Pendulums

Ms. D. wants to focus on inquiry. She wants students to develop an understanding of variables in inquiry and how and why to change one variable at a time. This inquiry process skill is imparted in the context of physical science subject matter. The activity is purposeful, planned, and requires teacher guidance. Ms. D. does not tell students that the number of swings depends on the length of the pendulum, but creates an activity that awakens students' interest and encourages them to ask questions and seek answers. Ms. D. encourages students to look for applications of the science knowledge beyond the classroom. Students keep records of the science activities, and Ms. D. helps them understand that there are different ways to keep records of events. The activity requires mathematical knowledge and skills.. The assessment, constructing a pendulum that swings at six swings per second, is embedded in the activity.

[This example highlights some elements of Teaching Standards B, C, and D; Assessment Standard B; 5-8 Content Standards A and B; and Program Standard C.]

The students in Ms. D.'s fifth grade class are studying motion,direction,and speed. One experiment in this study is designed to enable the students to understand how and why to change one variable at a time. Ms. D. has the students form groups of four; each student has an assigned role. One student—the materials manager—goes to the supply table to pick up a length of string, scissors, tape, and washers of various sizes and weights.Each group is directed to use these materials to 1) construct a pendulum, 2) hang the pendulum so that it swings freely from a pencil taped to the surface of the desk, and 3) count the number of swings of the pendulum in 15 seconds.

The notetaker in each group records the result in a class chart. Ms. D. asks the students to examine the class data. Because the number of swings recorded by each group is different, a lively discussion begins about why this happened. The students decide to repeat the experiment to make sure that they have measured the time and counted the swings correctly. When the second set of

data are entered on the class data table, the results make it clear that the differences are not because students did not count swings or measure time correctly. Again the class discusses why the results are different. Some of the suggestions include the length of the string, the weight of the washer, the diameter of the washer, and how high the student starting the pendulum held the washer to begin the swing.

As each suggestion is made, Ms. D. writes it on the board. The class is then asked to design experiments that could determine which suggestion is correct. Each group chooses to do an experiment to test one of the suggestions, but before the group work continues, Ms. D. collects the pendulums that were used to generate the first and second sets of data. As the groups resume work, one group keeps the string the same length but attaches washers of different diameters and tries to start the swing at exactly the same place. Another group uses one piece of string and one washer, but starts the swing at higher and higher places on an arc. A third group cuts pieces of string of different lengths, but uses one washer and starts the swing at the same place each time. Discussion is animated as students set up their pendulums and the class quiets as they count the swings. Finally, each group shares with the rest of the class what they did and the data they collected. The class concludes that the difference in the number of swings that the pendulum makes is due to the different lengths of string.

The next day, students notice that Ms. D. has constructed a board for the pendulums at the front of the room. Across the top are pegs from which to hang pendulums, and across the bottom are consecutive numbers. The notetaker from each group is directed to hang the group's original pendulum on the peg corresponding to its number of swings in a fixed time. When all of the pendulums are hung on the peg board, the class is asked to interpret the results. After considerable discussion, the students conclude that the number of swings in a fixed time increases in a regular manner as the length of the string gets shorter.

Ms. D. notes that pendulums were constructed with five and seven swings per 15 seconds on the peg board, but no pendulum with six; she asks each group to construct a pendulum with six swings per 15 seconds. After much measuring and counting and measuring again, and serious discussion on what counts as a "swing," every group declares success. Ms. D. then asks how they can keep the information on the relationship between the length of the string and the number of swings in a form that is more convenient than the peg board and directs the students to make a drawing in their science journals to keep that data. Most students draw the pegboard with the pendulums of different lengths, but some students draw charts and a few make graphs. Ms. D. challenges students to find examples of pendulums at home and in their neighborhoods.

The next science class is spent discussing graphing as students move from their pictures of the string lengths, to lines, to points on a graph, and to a complete graph. Finally, each student is asked to use his or her graph to make a pendulum that will swing an exact number of times.

Students have described, explained, and predicted a natural phenomenon and learned about position and motion and about gathering, analyzing, and presenting data.