

# **AC 2008-1600: A WRITING-INTENSIVE FLUID MECHANICS LABORATORY**

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## **Background**

CE330, Fluid Mechanics, is required of all Civil and Environmental Engineering students at the University of Wisconsin-Platteville. This four credit class consists of three 1-hour lectures and one 2-hour laboratory each week. Approximately 40 students enroll in the course each semester.

When I teach the course, my class completes one laboratory assignment each week. Traditionally, the results of the assignment have been written up each week as a formal laboratory report. Grading these reports weekly is a time consuming chore, yet one that I take seriously given our program's emphasis on creating engineers that can write effectively.

The reason I changed my grading technique, as described in this paper, is that the manner in which I was grading was time consuming, unrewarding, and ineffective. Only the rare student carefully considered the feedback I provided. The student reports were repetitive and very uninteresting to read. Many of the reports were carelessly written, and I was especially discouraged at investing time grading reports for students who were only aiming for a grade of 'C', or perhaps 'D.' Perhaps most discouraging was that students were not improving as the semester progressed; despite my efforts at providing quality feedback, I continued to see the same errors repeating themselves.

About the same time that I became disenchanted with my grading process, I realized that our students were not experiencing writing as an iterative process. This was an important realization, since most of the writing undertaken by professionals is written and rewritten many times before it is made available to the intended audience.

Further rationale for this new approach was that many faculty members cite their co-writing of reports and papers with their graduate school research advisor as having the most influence on their writing ability. My goal was to replicate this experience for undergraduates.

Thus, I created three "Writing Intensive" laboratory assignments, designed to make my grading feedback more effective and to provide students with an opportunity to resubmit their work multiple times. The challenge in designing the new process was to ensure that the new process would be "grading-load-neutral" – i.e., I would spend no more time assessing these reports than I had spent grading laboratory reports in previous semesters.

## **Description of Writing Intensive Lab Reports**

The use of Writing Intensive lab reports, as described in this section, was implemented in the Fall 2007 semester. The lab work for the writing intensive lab reports was completed in the two-hour laboratory session. 40 students were enrolled in the course.

For the Writing Intensive lab reports, students had to write a relatively brief (2-3 page) report. These reports were not "formal" lab reports in the sense that I did not require Introduction, Procedure, Results, etc. sections. (I believe that such reports do not provide "authentic" writing experiences for students; many students do not take such reports seriously, and I find them tedious to grade.) Two of the Writing Intensive assignments required students to respond to

three or four relatively open-ended questions, and they were to support their responses with appropriate tabular or graphical evidence. I did not prescribe the types of information to include or how to present their results. Also, students only placed their name on the back of the back sheet of the report, so that I could grade them without knowing whose paper I was grading. The third writing intensive assignment was a technical memo, and students submitted these as an attachment to an e-mail. I gave comments electronically (using “comments” and text boxes in MS-Word), and returned the file to the students via e-mail.

The writing intensive reports were due on Monday, and I evaluated and returned the reports to students by Wednesday. The students then had to revise their report in response to my comments and resubmit the revised lab report by the following Monday. This cycle repeated itself for a maximum of two more weeks. Thus, students had three opportunities to revise their work for the first two writing intensive labs, and two opportunities for the final writing intensive lab. Lab reports that were deemed “outstanding” received a perfect score. Moreover, once a student earned an “outstanding” rating, they were not required to hand in any more drafts of that paper. This was intended to be a huge incentive for students, as they could in effect have up to three weeks “off” from writing reports.

Students who did not achieve an outstanding rating by the end of four submissions received a grade of 0; given that the three writing intensive lab reports were given one half of the laboratory grade, the consequences of never obtaining an “outstanding” ranking were significant.

