Accurate Technical Communication

We are what we repeatedly do. Excellence is therefore not an act, but a habit.

-Aristotle

One of the goals for all math courses I teach is to allow you to discover and practice *accurate technical communication*. This will be a very important skill when you graduate and get a job in any technical field.

- Your calculations will need to be checked by others.
- You will be sending many emails and memos on technical subjects.
- You may need to prepare technical specifications for new designs.

If you make the proper calculations but nobody can understand your written work, the work will need to be done over. Or worse, people may make assumptions about the content. I believe that more problems occur due to poor communication than poor calculations.

For example, the Mars Climate Orbiter was lost in space due to "the failed translation of English units into metric units" when results of calculations were passed, with units unspecified, from one group to another.

My goal is *not* to force you to recopy your homework. On the contrary, I want you to be able to create readable work the *first time*. It's alright to erase a lot of things, or even cross out mistakes. The work should be neat, which means legible and well organized. It does not need to be beautiful.

Assignment Number 0

Here are some examples of poor written work in the context of a math class. Each problem illustrates a different communication issue. In most cases *the underlying math is correct*, it is just not communicated effectively. For each problem, write a new solution, making it more readable, accurate, and understandable.

1. The spiral. Some people eat the entire crust of their sandwiches before they eat any other part. This is fine, but your technical work should not spiral in a similar way. Each statement should begin on a new line. The answer below makes sense if you read it in a clockwise spiral to the center. Rewrite the answer below with a better arrangement. With the exception of the arrangement on the page, the answer below is correct.

Problem: Solve $\sqrt{4x^2 - 12x} = 4$ for x. Answer:

$$\begin{array}{rl} \sqrt{4x^2 - 12x} = 4 & 4x^2 - 12x = 16 & 4x^2 - 12x - 16 = 0 \\ 4 \neq 0 & x = -1, 4 & 4(x^2 - 3x - 4) = 0 \\ x + 1 = 0 \Rightarrow x = -1 & x - 4 = 0 \Rightarrow x = 4 & 4(x - 4)(x + 1) = 0 \end{array}$$

2. Everything equals everything else. Some people use "=" to separate mathematical sentences, not just to show equality. This is confusing and sometimes downright wrong. The answer below contains too many equals signs. Note that if we take the answer literally, we get 6 = 0 = -1, which is obviously false. Rewrite the answer, removing some of the equals signs, and separating the sentences by moving down the page.

Problem: Solve $3x^2 - 3x = 6$ for x. Answer: $3x^2 - 3x = 6 = 3x^2 - 3x - 6 = 0 = 3(x^2 - x - 2) = 3(x - 2)(x + 1) = -1, 2$

3. Nothing equals anything. The opposite of the above problem is a fragmented approach that says absolutely nothing. The equals sign is the verb of the mathematical sentence. The following answer has no verbs, whereas the previous answer was one big run-on sentence. Rewrite the answer, adding equals signs and making a new line for each mathematical sentence.

Problem: Solve $3(x^2 - x) = 6$ for x.

Answer: $3(x^2 - x) - 6$ $3x^2 - 3x - 6$ $3(x^2 - x - 2)$ 3(x - 2)(x + 1) -1, 2[Equivalently bad answer: $3(x^2 - x) - 6 \Rightarrow 3x^2 - 3x - 6 \Rightarrow 3(x^2 - x - 2)$ $3(x - 2)(x + 1) \Rightarrow -1, 2$]

4. Keep the audience in mind. Your job as the writer of mathematics is to lead the reader through your solution. The reader is not only interested in your answer, but wants to be reasonably sure that you did everything correctly. Do not skip major steps in your documentation, and conversely do not bore the reader by including too much. By far the most common of these two offenses is that of skipping major steps. Leaving "road signs" such as, "using the quadratic equation we get," is one way to help the reader navigate your solution. The answer below skips many steps, and it's difficult to figure out what the person did. Rewrite the answer, filling in the gaps.

Problem:
Answer:
Solve
$$\sqrt{4x^2 - 12x} = 4$$
 for x .
 $4(x-4)(x+1) = 0$
 $x = -1, 4$