Lessons Learned with Teachers

Carnegie Mellon presented a scaled down version of the Robot Algebra project to a group of thirty mathematics teachers at a professional development seminar. Teachers were posed with the following challenge: Given a robot with 5.6 cm diameter wheels and wheel encoders accurate to 1 degree of wheel rotation, program your robots to travel exactly 31 centimeters (the length of a ruler, it is easier to find rulers than it is to find meter sticks The teachers were broken into teams and tasked to calculate the mathematics to solve this problem, they were shown how to enter the values they calculated into their robot to test their results. Within 15 minutes, all teacher teams solved the problem. During the debriefing session teachers were asked to explain how they calculated the number of degrees the robot traveled. Below are the results. There are slight variations due to rounding, but the answers are basically the same.

Strategy 1 (direct proportion)

360 degrees / 17.59cm = (x) degrees / 31cm =
17.59 * x = 360 * 31
x= 634 degrees

Strategy 2 (unit ratio)

31cm / (.0488cm/degree) =
31/.0488 = 635 degrees

Strategy 3 (unit ratio)

31cm * 20.408 degrees/cm =
31 * 20.408 = 632 degrees

Strategy 4 (scale factor strategy)

31 cm is the distance to travel
17.59 is the distance traveled per rotation
31 / 17.59 = scale factor

360 degrees * scale factor = new number of degrees;
360 degrees * 31 /17.59 = new number of degrees ;
360 degrees * 1.76 = 634 degrees

Strategy 5 (iterative testing – guess and check)

This sample group of math teachers identified five different ways to solve this simple robot math problem. And each group of teachers might argue that their method was the best one to solve this problem. At the very least, it was the method that they selected.

Students arrive in class with an intuitive understanding of proportional reasoning. Imagine a less than confident math student sitting in a classroom being taught a strategy to solve the problem that was incompatible with the student's cognitive model. If the intuitive understanding that the student has is incompatible with the way that the teacher presents the solution to the problem, and if the teacher insists that their way is the best or only way to solve the problem, then the student may experience uncomfortable levels of cognitive dissonance which can lead to low self-esteem and a less math confident student. It is important that teachers recognize and position mathematics as a thinking tool and that the tool can be used many different ways to the same problem similar to the way that a person driving car can go from point "A" to point "B" using many different routes, but still getting to the same destination.