Learning Physics from a Dynaturtle

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The Logo turtle has proved a remarkably good microworld in which students can experience and learn mathematics painlessly while pursuing personally satisfying activities. To see if a similar idea could work for physics, author diSessa created a dynamic turtle, *dynaturtle* for short, which obeys Newton's Laws of motion. A dynaturtle remains at rest or travels at a uniform velocity in a straight line except when acted on by forces. The forces are little pushes, or kicks, specified by the student via the keyboard. Depending upon their direction, kicks can cause the dynaturtle to speed up, slow down, or change direction. (Although a dynaturtle doesn't presently come built in to Logo, the language makes it extremely easy to add one.)

Experience with elementary school students proved that even simple activities with the dynaturtle (such as driving it to intercept a target) were, indeed, both motivating and instructive. For example, the students had an apparently deep-seated misconception that things always go in the direction you push them. In reality, as Newton showed and a dynaturtle exemplifies, a push merely adds to the existing momentum of an object and typically only deflects it.

When the students translated this belief about force and motion into a strategy for hitting the target, as shown in figure 1, they would inevitably miss the target. With time and practice, the feedback from the microworld allowed the students to gain a better understanding of how forces should affect the motion of an object. Subsequent work with university physics students showed misconceptions and patterns of learning similar to those held by the elementary school students. This accords with recent research that shows how little conventional instruction affects intuitive beliefs concerning the laws of physics.

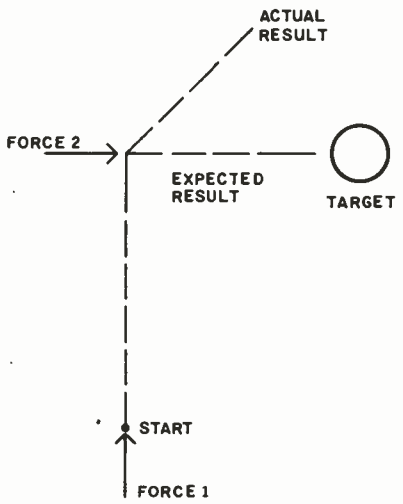

Figure 1: *Dynaturtle helps students gain a better understanding of how force affects a moving object.*

Dynaturtle, like the original Logo turtle, is a tool for students and teachers alike. Various researchers have and are creating materials for using a dynaturtle in the context of a programming experience for elementary school students (including handicapped students, as a replacement for the usual kinesthetic experiences through which we develop physical intuition).

To aid in teaching physics, author White has developed a "curriculum" in the form of a series of games using the dynaturtle. The idea is that with particular goals and problem situations, the games will focus students' attention on difficulties in their conceptions about force and motion and thus, step by step, lead them to a solid understanding of the problem.

White's curriculum began with a detailed study of the many kinds of difficulties high school students have with fundamental force and motion problems. She concentrated on the simplest qualitative ideas where "formula cranking" will not help. Thereafter, she developed the series of games and also devised a set of problems to assess changes in the students' level of understanding. In a controlled experiment, the games proved strikingly successful at eliminating basic misconceptions and at improving overall understanding. This finding is an encouraging indication that such game-like activities can be used not only for entertainment, but also for solving significant pedagogical problems.■

References

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