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Writing to Learn Math: A Dialogue

Editor's Note: *This article is a recent dialogue between a writing instructor and a math instructor at Jefferson Community College.*

Rita: Using writing as a means of knowing, not just as a way to demonstrate what you know, has long been appreciated by teachers of composition (naturally) and teachers in other disciplines such as history, literature, and the social sciences. But, more recently, mathematics teachers have begun to discover writing as a pedagogical tool for teaching both basic and advanced math.

Carrie and I discovered, somewhat by accident, that the processes inherent in writing were similarly efficacious for both our disciplines, composition and math. Sharing an office complex we regularly observed and overheard each other in conference with our respective students. The tone and structure of our conferences were amazingly similar: we defined concepts, asked for clarifications, demonstrated process, invited questions, facilitated comparisons and contrasts, and encouraged analysis.

As Plato discovered centuries ago, open dialogue is at the heart of learning. I tell my writing students that they must learn to "talk to themselves" to become good writers who can take their ideas through the personalize/objectify dialectic that leads to discovery and clarification. This kind of dialogue, I believe, is what Carrie and I heard each other encouraging as we attempted to meet our students' needs.

As we worked through writing/math anxieties, we tried to meet the same needs: the need to see relationships, to recall, to summarize, to forecast. In the process of the conference experiences, we heard our students validating or amending their classroom experiences, leaving ideally with better strategies for learning.

Writing was the way to make these conference processes concrete and ongoing, a way to practice those skills that cognitive research indicates are necessary for all learning. This research stresses the essential relationship between thought and language. If we can verbalize it clearly, we can know it clearly. Our conversations about this spurred Carrie and some of her colleagues to expand on the writing they were already having their math students do.

Carrie: In the past several years, I have found that students want to memorize a mathematic formula or process until the test date and then promptly forget the process. However, in math classes, the next information taught very often hinges on what was just taught, and hence the process of learning mathematics breaks down if students use only memorization skills. In trying to coerce my students to retain more of the processes I was teaching, I resorted to verbalization of the concept. At first I used term papers in applied courses such as Finite and Business Calculus. Then I had students write their own story problems.

Rita: Writing "story problems" is just one of many strategies composition research Ann Berthoff lists for her students in preparing a "double-entry notebook." Designed as a tool for critical thinking for writing, the notebook provides a way for students to work through an idea and then think about the process they used. On one side of the notebook, the students write observations, ideas, summaries, even make drawings to record their learning. Then, on the opposite side, perhaps later, they re-think their first entries, ask questions, make corrections or amendments, and reach conclusions.

Carrie: Adapting Berthoff's idea, I had the student keep a written journal on the left side of the page which explained what he/she was performing mathematically on the right side of the same page. The student was to use names of the principles and laws and to label steps or processes with which he/she was not familiar or comfortable. These latter comments were to be asked about in the next class meeting.

At the end of certain sections, exercise sets, or chapters, I requested extra assignments. These included comparisons of two chapters or perhaps just two problems and categorizations of problems such as word problems into distance, geometry, motion, mixture, or consumer categories.

The notebook was very useful to both the student and me. With mistakes corrected, the notebook became the student's individual textbook for the course. Each chapter had numerous worked problems—each with an explanation that this particular student could read and understand. For myself, I could read any page and see whether

a student was having difficulty understanding the process being taught. In the privacy of my office, or in the learning lab, I could discuss the problem with the student in his/her own words and be more apt to correct it.

The notebook does take considerable time to read and evaluate, but the same benefits from verbalizing math concepts can be obtained in other ways. In a recent semester I used a mini-notebook idea which I called the "Concept Problem." One or two weeks before the exam, students would be given problems which included specific mathematical concepts over which they would be tested later. The students were to complete these problems using the double-entry format.

These problems were collected and returned by the next class meeting. The student who received a "✓+" had demonstrated a good understanding of the mathematical concepts being applied, and he/she was allowed to take the exam on the scheduled date. The student receiving the "✓-" had to correct noted mistakes and return the corrected exercise before taking the test. Any student receiving the minus not only had to correct the mistakes, but also had to set up a conference with me.

Each conference would consist of examining the student's homework and discussing mistakes and methods of correcting those mistakes, discussing study skills and test-taking skills, and quizzing the student on a new "concept problem." At the end of this conference, the student would either be allowed to take the exam with the class or be given remediation work and a new test date would be scheduled.

This semester I am giving my students selected problems I have chosen to use as examples in my daily lecture. The students already have the "math" in hand and are now able to take notes in the half of the page provided. They can write concepts, procedures, and alternate methods on this single page, divided double-entry style. I am hoping this will encourage them to think about how they take notes in a math class and realize I am not just teaching numbers and variables. I am teaching students how to process information.

This same process can be encouraged by simple, occasional writing tasks such as these:

1. Describe your last encounter with story or word problems.
2. Using your everyday experiences with numbers (finances, mileage, recipes, job, etc.), write a word problem that describes your experience.
3. Work a problem on the right side of the page; on the left, describe step-by-step what you're doing. Include definitions of mathematical terms you use.
4. Given a set of word problems, rearrange into separate categories of your choice. Give a description and rationale for the category.
5. Now that we have finished chapters 1-3, take a look at the processes we have used. Write an essay that explains the similarities and differences in the processes we learned.

Rita: These kinds of written responses put math learning into a student's native tongue. As researcher Marsha Hurwitz comments in "Student-Authored Manuals as Semester Projects" (*Mathematics Teacher*, December, 1990), writing restores meaning to symbols:

> Much of the elegance of mathematics lies in symbolism that allows us to manipulate complex ideas. However, without comprehension of the substances behind the symbolism, the memorization of symbols is meaningless.

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