“Radio-Active” Learning: Visual Representation of Radioactive Decay Using Dice

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The idea of using a dice game to simulate radioactive decay is not new.[1] However, modern pedagogy encourages, if not requires, us to provide multiple representations and visualizations[2] for our students. The advantage of interactive engagement methods also has been made clear.[3] Here we describe a highly visual and interactive use of dice to develop student understanding of radioactive decay.

Initially we scavenged five meter-long, 2.54-cm diameter tubes from the stockroom by dismantling several speed-of-sound experiments[4] and mounted them against the chalkboard (see Fig. 1). We purchased dice at 50 for $1 at the local 99¢ store. Each tube can hold about 60 dice. Typically we use a total of about 200 dice.

First we illustrate the effect of a 50% probability of decay per toss by letting the class agree on three numbers that will represent a decay (such as even numbers 2, 4, and 6). They all perform their first roll of the dice. The students bring up to the board all the dice that “decay” and place them in the first tube. When they are back in their seats, the top of the first tube is covered with tape to ensure that future rolls don’t accidentally wind up in the wrong tube. The class then performs the second roll and places the decays in the second tube. The process continues until all five tubes have been used (see Fig. 1). The decay curve can then be sketched on the board by drawing it in between the tubes. A preliminary discussion of the half-life concept takes place at this point.

The next step is to change the probability of decay to seek understanding of its relationship to the decay curve and half-life. We have the class agree on two numbers that will represent a decay and predict the changes they expect in the decay curve and half-life. We remove all the dice from the tubes, leaving the 50% decay curve sketched on the board, then repeat the dice-rolling activity, filling tubes with the “decays” on each roll. The new decay curve and half-life are then discussed and compared with the 50% decay curve and half-life. Key points to emphasize are that the probability of decay is directly related to the steepness of the decay curve and therefore the half-life.

There are at least two distinct advantages of using the tubes at the blackboard over the traditional paper-and-pencil dice-rolling activity. First, student engagement is enhanced by both rolling the dice and by placing dice in plastic tubes at the front of the classroom, giving the kinetic learners the opportunity to get out of their seat. Second, the result is a visual representation of the data in a graph created by the actual dice, providing an additional representation to enhance student learning.

Fig. 1. The tubes, mounted against the blackboard, filled with dice using a 50% probability of decay.

References

1. L. Kowalski, “Simulating radioactive decay with dice,” *Phys. Teach.*, **19,** 113 (Feb. 1981).
2. For example see, A. Van Heuvelen and X. Zou, “Multiple representations of work–energy processes,” *Am. J. Phys*. **69**, 184–194 (Feb. 2001).
3. R. Hake, “Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses,” *Am. J. Phys*. **66,** 64–74 (Jan. 1998).
4. For example see U.C. Berkeley Physics Lecture Demonstrations at http://www.mip.berkeley.edu/physics/B+60+0.html.

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