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SPRING 2008

TEACHING WITH COLLECTIONS

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NATIONAL STANDARDS

The lessons address NCTM Principles and Standards for School Mathematics:

- Number and Operations Standard for Pre-K–2 and 3–5
- Algebra Standard for Pre-K–2
- Measurement Standard for Pre-K–2 and 3–5
- Data Analysis and Probability Standard for Pre-K–2, 3–5, and 6–8
- Connections Standard for Pre-K–2, 3–5, and 6–8

Lesson 2 addresses NAS National Science Content Standards for systems, order, and organization, and for the characteristics of organisms.

STATE STANDARDS

See how the lessons correlate to standards in your state by visiting www.SmithsonianEducation.org/educators.

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TEACHING WITH COLLECTIONS

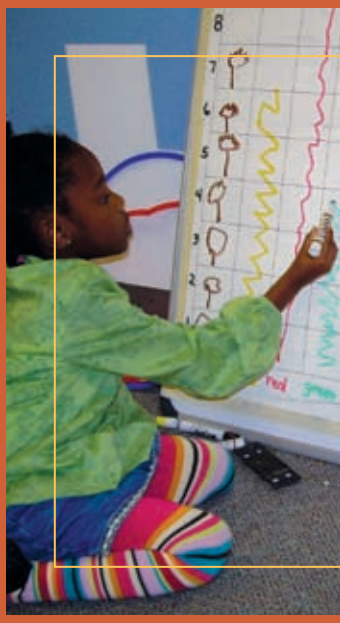
Twenty years ago, the Smithsonian established a preschool and kindergarten on the National Mall in Washington, D.C., the Smithsonian Early Enrichment Center (SEEC). One of the missions of SEEC is to foster critical-thinking skills through "real-world learning." The center's location, amid the collections of the Smithsonian's many museums, offers its teachers plenty of opportunities for this.

The collections include objects whose place in history gives them the status of inanimate celebrities: the plane flown by Charles Lindbergh across the Atlantic, the command module that carried the Apollo 11 astronauts to the moon, the very flag that inspired "The Star-Spangled Banner." But throughout the Smithsonian are also thousands of objects whose interest lies in being unfamiliar versions of familiar household items. Teachers at SEEC use these as an introduction to other cultures and other periods of history. A study of clothing, for instance, might include a visit to an exhibition of special sandals worn by clerics of ancient India. Before the children look for what the objects tell us about lives in another time and place, they see at a glance what connects those lives to their own: the objects, for all of their difference, are shoes.

The two lessons in this issue, both created by SEEC educators, bring collections into the classroom to give tangibility to mathematics—to turn numbers on a page into numbers of actual things. The first lesson, aimed at the youngest grades, follows the SEEC model of introducing new concepts with familiar items. The students take a close look at something we use every day but rarely think about until it's missing—the button. In early-algebra exercises of sorting and classifying, they organize a collection of random buttons, counting and multiplying them according to attributes. In the second lesson, students work with a collection of seashells and come to see how sorting and classifying relates to the work of scientists.

In an introductory article, SEEC's director, Sharon Shaffer, describes some of the other ways that SEEC uses objects in its lessons. To learn more about SEEC, including the professional-development programs it offers to teachers across the country, visit **www.seec.si.edu**.

Background



COLLECTIONS IN THE CLASSROOM

Sharon Shaffer
Executive Director, Smithsonian Early Enrichment Center

Children are natural collectors. They eagerly fill their pockets with small treasures or display objects that proclaim some personal enthusiasm—for cars or trains, sports or animals, or anything else. The process of collecting, especially for young children, is a step in giving meaning to the world. It is an important step, too, in cognitive development. The child recognizes distinct details associated with each object and becomes adept at identifying similarities and differences. Enthusiasm and knowledge grow naturally with the collection.

For teachers, a collection can be a terrific focus for learning, whether the set of objects belongs to an individual or a museum. In a museum, curators select objects from a collection to create a narrative or to communicate information. In creating a display, they make decisions about how to classify and arrange the objects. Personal collections have the same potential for the exploration of ideas.

