***Reflections**...continued from page 20*

whose only questions of me in the past were: "Is it going to be on the test?" and "Show me how to get the right answer." actually asked me a genuine "what if" question. What's particularly satisfying about that is if he asks me such a question once, there is a good chance he will ask it again! And that is my Standard when I use Logo to teach math with.

Some final thoughts....

It's one thing to write down that you should do problem solving, but its another thing to actually have teachers get children to practice it.

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One of the ramifications of the Standards will be that every vendor at all conferences from now on will tell you how their textbook meets the Standards.

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My intent here is not to criticize the Standards. The document does include many examples of good activities to do with children. But I question how many people will actually spend the time to read this large book. (I just read parts of it.) I would probably use this document as a part of a teacher education program with perspective math teachers in a university. Δ

***Modeling**...continued from page 7*

happy, partly because it takes a long time for the missile to reach road level. The kids take a crack at estimating some of the remaining missing values in the table.

MSL HEADING	130	125	120	115	110	105	100	95	92	90
FWD VECTOR	16	19	23	28	34	47	60	80	120	∞

For the angles close to 90 degrees I ask, "If one pass across the screen produces a down vector of 1 dot, how many screen passes would it take to reach road level?" Some kids pick up on the ratio, and we write the proportion and solve. I remark about the time cost of these more extreme measurements, and the value of good extrapolation methods like ratios.

We take the time to draw a graph, plotting missile headings as y-coordinates and forward vectors as x-coordinates. This orientation keeps the vectors horizontal. I remind the kids that with any two numbers you can plot a point. Plot a lot of points, and if you see a pattern, you can make predictions!

Using the table, we resume taking turns. Given a random missile heading selected by the computer, pick the closest value from the table and select the approximate forward vector. This leads to some planning and thinking, and some teamwork. Some hits are scored, but it's still hard. I see kids with fingers spread, measuring and moving them across the screen. Someone says to take the truck's forward speed into account. "Do you add it or subtract it?" Much confusion, but the main idea clearly is shooting, not planning.

Before this class ends, I force the planning by stopping the game and asking students to explain what a forward vector is, why we're not hitting the target, and how we might be more effective. Other students critique each explanation. The kids have been speaking and writing English language solutions to a variety of mathematical problems. Now I ask them to apply their skills to a discussion of the problems facing us in this computer game. I want to see if talking applied mathematics with some precision leads to a plan of what additional information is needed, what further needs to be measured, and how to apply it to score hits every time. The kids will go home tonight with a paragraph to write based on the class work.

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The exercise continued for two more periods. Forward vectors for the truck were measured against the drop of the missile to the road level, and another table was constructed. An IF-THEN-ELSE statement was developed to respond to a hit and trigger the truck explosion. When the missile reached a certain y-coordinate, the game was designed to recycle with all new random values for the speed variables. Other ideas were brought up by the kids, some of which could be worked on fruitfully, some not.

What has been learned? What role has Logo played in this process? What effect did the kids' prior and concurrent training in the language have on their learning? At what disadvantage are Logo novitiates? What is enabled by a teacher's personal ability and degree of comfort in the language? These questions are perhaps partly answered by the description of what happened when we immersed ourselves in the exercise, and by the fact that we keep on doing it.

There is satisfaction in being able to model, in however rudimentary a fashion, engaging processes on a computer with a language whose graphic capabilities and programming styles are within the reach of most kids. Such modeling leads to surprisingly rich problems to solve and many teacher opportunities for selection and emphasis of mathematical content. Because we go where we are led by our imaginations, there is no written plan or support material. This is part of the reason for the emphasis on precise speaking and writing about what's happening and what to do about it. This provides the basis for written and oral assignments, many requiring geometric drawings. Also helpful in this regard are program printouts with assignments to explain command sequences selected for specific mathemati-

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