Modeling Positive and Negative Number Concepts with Microworlds

by Robert M. Berkman

Mel Levine, a noted expert on learning disabilities at the University of North Carolina at Chapel Hill, relates an interesting story about sitting on an airplane next to a professor of electrical engineering, and asking him to explain how electricity moves through a wire. The professor told Levine that he thinks of the wire as a piece of sandpaper, and to keep the idea clear that different types of wires have different kinds of "resistance," he keeps an image in his mind of his hand moving across the surface. Levine found this image very provocative and asked whether the professor taught this to his students. "Oh no," he replied, "I want them to come up with their own models."

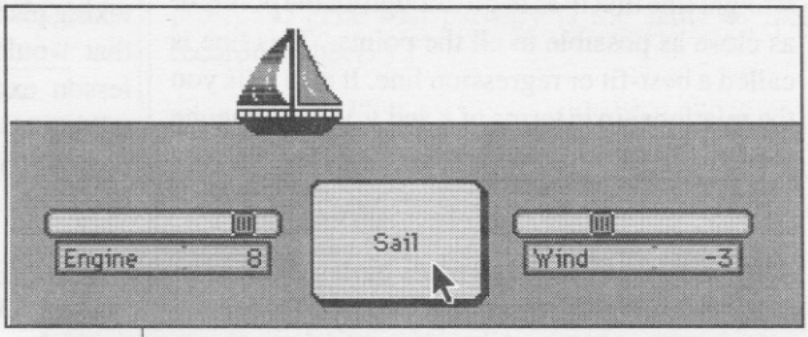
THE TWO SLIDERS CREATED A DYNAMIC ENVIRONMENT FOR INVESTIGATING ADDITION OF POSITIVE AND NEGATIVE NUMBERS.

While the concept of resistance may be difficult for students attempting to master the physics of electricity, the concept of positive and negative numbers is equally mysterious to the average 7th grader. Many teachers are content to introduce a couple of examples where positive and negative numbers are used (temperature, bank balances and altitude are the ones found most often in textbooks) and move on to the various rules that surround them. Of course, this leads to a very shallow understanding of what positive and negative numbers are and the ways they can be manipulated.

One of the greatest challenges students face as they attempt to master the concepts of integers is the fact that up to this point, numbers have been modeled as things that express discrete magnitudes, that is, they have a "positive" size, and as shown in many textbook series, are "whole." (I would love to author a textbook some day where every single solution is a non-whole number.) It is not until 7th grade that students learn that numbers can also have "direction," that is, they can be positive or negative. Along with this comes a great deal of confusion, as students puzzle over whether -10 or +10 is a "bigger" number, and what happens when operations are performed upon them.

Throughout my years of teaching I have attempted to come up with various models for conveying understanding of positive and negative numbers. One recent inspiration came while introducing *Microworlds Math Links* to a group of middle school teachers. I was demonstrating some of the new features when I came upon the idea of showing how two sliders could be combined to form a sum. The model went like this:

Suppose you had a boat which was sailing from left to right. The speed of the boat was determined by two forces: its engine speed the wind speed. Furthermore, these two forces could also have "direction," which is that both the engines and wind could push the boat



"forwards" and "backwards." By setting up two sliders which were programmed to "run" the boat, it was possible to determine the speed of the boat using positive and negative numbers. One represents the engine which could either push the boat forwards (positive) or backwards (negative.) The wind slider works the same way: the wind would push the boat backwards (negative) or forwards (positive.) The two sliders created a dynamic environment for investigating addition of positive and negative numbers.

The procedure for creating this situation uses a rather simple program. First, create a slider and set its range from -10 to 10, and call it "engine." A second slider is set up the same way, but it would be called "wind."