In addition, the editors who responded to the survey agreed that the factors listed on the questionnaire affected the quality of printed graphs.

I concentrated on the quality of graphs published in the journals and their instructions for preparation of graphs. I was not able to assess variables related to authors, for example, whether they had help from a designer or which graphics programs they used. Certainly, a more comprehensive

Quality of Graphs continued

study covering a longer period would be worthwhile, but the results of this quick survey should be useful to journal editors.

Most style manuals for scientific writing discuss graphs, and several books devoted to illustration techniques are available. They all agree on the importance of good graphs and identify quality problems, particularly those associated with computer use. Robert Day[2] noted that "the ease with which charts and graphs can be created electronically often leads to confusing or deceptive graphics. Graph-making is not a job for amateurs." According to Maeve O'Connor,[3] "figures must be simple and clear enough for readers to get the message immediately." She recommended help from a professional designer. A Council of Biology Editors manual[4] outlined specific steps to produce good graphs and commented that "the market is flooded with computer graphics systems that cannot produce illustrations of publication quality." Another CBE publication[5] warned that "readers may be distracted from the data by graphs that are cluttered, noisy, empty, or use 3-D for 2-D data." The style guidelines in that book mentioned several problems included in my survey.

The survey results confirmed that quality of graphs is a concern of journal editors in many scientific disciplines. In addition to their answers on the questionnaire, several editors offered comments about the problems caused by use of computer graphics programs. They shared my impressions that these programs resulted in overcomplicated graphs and that most scientists are not good designers. However, one editor noted that authors "nearly always respond favorably when given clear editorial direction as to how a poor graph should be revised." This again emphasizes the role of editors in controlling the quality of their journals.

In spite of instructions to authors and the efforts of editors, mediocre graphs are often published. A major reason may be lack of time to make corrections. Carelessness by editors or production staffs (indicated by the number of journals with variable quality) and the inability of authors to improve graphs probably contribute.

Recommendations

Two procedures are needed to improve the quality of published graphs. First, all scientific journals should provide detailed instructions addressing potential problems such as those listed in Table 1. Each issue of the journal should contain instructions for graph-making or a reference to them; authors should not have to search for them. The instructions should include a suggestion that authors seek help from a graphics designer if they are unable to achieve the required quality with their computer programs. Second, editors of scientific journals should be thoroughly familiar with these instructions, enforce them, and refuse to publish poor graphs.

References

1. Schofield E. Good-quality graphs for publications. Media Mix 1998; Jan-Mar:3.

2. Day RA. How to write & publish a scientific paper. Fifth ed. Phoenix: The Oryx Press; 1998.

3. O'Connor M. Writing successfully in science. London: Chapman & Hall; 1991.

4. Council of Biology Editors, Scientific Illustrations Committee. Illustrating science: standards for publication. Bethesda (MD): Council of Biology Editors; 1988.

5. Peterson SM. Editing science graphs. GuideLines number 2. Reston (VA): Council of Biology Editors; 1999.

What's New

a new job?
a prize?
an award?
publication of a book?
a degree or certificate?
recent retirement?

If you have something new in your professional life, we invite you to share the news with readers of *Science Editor*. Please supply a brief announcement to Barbara Gastel, Editor, *Science Editor*, Department of Journalism, Texas A&M University, 4111 TAMU, College Station, TX 77843-4111, fax 979-845-6887, e-mail *b-gastel@tamu.edu*.