A Simple Approach to Improve Student Writing

Catherine A. Carlson
Eastern Connecticut State University
carlsonc@easternct.edu

Introduction

Communicating scientific results is an essential component of any scientific study; however, most students fail to see the importance of presenting their work in written form. They focus their efforts on the fieldwork, calculations, and/or methods needed to complete homework or laboratory assignments while neglecting the written report. Many of my students complain that they should not be graded on their writing because they are taking a hydrology course (i.e., science), not an English course. Behind this resistance lies, I believe, both ignorance and fear. First, students tend to be task oriented rather than goal oriented. They want to get the assignment done and, to them, that means the fieldwork, calculations, or standard methods. They do not understand that the ultimate purpose or goal of an assignment is to provide needed information to an employer, graduate advisor, or the public so that decisions may be made based on their work. The big picture, the reason the work was done in the first place (i.e., goal), does not register with them.

Second, as with all writers, when students are faced with that blank page, they feel clueless about how to fill it. What should be said? How should it be said? For whom am I writing, my instructor who knows more than I do on the subject? We, as instructors, would like to believe that writing is a transferable skill between English and science and that we only need to teach science. However, the genre of scientific writing often is very different from the genres taught in English courses. Our students need to learn from us what English writing instructors call rhetorical knowledge and rhetorical awareness. In other words, they need to learn to write like scientists/hydrogeologists.

A Simple Approach

There are many approaches to teaching writing in science courses. I offer one simple approach here based on the journalistic questions of “who, what, where, when, how, and why” to help students become independent writers. Most students are familiar with these questions and can rattle them off. This familiarity is important because it provides a bridge to previous writing experiences and a familiar template of what is expected of their writing. In addition, these six questions provide a framework for structuring their writing. The next step is to help the students frame the questions that they need to answer. For example, the question “what” becomes “what did you do?” and “what did you find out?” The question “why” under “what did you find?” leads to consideration and development of multiple working hypotheses. By helping students identify the questions that need to be answered in their writing, we help them to become independent thinkers as well as independent writers.

So how is this simple approach taught? Early in the semester, I introduce my hydrology class to the simple approach and inform them that they are required to use the approach for writing up homework and laboratory assignments. The first semester I used the approach I only recommended its use and few students used it, so I now require it. I teach the approach by modeling the writing process using an assignment my students have recently begun but not completed. This way, their first attempt at using the approach follows the example given in class very closely. Modeling the writing process also may be done spontaneously with the students devising both the questions and answers, although I would recommend using such an approach only after the students have been introduced to the approach with a prepared example.

Instructor's Notes

I first introduce the journalistic questions as a way to make a connection between the scientific-writing genre and other genres the students have used previously in non-science courses. I then suggest that we rearrange the original order of the questions to provide a more logical order for the report. We then address the question "what?" by expanding it into two questions, "what did you do?" and "what did you find?" as mentioned above. I suggest that each of these two questions will require its own paragraph or section in the report.

We begin with the question, "what did you do?" and we attempt to answer the question as concisely as possible. I advise the students that we will embellish on the sentence(s) as we answer the other questions and so not to worry that the first sentence(s) seems so paltry. As we proceed with the first paragraph/section, we answer all the other questions (who, when, where, how, and why). The process involves formulating questions in a logical order and then answering them as concisely as possible. The students see the paragraph evolve as we work through the example. It is my intention that they understand that writing is a *process* and that revising is a necessary component to effective writing. By taking these incremental steps, we arrive at a respectable first paragraph.

We then proceed to the second "what" question—'what did you find?'—and again formulate appropriate questions based on the journalistic questions (who, when, where, how, and why). Again, these are answered as concisely as possible and the paragraph/section develops incrementally. Students often fail to consider more than one option for explaining their results. Answering the question "why" leads to a discussion of possible explanations and, consequently, the development of multiple working hypotheses to be tested. Once all the questions have been answered satisfactorily, we combine our two paragraphs/sections into one report and add the finishing touches. I ask the students what we need as finishing touches and let them think about what should be added. The finishing touches generally include a title, citations, and any needed figures, tables, and/or appendices. At this time, I take the opportunity to discuss the use of figures, tables, and appendices, their numbering, and captions.

