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**Winter 2014 Teaching Skills Study Award Report**  
**Davida Fischman, Department of Mathematics, [fischman@csusb.edu](mailto:fischman@csusb.edu), 7-5394**  
**Joint Mathematics Meetings, January 15-18, 2014, Baltimore, MD**

Dr. Ed Burger, the Francis Christopher Oakley Third Century Professor of Mathematics at Williams College wrote, in *Essay on the Importance of Teaching Failure*, Inside Higher Ed, December 2013:

*Individuals need to embrace the realization that taking risks and failing are often the essential moves necessary to bring clarity, understanding, and innovation. By making a mistake, we are led to the pivotal question: "Why was that wrong?" By answering this question, we are intentionally placing ourselves in a position to develop a new insight and to eventually succeed. But how do we foster such a critical habit of mind in our students — students who are hardwired to avoid failure at all costs? Answer: Just assess it.*

Having read this article, I attended Ed Burger's session at the Joint Mathematics Meetings, and determined to try to implement some form of formal assessment of quality of failure. Below is a description of my own failure in the first attempt, and how I revised the process in the hopes of improvement.

**Winter 2014, Math 499, Mathematics in the Secondary Classroom:** I included a discussion of "quality of failure" in my first class (What comes to mind when you think of failure? What could "quality of failure" mean?), asked students to read the article, and included in their homework a reflection on how they learned from their failures. Students were generally very open about their feelings and experiences with failure; their essays included statements such as:

- All the pressure from my family has given me this negative view of failure when it is associated with me, but it has also given me a perception from a person experiencing it.
- When I am in the classroom, I do not look down upon those who are struggling to succeed. Those are the students I enjoy working with the most.
- Webster's definition of failure is "the lack of success", but my definition of failure is of the opinion that I gave up, that I did not try my best, or that I did not give it my all.
- It is not only the teacher's responsibility to find the problem area of this student but also the student must realize that he or she is not doing well in a certain area and must ask for help. I believe that success or failure is a two way street.

On and off during the quarter we discussed how students had learned from their failures, and how as teachers they would address student misconceptions, but I didn't have a sufficiently structured or consistent approach to the issue. It's not clear to what extent students benefited from these discussions.

**Winter 2015, Math 329, Transformation Geometry:** Determined not to give up on the idea of learning through a high quality of failure, I have assigned a project (see attached for project requirements) that involves reflecting on growth throughout the course, and in particular reflecting on what the students learned from their mistakes. So far, this seems to be working out better, possibly because of the increased structure of the assignment, and possibly because it clearly accumulates throughout the quarter, and students are accountable to demonstrate growth.

I responded to first and second drafts with comments but no grades; only the final draft was graded. I hoped that this approach would lead to an increased attention to comments and learning, rather

than a primary focus on the grade earned.

The results on the whole were very gratifying. Below are some excerpts from student reflections; these students also showed marked increase in the quality of their work through the quarter.

**Excerpts from reflections:**

I began to do some research on this theorem and found that it is often proved by the Pythagorean theorem, AAS or SSA congruence conditions; none of which we had gone over in class yet. Since we were not assuming the fifth postulate, didn't think that I was able to make assumptions about the sums of the angles. Finally, I looked at some information regarding one of the "Now Solve This" problems (1.2). This was a quick experiment to exemplify that the altitude in an isosceles triangle is also the perpendicular bisector and angle bisector of the base. This led to theorem 1.5, regarding the median being the perpendicular bisector as well as the angle bisector. I believe that this information allowed me to finish my proof without assuming additional information not yet covered in class.

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In my initial trial of this proof, I did more work than was necessary because I did not originally refer back to the theorem. I solely went off of the definition, and therefore thought that I needed to prove all three aspects of a parallelogram: diagonals divide each other into 2 congruent triangles, each pair of opposite sides are congruent, and that diagonals bisect each other. Of course proving one then leads to the others, but in this proof, the parallelogram MNQP was not the point of my proof. It was just a necessary step in order to get to my final steps. My proof also relies heavily on the Midsegment Theorem.

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I first approached this problem with the idea of reflecting  $\triangle ABC$  over  $\overline{AC}$  and creating a triangle that was congruent to  $\triangle ABC$ , labeled as  $\triangle AB_2C$ . However, I realized that proving my newly constructed triangle was congruent to  $\triangle A_1B_1C_1$  would not allow me to prove that  $\triangle ABC$  was congruent to  $\triangle A_1B_1C_1$ , which was the statement I was aiming to prove. Therefore, I realized I would need to create a triangle congruent to  $\triangle A_1B_1C_1$  and then prove this triangle to be congruent to  $\triangle ABC$  instead. Also, from quiz #1, I found out that I couldn't simply reflect a triangle and claim it is congruent. I must instead construct pieces to then create a congruent triangle. I think my original idea came from looking at the illustration in the book, but not analyzing it closely enough to realize what the triangle under  $\triangle ABC$  was meant to be a congruent triangle to  $\triangle A_1B_1C_1$ . Another issue I realized was that I had created triangles that appeared as though they were equilateral. This started to confuse me because I was having trouble discerning which sides I knew were congruent rather than sides that I had constructed to look congruent. Therefore, I had to redraw my triangles so that they appeared scalene. This made it much easier for me to keep my sides in order.