I made students aware that I would not be “correcting” their writing, but rather pointing out areas that needed improvement. For example, when I found a sentence fragment, I did not give any guidance on how to fix the fragment, but rather I circled the fragment and labeled it with a “s.f.” notation. (I gave students a list of my common editorial abbreviations.) Of course, I was happy to work with students in my office to help them correct the problems; but by identifying the problem areas rather than correcting them, I hoped to encourage students to reconsider the error themselves, and thus teach themselves how to become more effective writers.

I also emphasized to the students that “outstanding” did not equate to “perfect.” To me, an “outstanding” paper was one which I would be happy to have students show a potential employer as an example of their writing ability. However, communicating my vision of “outstanding” was the most difficult aspect of the grading.

In an attempt to keep the new process grading-load neutral, I did not have any additional written reports due for those laboratory exercises which were conducted in the weeks that students were submitting writing intensive lab reports. Rather, in these “off weeks,” the laboratory exercises were redesigned, such that they could be completed by the students during the laboratory session. Typically, students had to hand in a page or two of calculations or graphical/tabular results, with a minimum of textual support, and these “mini reports” were due by the end of the lab period. Although the redesigned lab exercises were successful in that they did not create any additional work for the students (as compared to previous semesters), my grading load increased a small amount as I had to grade the mini reports. However, these were typically not burdensome to grade.

## Findings

The performance on the laboratory reports is shown in Figure 1. The possible scores given were 0, 10 or 20. I relented from only assigning grades of 0 or 20, as I felt that reports that appeared to only need one more submission deserved to at least receive 50% of the points. More than two thirds of the class received a perfect score on the first lab report. My motive was to not discourage the students when submitting future Writing Intensive reports. I conveyed my rationale to the class, and gave them ample warning that future submission would be graded more stringently.

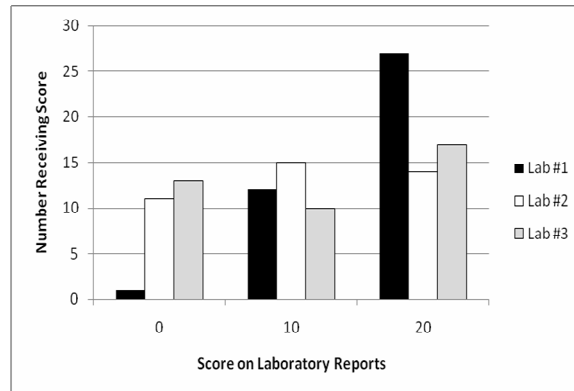


Figure 1

Figure 1 also shows that an increasing number of students received grades of 0 for each successive lab report. This may be because I inadvertently raised my standard for “outstanding.” Another possible explanation is that students were becoming worn out as the end of the semester approached. The material increased in complexity for each lab assignment, which also may explain this trend.

Figure 1 could also be interpreted as illustrating that the students did not improve their writing effectiveness, but I strongly disagree with this interpretation. Based on my observations, which I wrote down in a journal throughout the semester, I feel confident that students did improve their writing effectiveness. Certainly, improvement was made from week to week for a given writing intensive assignment – such improvement was assured given the nature of the assignment. But I also saw improvement from writing assignment to writing assignment (e.g. between Lab #1 submissions to Lab #2 submissions). For example, many of the fundamental conventions of engineering writing (e.g. formatting, organization, referencing tables and figures) were only rarely seen in the Lab #2 and #3 submissions. Although I did not track the types of errors I encountered for each submission, I feel that the number of rudimentary grammar mistakes (e.g. run-on sentences and sentence fragments) decreased as the semester progressed. From this standpoint, grading the reports was much more rewarding than in previous semesters.

Figure 2 shows a histogram of how the students performed throughout the semester. The highest score possible is 60 points, equating three writing intensive labs each worth 20 points. Figure 2 shows that 12 of the 40 students received either 55 or 60 points. This illustrates that a significant portion of the students were able to create “outstanding” work.