When we review the completed report, I ask the students if they think they can use the approach for the pending assignment. This query reminds the students that they must use this approach throughout the semester—another task has been added to their list—and generates concrete questions from them about the approach in the context of a real assignment.

An Example

What follows is an example I have used with my students. Prior to this presentation, the students have been working on developing a rating curve using stage-discharge data from the USGS NWISWeb Data for the Nation (http://waterdata.usgs.gov/nwis). I project the example onto the screen for discussion and provide the students with a handout identical to the example on the screen. Each addition to the writing is highlighted in yellow to show the development of the report. Citations are highlighted in blue to ensure they are included in the reference section. The comments in small caps are not shown to the students and are used here to elucidate the approach for instructors.

	WHO		***WHAT***
	WHAT		***WHERE***
(FAMILIAR QUESTIONS)	***WHERE***	(SUGGESTED REORDERING)	***HOW***
	WHEN		***WHEN***
	HOW		***WHO***
	WHY		***WHY***

WHAT

(WE BEGIN BY IDENTIFYING THE TWO MAJOR "WHAT" QUESTIONS. EACH QUESTION WILL GENERATE A PARAGRAPH OR SECTION OF THE REPORT.)

1. ***What did you do?*** (WE ANSWER THIS "WHAT" QUESTION TO WRITE THE FIRST PARAGRAPH/SECTION. ALL SIX W-QUESTIONS WILL BE ANSWERED IN THIS PARAGRAPH/SECTION. WE WILL THEN RETURN TO THE 2ND "WHAT" QUESTION TO WRITE THE SECOND PARAGRAPH.)

2. *What did you find?*

***WHAT** (did you do?)*

A rating curve was developed.

WHERE

For where did you develop the rating curve?

The rating curve for Burlington Brook near Burlington, CT (USGS gaging station 01188000), was developed.

HOW

How did you develop the curve?

The rating curve for Burlington Brook near Burlington, CT (USGS gaging station 01188000), was developed using published streamflow data.

WHEN

When were the data collected that you used to develop the rating curve?

The rating curve for Burlington Brook near Burlington, CT (USGS gaging station 01188000), was developed using published streamflow data for the period 1973 to 2003.

WHO

Who collected the data that you used to develop the rating curve?

The rating curve for Burlington Brook near Burlington, CT (USGS gaging station 01188000), was developed using published streamflow data for the period 1973 to 2003 (U.S. Geological Survey, 2003).

WHY

Why did you develop the rating curve?

The rating curve for Burlington Brook near Burlington, CT (USGS gaging station 01188000), was developed using published streamflow data for the period 1973 to 2003 (U.S. Geological Survey, 2003). The rating curve shows the relation between stage (h) and stream discharge (Q), thereby providing a powerful tool for determining continuous discharge values from stage measurements at gaging stations.

(THIS COMPLETES THE FIRST PARAGRAPH/SECTION OF THE REPORT ANSWERING "WHAT DID YOU DO?" WE NOW PROCEED TO THE SECOND "WHAT" QUESTION TO WRITE THE SECOND PARAGRAPH/SECTION.)

***WHAT** (did you find?)*

1. *What did you do?* (COMPLETED AND SET ASIDE FOR THE MOMENT)
2. ***What did you find?*** (ALL SIX W-QUESTIONS WILL BE ANSWERED IN THIS SECTION.)

The rating curve equation is $Q=0.0467(h-0)^{5.21}$.

WHERE

Where does the rating curve apply?
Where do the data plot with respect to the best-fit line?

The stage-discharge relation for Burlington Brook is represented by the rating equation, $Q=0.0467(h-0)^{5.21}$; however, the data do not plot in a straight line.

WHY

(STUDENTS OFTEN FAIL TO CONSIDER MORE THAN ONE OPTION FOR EXPLAINING THEIR RESULTS. THIS QUESTION LEADS TO A DISCUSSION OF POSSIBLE EXPLANATIONS AND, CONSEQUENTLY, THE DEVELOPMENT OF MULTIPLE WORKING HYPOTHESES.)

Why don't the data plot along the straight line?

