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BUILDING A VISION OF INQUIRY-CENTERED LEARNING A WORKSHOP DEMONSTRATION

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The National Science Resources Center (NSRC), a science education center operated jointly by the National Academy of Sciences and the Smithsonian Institution, has developed a series of workshops that can be used to demonstrate inquiry-centered science learning. These "jigsaw workshops" have been very effective, not only with teachers and educational leaders, but also with university scientists and corporate leaders, as a way of building a new vision of the benefits of teaching science by engaging learners in scientific inquiry.

At the meeting of the Pontifical Academy of Sciences Working Group on "The Challenges for Science: Education for the Twenty-First Century", the members of the working group had an opportunity to participate in a jigsaw workshop on buoyancy developed by the NSRC. This workshop is based on learning activities drawn from the *Floating and Sinking* curriculum unit, which is a part of the NSRC's *Science and Technology for Children* (STC) elementary science program.

Working in groups of three, the participants performed one of the following investigations, using the simple apparatus designed for the STC program.

(A) This group was given a set of sixteen objects, which included a fishing bobber, wooden bead, glass marble, lump of clay, nylon bolt, aluminum nut, and eight large and small cylinders made of wood, aluminum, acrylic, and polyethylene. They were asked to: (l) predict which objects would float and which would sink; (2) develop a statement that would describe the properties of the "floaters" and the "sinkers"; (3) test their predictions by placing the objects in a water tank; (4) record their results and compare these results with their predictions; and (5) identify the major concepts and skills that children might develop by engaging in these activities.

(B) This group was given an uncalibrated spring scale, a box of paper clips to use as weights, and a set of five objects which included a large fishing bobber, a small fishing bobber, an acrylic cube, a nylon bolt and nut, and a large metal washer. They were asked to: (1) without using the spring scale, develop a strategy to compare the weights of the five objects and to place them in order from lightest to heaviest; (2) use the paper clips as weights to calibrate the spring scale; (3) using the spring scale which they calibrated, weigh each object, and compare this with their earlier results; and (4) identify the major concepts and skills that children might develop by engaging in these activities.

(C) This group was given a tank of water, a calibrated spring scale, a hook with a small suction cup that could be attached to the bottom of the tank, a nylon string, and a set of three fishing bobbers of different sizes. They were asked to: (1) without using any measurement tools, roughly compare the weights and volumes of the three fishing bobbers; (2) investigate the buoyant force on each fishing bobber by pushing it under water; (3) use the spring scale to weigh each of the bobbers; (4) using the spring scale, the hook attached to the suction cup, and the string, measure the buoyant force exerted by each of the fishing bobbers; (5) discuss their observations in order to draft a statement about the effect that volume has on the buoyant force; and (6) identify the major concepts and skills that children might develop by engaging in these activities.

(D) This group was given a tank of water, a lump of clay, and a bag of marbles. They were asked to: (1) discuss together a strategy that might be used to modify the shape of the clay, without changing the amount of clay, so that it will float with a cargo of 25 marbles; (2) test and modify this design until the clay boat floats with the 25 marbles; (3) design and construct a boat that will float carrying as many marbles as possible; (4) discuss the variables that affected the performance of their boat designs, including the effect of changing the volume of the boat; (5) identify the major concepts and skills that children might develop by engaging in these activities.

(E) This group was given a tank of fresh water, a calibrated spring scale, and a set of objects that included a metal cylinder, wooden cylinder, polyethylene cylinder, acrylic cylinder, black plastic cylinder, and a hollow cylindrical plastic container (all of the same diameter and volume). They were asked to: (1) predict which objects would sink and which ones would float in fresh water; (2) test their predictions by placing each cylinder into the tank of fresh water; (3) use the spring scale to weigh each cylinder and

record these weights; (4) fill the hollow plastic container with water, record its weight, and compare this weight with the weight of the other cylinders; (5) develop a statement that describes the relationship between the weight of each of the cylinders, the weight of the container of fresh water, and each cylinder's tendency to float; (6) identify the major concepts and skills children might develop by engaging in this learning experience.

(F) This group was given a tank of salt water, a calibrated spring scale, and a set of objects that included a metal cylinder, wooden cylinder, polyethylene cylinder, acrylic cylinder, black plastic cylinder, and a hollow cylindrical plastic container (all of the same diameter and volume). They were asked to: (1) predict which objects would sink and which ones would float in *salt* water; (2) test their predictions by placing each cylinder into the tank of salt water; (3) use the spring scale to weigh each cylinder and record these weights; (4) fill the hollow plastic container with salt water, record its weight, and compare this weight with the weight of the other cylinders; (5) develop a statement that describes the relationship between the weight of each of the cylinders, the weight of the container of salt water, and each cylinder's tendency to float; (6) identify the major concepts and skills children might develop by engaging in this learning experience.

After engaging in these activities, the participants discussed the "Focus-Explore-Reflect-Apply" learning sequence that is utilized in the STC science learning materials. The participants also discussed the special benefits that result from engaging children in inquiry-centered science learning as demonstrated in the *Floating and Sinking* demonstration workshop.