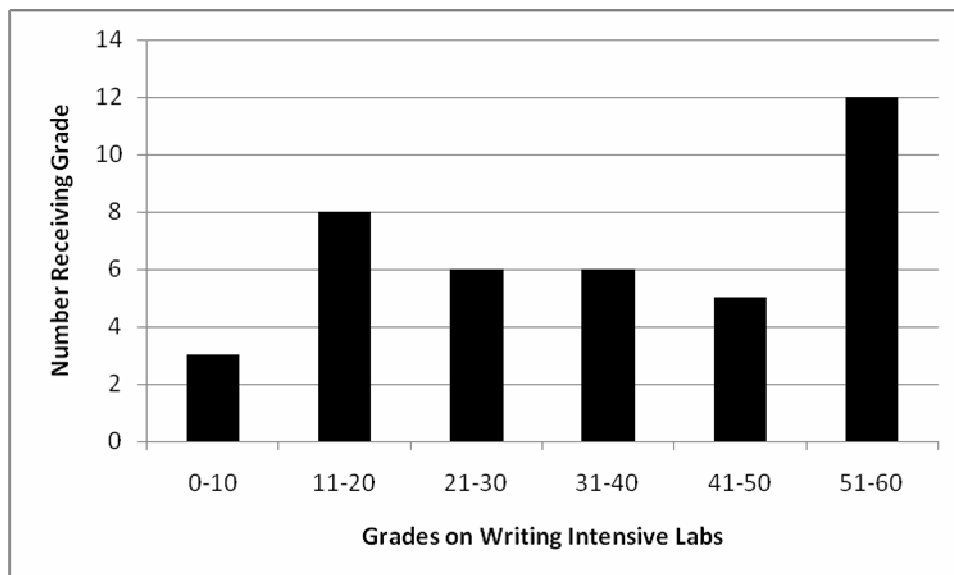


Figure 2

One consequence of the new approach was that I had a large number of students visiting me in office hours to talk specifically about rewriting their laboratory reports. I quickly noticed the increase in “traffic” and tabulated the results as the semester progressed. A bar graph showing these visits is provided in Figure 3. The three writing intensive lab reports are shown on the x-axis. The bars labeled ‘Rewrite #1’ represent the number of students who visited my office after the initial submission was returned to them and before their first rewrite. This graph also suggests why more students were not successful, as many students failed to come for assistance until immediately before their final submission.