Develop working hypotheses, for example:

1. ***the channel geometry may have changed, altering the stage-discharge relation***

(WE WILL WORK WITH THIS HYPOTHESIS FIRST, THEN RETURN TO THE 2ND HYPOTHESIS. WE WILL ANSWER "WHY, HOW, WHEN, AND WHAT" FOR EACH HYPOTHESIS.)

2. *the stage-discharge relation may be best represented by two curves*

The stage-discharge relation for Burlington Brook is represented by the rating equation, $Q=0.0467(h-0)^{5.21}$; however, the data do not plot in a straight-line. The channel geometry may have changed over the period of record, altering the stage-discharge relation.

HOW

How might you test this working hypothesis?

The stage-discharge relation for Burlington Brook is represented by the rating equation, $Q=0.0467(h-0)^{5.21}$; however, the data do not plot directly along the straight-line. To test whether the stage-discharge relation has changed over the period of record, the streamflow data were divided into two data sets and replotted.

WHEN

When were the data collected that you used in the two data sets?

The stage-discharge relation for Burlington Brook is represented by the rating equation, $Q=0.0467(h-0)^{5.21}$; however, the data do not plot directly along the straight-line. To test whether the stage-discharge relation has changed over the period of record, the streamflow data were divided into two data sets (1973 - 1992 and 1993 - 2003) and replotted.

WHAT

What did you find from replotting the data in two data sets?

The stage-discharge relation for Burlington Brook is represented by the rating equation, $Q=0.0467(h-0)^{5.21}$; however, the data do not plot directly along the straight-line. To test whether the stage-discharge relation has changed over the period of record, the streamflow data were divided into two data sets (1973 - 1992 and 1993 - 2003) and replotted. Both data sets plot along the same curve indicating that the stage-discharge relation (i.e., rating curve) has remained essentially constant over the period of record.

WHY

(WE NOW RETURN TO THE SECOND HYPOTHESIS.)

Why don't the data plot along the straight line?

Develop working hypotheses, for example,

1. *the channel geometry may have changed, altering the stage-discharge relation, or*

(COMPLETED AND SET ASIDE FOR THE MOMENT.)

2. the stage-discharge relation may be best represented by two curves.

The stage-discharge relation for Burlington Brook is represented by the rating equation, $Q=0.0467(h-0)^{5.21}$; however, the data do not plot directly along the straight-line. To test whether the stage-discharge relation has changed over the period of record, the streamflow data were divided into two data sets (1973 - 1992 and 1993 - 2003) and replotted. Both data sets plot along the same curve indicating that the stage-discharge relation (i.e., rating curve) has remained essentially constant over the period of record. The stage-discharge relation for the Burlington Brook may be represented best by two curves (Figure 3), $Q=0.0124(h-0)^{6.81}$ for low-to-moderate flows (e.g., $h \le 2.7$ ft.) and $Q=0.200(h-0)^{4.01}$ for high flows (e.g., $h > 2.7$ ft.).

PUT IT ALL TOGETHER

(THE TWO PARAGRAPHS/SECTIONS ARE NOW COMBINED AND REREAD.)

The rating curve for Burlington Brook near Burlington, CT (USGS gaging station 01188000), was developed using published streamflow data for the period 1973 to 2003 (U.S. Geological Survey, 2003). The rating curve shows the relation between stage (h) and stream discharge (Q), thereby providing a powerful tool for determining continuous discharge values from stage measurements at gaging stations.

The stage-discharge relation for Burlington Brook is represented by the rating equation, $Q=0.0467(h-0)^{5.21}$; however, the data do not plot directly along the straight-line. To test whether the stage-discharge relation has changed over the period of record, the streamflow data were divided into two data sets (1973 - 1992 and 1993 - 2003) and replotted. Both data sets plot along the same curve indicating that the stage-discharge relation (i.e., rating curve) has remained essentially constant over the period of record. The stage-discharge relation for the Burlington Brook may be represented best by two curves (Figure 3), $Q=0.0124(h-0)^{6.81}$ for low-to-moderate flows (e.g., $h \le 2.7$ ft.) and $Q=0.200(h-0)^{4.01}$ for high flows (e.g., $h > 2.7$ ft.).

