

Title: Incorporating Writing into Mathematics Classes

Author: Myunghun Oh, Mathematics

Summary: A mathematics professor incorporates writing into two differential equations courses to encourage students to think beyond solving problems and to communicate their understanding of course material.

Background

Applied Differential Equations, Honors (MATH 221) and Elementary Differential Equations (MATH 320) are undergraduate-level courses. As a course that fulfills a University general education requirement, MATH 221 tends to draw a large number of non-majors; however, as an honors course, it is typically small in size. MATH 320 is essentially a majors course and fulfills a requirement for the Bachelor of Science in Mathematics degree, but it still draws many non-majors and typically has a larger enrollment.

There are two general course goals, for students to:

- Gain a better understanding of differential equations.
- Appreciate how the understanding of differential equations can apply to their majors.

During a Fall 2009 CTE Faculty Seminar, our discussion included the use of writing to increase student learning. I had not thought before about using writing. However, I had found that while students may be able to solve math problems, they often have a hard time communicating their knowledge, as well as explaining broader ideas such as “What are differential equations?” Therefore, I wondered if I could implement a writing component into a course traditionally based on problem solving and, if so, what change this addition would have on student learning.

Implementation

Traditionally, both courses are orientated toward problem solving, with in-class time consisting of lectures and students working through problems both individually and as a group. Problems given in MATH 221 often were more in-depth, requiring a greater understanding not only of how to solve a problem but also how to prove a given set of circumstances. Homework helped supplement in-class learning, and I used both quizzes and exams to assess student progress. Where and how, then, could I include a writing component?

In my first attempt to implement writing, I revised the courses in several ways: altering preexisting course elements, including different problem types, and adding a writing-specific assignment. During both the exams and the in-class quizzes, students not only had to solve problems but also had additional writing tasks. For the exams (two midterms and a final), along with traditional problem solving, I asked students to write out the thought process they used in solving each problem. Therefore, they not only had to show understanding of the math involved to solve the problem, but they also had to communicate the knowledge they used in the solving process. The students had a similar task on the quizzes.

To obtain student feedback about this new approach, I asked questions such as “What’s the most important thing you’ve learned in the past two weeks?” “What are you having problems with?” and “What would you like/what do you feel needs further explanation?” I used students’ responses to these questions and a midterm evaluation form to structure the remaining class meetings, which gave students an active role in their own learning experience.

While both MATH 221 and 320 saw new writing components on assessments, for 221 I also revised the types of problems given. When first tackling the question of how to use writing in a math course, I wondered at the effectiveness of adding a written portion to problem solving itself. Therefore, I began to give the honors students more in-depth word problems, with an eye toward the question: could those word problems help students gain a better understanding of the concept of differential equations?

I did not use a traditional rubric to evaluate either the in-class assessments or the revised problems. Rather, expected steps and outcomes were modeled during class time. As we worked through sample problems on the board, I discussed what elements I wanted to see in their own work. We would also work through the steps needed to solve the problem in question and what should, therefore, also be present in their discussions of their own processes.

Finally, I added a new project specifically focused on combining math and writing. Due to student resistance to engaging with writing in the above-mentioned areas (which will be more fully discussed in this portfolio’s Reflections), I assigned this project only to MATH 221. Students were asked to study a method of their choosing and analyze results obtained from applying the equation and models of that method. Therefore, while they

had to have an understanding of the math involved, the majority of the project was writing based. I assessed these projects using a four-level rubric.

Student work

Because my MATH 320 students were very resistant to the additional writing tasks on assessments, I did not assign them a project specifically focused on writing. Therefore, my discussion here of student work will focus only on MATH 221. The grade distribution for the project in 221 saw three As, ten Bs, one C, one D, and one F.

Although students earning both As and Bs generally provided clear, organized work, the A papers tended to go more in-depth into the problem than did the B papers. For example, although Students 1 and 2 chose difficult problems, they did not demonstrate original, critical thinking about the problems. This appeared to be a common trend throughout most of the projects. The students were free to choose their own topics, although in a few instances many people chose the same topic and were, then, asked to tweak or change topics. After they made the requested tweaks it became apparent that most students had chosen problem types common in their majors, which would be easy to research but that did not necessarily stretch students' critical thinking skills.

The high level projects, on the other hand, provided more in-depth thought about students' chosen problems. They also clearly addressed the chosen problem's relevance: why students picked the problem, why it was interesting to them. Student 3, for instance, noted how childhood curiosity tied into the problem chosen, and Student 4 addressed the logistical importance of his problem.

Lower level projects did not address relevancy nor did they provide much in-depth thought. Student 5 appeared to focus solely on filling in the areas mentioned on the assignment sheet but did not move beyond the surface, providing little discussion and presenting the material in an almost barely modified outline structure. Lower level projects not only evidenced less organization but also presented sloppier work.

Reflections

In attempting to introduce writing into a math course I saw two very different responses, which raised questions for future iterations of each class.

While MATH 221 students were willing to try something new, the MATH 320 students were much more resistant. I found that most students came into the course with a set idea of what to expect in a math class and were reluctant to change that mindset, with some even refusing to participate. This raises the question of how to balance student's expectations with changes or attempts to stretch their thinking into different areas. It also raises questions regarding my expectations. In this iteration I did not require that students complete the written portion explaining the solving process on exams; instead that portion was optional. Most MATH 320 students did not complete these portions, while most MATH 221 students did. Therefore, if I expect students to participate here, in future iterations I will need to make the writing portion tied to each problem's points.

An unexpected outcome of the implemented changes came in MATH 221 where some students moved beyond what was required and began creating their own problems. I had not seen this in previous iterations of the course. Students would also explain their work when solving problems on the board in class. A handful of MATH 221 students gave general, positive feedback at the end of the course.

The final grade distribution between the two courses would seem to support the idea that writing positively affected student performance. Comparison between the Fall 2010 MATH 221 iteration that included writing and previous semesters where writing was not included also appear to support my changes.

Another element to address for future classes specifically relates to the writing project. Although I utilized a rubric in grading the students' papers, I did not provide them with this beforehand. In the future, I will give students a copy of the rubric in hopes that doing so will help improve student performance by giving greater guidance regarding expectations. In addition, in the future, I would redesign my rubric to closely tie criteria to understanding strategies for solving differential equations.

Overall, even with the difficulties encountered, I feel this was a good first try at incorporating writing—something many math students see as being completely separate from math—into differential equations. While I will need to make adjustments before using writing in the future, it is definitely something to keep and continue to tweak. I look forward to seeing how future writing elements impact student learning and performance.