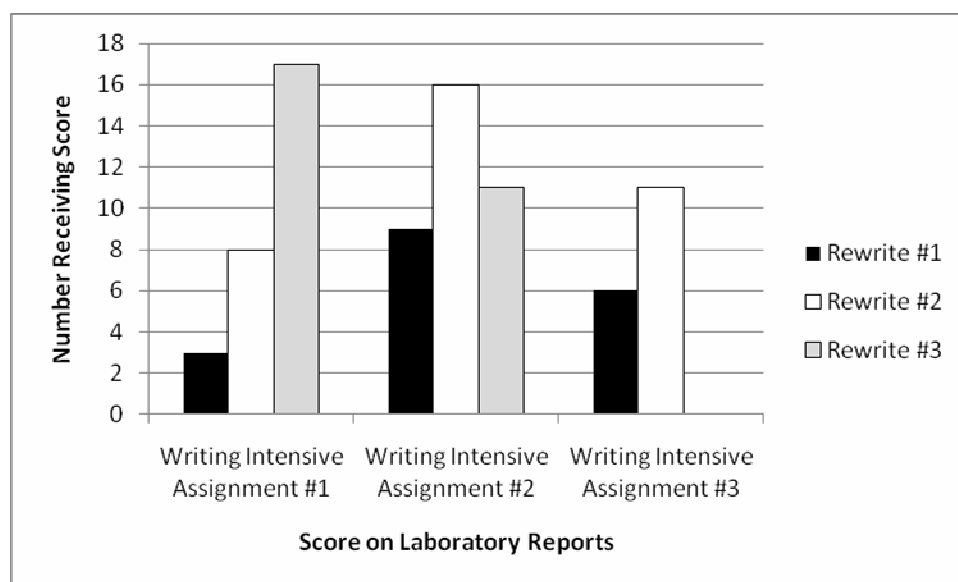


Figure 3

A few students struggled to make significant improvements from week to week. They would respond directly to my comments; for example, they would fix a sentence fragment. However, the resulting un-fragmented sentence might still be flawed for other reasons (e.g. faulty logic or a poor transition) that the student does not identify before resubmitting the paper. Some students felt that by correcting the sentence fragment, they had fixed all problems associated with the sentence, and were resentful when I identified other errors with the sentence, or when I found fault with how the corrected sentence “fit” with its surrounding sentences.

This inability of a student to go beyond correcting the specific flaw I identified and to re-read and improve the entire paragraph is illustrated in Figures 4 and 5. Figure 4 is a screen capture of a portion of one student’s next-to-last submission for the third writing intensive report. Figure 5 is the final resubmission, which I deemed unsatisfactory. The student addressed each of my comments, and felt that it was unfair that I described the resulting paragraph to be “unfocused and difficult to follow.”

To calculate the savings of water and money, I assumed that there were four people per household, 1.5 showers per household, 20 gallons of water a day were used in the showers, and the price per 100 ft<sup>3</sup> of water was \$2.42. The original cost for the residents for water is \$945,021.63. Because the fitting that will be installed in the showers will reduce the amount of gallons of water used, the residents will save \$54,729.50 annually. However, the city must spend an initial cost of \$375 to pay for the fittings that are installed. This will lower the annual cost of water to \$890,292.13 for the residents. Not only was the amount of money saved a great amount, but so was the amount of water saved. 17,000,000 gallons of water would be conserved per year just by installing the fittings. Because there is a great amount of water being conserved, the water treatment facility would be treat water with a higher quality since less is flowing through it.

Comment [p7]: how does the city “save” this money?  
 Comment [p8]: where is this from?  
 Comment [p9]: Seems like you are switching tenses...  
 Comment [p10]: round off greatly... This is just a memo, not a technical report so you can get away with lots of rounding.  
 Comment [p11]: fix  
 Comment [p12]: not necessarily true.

Figure 4

To calculate the savings of water and money, I assumed that there were four people per household, 1.5 showers per household, 20 gallons of water a day were used in the showers, and the price per 100 ft<sup>3</sup> of water was \$2.42. The original cost for the residents for water was \$945,021.63. Because the fitting that will be installed in the showers would reduce the amount of gallons of water used, the residents would save \$54,729.50 annually. However, the city must spend an initial cost of \$375. This will lower the annual cost of water to \$890,292.13 for the residents. Installing this fitting also decreased the amount of water that was used. 17,000,000 gallons of water would be conserved per year just by installing the fittings. Because there is a great amount of water being conserved, the water treatment facility would be able to treat a greater quantity of water and also has the capability for future expansion.

Comment [p2]: this structure is not parallel  
 Comment [p3]: seems unfocused and difficult to follow.

Figure 5

## Discussion

I will continue to implement these writing intensive lab assignments in following semesters. Grading them was much more rewarding, and many students appreciated the fact that their writing improved significantly. The grading was rewarding because it was more interesting to me, I knew students were considering my feedback carefully, and I did not have to “agonize”

each week over assigning numeric grades. The most common complaint on student evaluations was that the grading seemed unfair; they felt a grade of 0 was too harsh for work that was not necessarily “poor,” but for which I felt would need more than one iteration to improve. They also felt that a grade of 50% was unfair for papers that I felt only needed on more iteration. I will continue to use this grading scale however. I feel that the students have many opportunities to obtain an outstanding ranking. In addition to visiting me in office hours, they can have one another review their work, and the University has a Writing Center created to help students improve. Additionally, I want the grading to be relatively harsh, as I do not want students to be aiming for ‘C’ or ‘D’ quality work. Finally, giving grades in these three bins (0, 10 or 20) simplifies that portion of grading.