FINISHING TOUCHES

(AT THIS POINT, WE CONSIDER WHAT STILL NEEDS TO BE ADDED TO OUR REPORT. THIS IS A GOOD OPPORTUNITY TO IMPRESS ON THE STUDENTS THE IMPORTANCE OF A DESCRIPTIVE TITLE, THE USE OF CITATIONS, AND THE PROPER FORMATTING OF FIGURES.)

RATING CURVE FOR BURLINGTON BROOK NEAR BURLINGTON, CT
(USGS GAGING STATION 01188000)

The rating curve (Figure 1) for Burlington Brook near Burlington, CT (USGS gaging station 01188000), was developed using published streamflow data for the period 1973 to 2003 (U.S. Geological Survey, 2003). The rating curve shows the relation between stage (h) and stream discharge (Q), thereby providing a powerful tool for determining continuous discharge values from stage measurements at gaging stations.

The stage-discharge relation for Burlington Brook is represented by the rating equation, $Q=0.0467(h-0)^{5.21}$; however, the data do not plot directly along the straight-line (Figure 1). To test whether the stage-discharge relation has changed over the period of record, the streamflow data were divided into two data sets (1973 - 1992 and 1993 - 2003) and replotted (Figure 2). Both data sets plot along the same curve indicating that the stage-discharge relation (i.e., rating curve) has remained essentially constant over the period of record. The stage-discharge relation for Burlington Brook may be represented best by two curves (Figure 3), $Q=0.0124(h-0)^{6.81}$ for low-to-moderate flows (e.g., $h \leq 2.7$ ft.) and $Q=0.200(h-0)^{4.01}$ for high flows (e.g., $h > 2.7$ ft.).

REFERENCE

U.S. Geological Survey, 2003, National Water Information System (NWISWeb) data available on the World Wide Web, accessed September 28, 2003, at URL http://nwis.waterdata.usgs.gov/ct/nwis/measurements/?site_no=01188000&agency_cd=USGS.

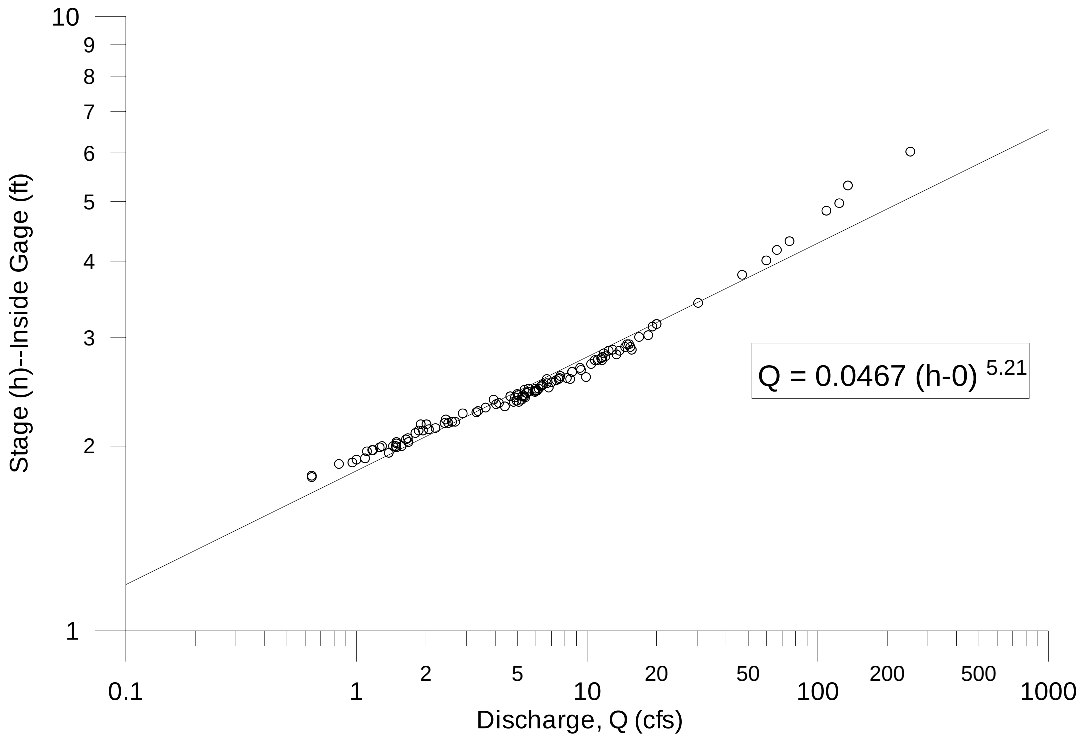

Figure 1. Rating Curve for Burlington Brook near Burlington, CT (USGS Gaging Station 01188000), determined from USGS discharge-stage data for 1973 to 2003 (U.S. Geological Survey, 2003).

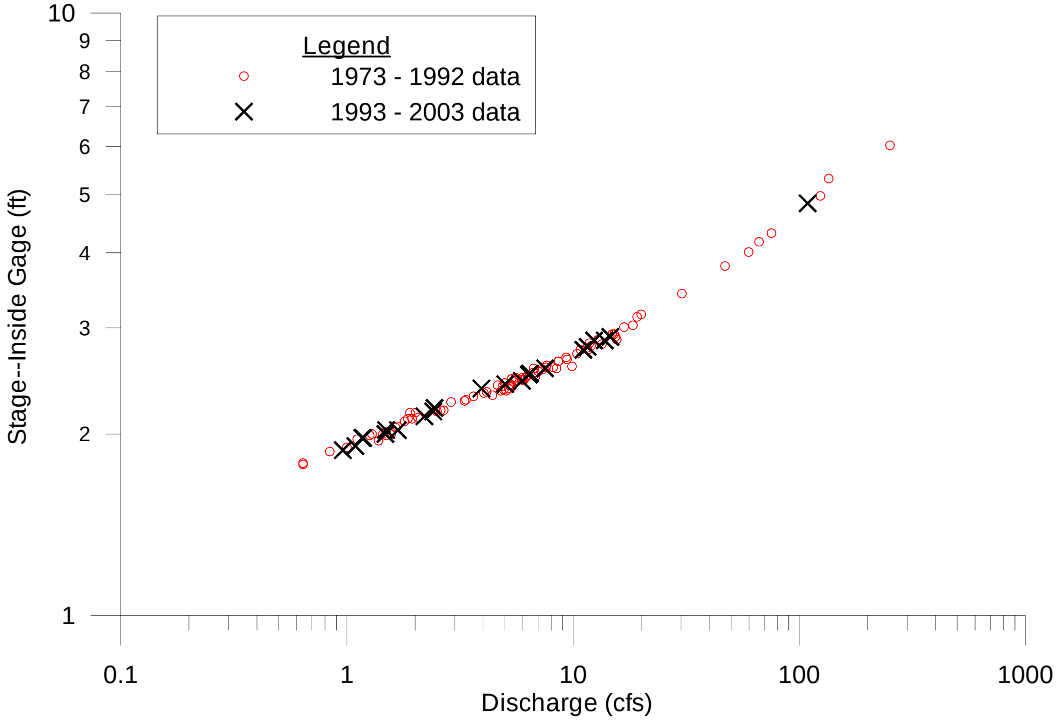

Figure 2. Rating Curve for Burlington Brook near Burlington, CT, plotted in two data sets, 1973 - 1993 and 1993 - 2003, to show that the stage-discharge relation has remained essentially constant over the period of record.

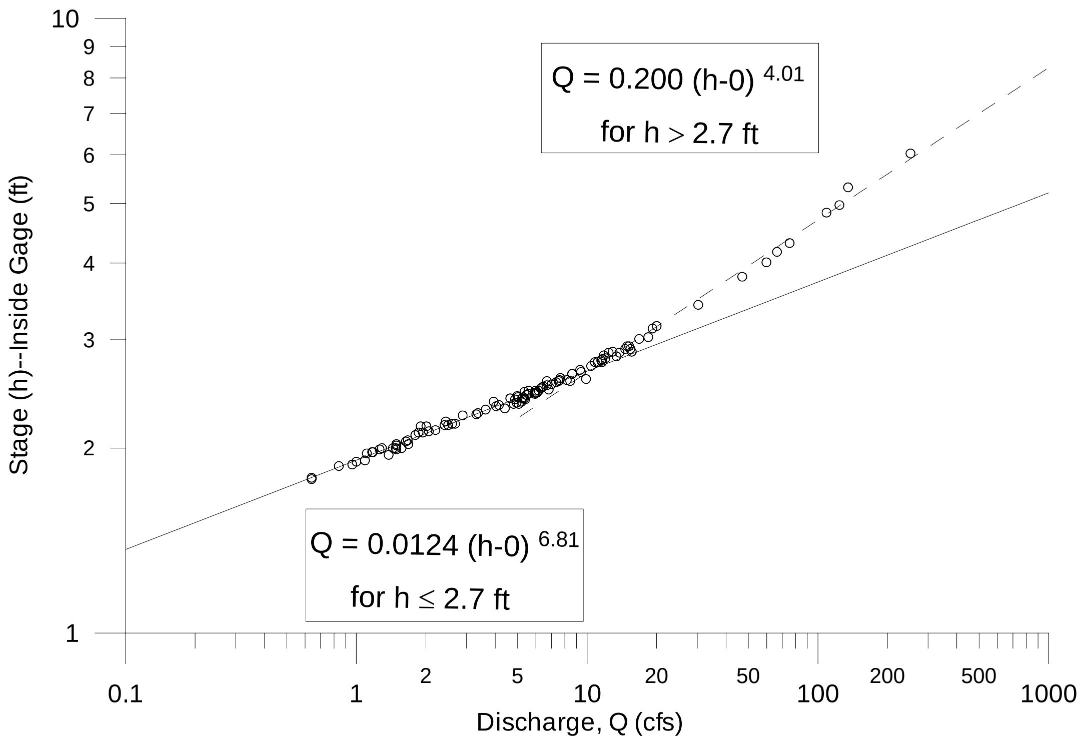

Figure 3. Rating Curves for Burlington Brook near Burlington, CT (USGS Gaging Station 01188000), determined from USGS discharge-stage data for 1973 to 2003 (U.S. Geological Survey, 2003).

Evaluation of the Simple Approach

From an instructor's perspective, using this process I have seen significant improvement in student writing over the period of a semester. The writing is much more focused by semester's end, and there is evidence of real effort. A few students consistently requested that I comment on their writing before they turned in their assignments so that they could revise their work—they, of course, improved the most. Only two students appeared to ignore the approach and continued to turn in poor writing with little evidence of even trying to convey pertinent information. Overall, I am encouraged by the improvement in writing using this simple approach.

A student survey was conducted at the end of the Fall Semester, 2005, to assess student perspective on the simple approach presented above. Twelve students completed the survey, and only two offered written comments. The majority of students found the presentation useful and used the handout (with the example) as a guide for writing assignments. Half to slightly more than half of the students felt more confident in their writing and better prepared to enter the workforce. Only a third of the students used the approach in their other courses, a small number explained perhaps by the student comment regarding faculty writing-style preferences. The results of the survey are presented below.

Please respond to each of the following statements by circling the number that best represents your views.	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree	Missed Presentation
The presentation was a useful example of how to approach scientific writing as a step-by-step process.	1	10	1	0	0	0
I used the handout during the semester as a guide for writing lab/homework assignments.	4	6	2	0	0	0
I used this approach to writing in other courses.	1	3	5	2	1	0
I am more confident in my writing ability since using this approach.	0	6	5	1	0	0
I am more prepared to enter the workforce where I will be expected to write scientific/technical memos and reports.	1	6	3	2	0	0
Your comments are invited and welcomed. (Student comments) • Difficult at times to express concepts but overall an effective approach. • Instructors within the dept tend to prefer different writing styles. Therefore until some standardization is achieved this is not as effective as it could be.						

Conclusion

Ultimately, teaching students to write scientifically is teaching them to think scientifically. Role modeling how to think about, and thereby, write about the scientific work they are doing helps students to develop critical thinking/writing skills and become independent thinkers and writers.