COLLECTIONS AT THE SMITHSONIAN EARLY ENRICHMENT CENTER

Kindergartners enrolled in the Smithsonian Early Enrichment Center (SEEC) are surrounded by the collections of the world's largest museum complex, but they are also introduced to collecting through hands-on activities in which they themselves act as curators. In one such activity recently, the teacher began by showing the students an old-fashioned kitchen mixer and reading the book *Thunder Cake* by Patricia Polacco. She told the class about her love of cooking and her memories of baking cakes with her grandmother. Each child then brought one object to school that illustrated personal interests or experiences, and each shared his or her own story. The class went on to create an exhibition, writing labels that gave information on each object.

Last October, the kindergartners brought autumn leaves to school, which they categorized on the basis of similarities and differences. They were excited to discover that there were many different ways to sort the leaves—by color, size, shape, number of points, the kinds of trees they came from. The project led to a graphing exercise in which the children set the criteria for sorting. Later, they used leaf rubbings to demonstrate their skill at creating math patterns, which were as simple as ABAB and as sophisticated as AABCCDAABCCD.

In another math activity, the teacher introduced a collection of various kinds of soap—bath soaps, miniature hotel soaps, detergents, lotions, soap on a rope, glitter soap. The students sorted and classified according to categories such as color, size, and liquid vs. solid. They noticed that some soaps might appeal to children and others to adults, and they discussed the different purposes for soap—hand washing, hair washing, dishwashing. They saw that there are many kinds of soap for each purpose, and that for each purpose we have choices of soaps.

As do many kindergarten classes, SEEC children celebrate their first hundred days of school. Everyone brings in a collection of one hundred objects: a hundred marbles, a hundred M&M's, a hundred pennies, a hundred buttons, or a hundred of anything else that interests the child. Combined as a class exhibition, the collections are a source of excitement for many days. The children discuss their reasons for choosing a category of things to collect and how they went about gathering so many examples to fit the category. They take great pride in having learned to count to a hundred, and this achievement is there for all to see in the exhibition.

TELLING STORIES WITH COLLECTIONS

Everyone is a collector in one way or another. Some of our collections have special meaning for us (postcards, photographs, dishes inherited from a favorite aunt) and some are purely practical (cookbooks, recipes from magazines, ties, shoes). It takes just a little imagination to see that these things we save at home would hold the same interest in the classroom.

When putting together a class exhibition, the organization of the objects is dictated by the story we want to tell. Let's take a collection of children's shoes and think about the concepts a class could explore. After the students have a few minutes to examine the shoes, the teacher asks them what they notice. Their thoughts might be about pairs and what that means, about differences between boys' shoes and girls' shoes, about types of fasteners (buckle, tie, Velcro), about size, style, material, or function.

A separation of the collection into categories begins with careful observation. The categories serve as a framework for sorting the objects and offer great opportunity for class discussion. The students might organize the shoes on a timeline to show when each type of fastener was invented. They might arrange the shoes from smallest to largest to tell a story of the physical growth of a child. Or they might tell a story about shoe design, which would require the class to discuss the criteria they wish to use for the categories.

TEACHING MATH WITH COLLECTIONS

The skills that go into the organization of a collection—recognizing attributes, making comparisons, noticing similarities and differences, defining criteria for categories—are important to the early development of mathematical understanding. When the students themselves are engaged in creating these categories, they are moving beyond simple algorithms. They are laying the foundation for data analysis and probability.

Whether the students are creating patterns with the objects or just counting the items in the collection, mathematical thinking is at work, and math takes on personal meaning when illustrated by objects that hold intrinsic interest. For young students, learning is all about active engagement. Collections are an ideal way to make that connection.

COLOR
silver

SHAPE
round

SIZE
medium

TEXTURE
highly textured

MATERIAL
metal

DESIGN
decorative, ornate floral embossment; one-hole fastener in back

COLOR
green

SHAPE
round

SIZE
medium

TEXTURE
smooth

MATERIAL
plastic

DESIGN
simple; raised edge and center; four holes

COLOR
light blue

SHAPE
round

SIZE
small

TEXTURE
smooth

MATERIAL
plastic

DESIGN
simple, wheel-like; four holes

COLOR
light brown

SHAPE
cylindrical

SIZE
large

TEXTURE
smooth

MATERIAL
wood

DESIGN
decorative toggle, three ridges in center; one-hole fastener

COLOR
red

SHAPE
heart-shaped, scalloped edges

SIZE
large

TEXTURE
smooth

MATERIAL
plastic

DESIGN
decorative; two holes

COLOR
multicolored (dark blue, light blue, gold, silver)

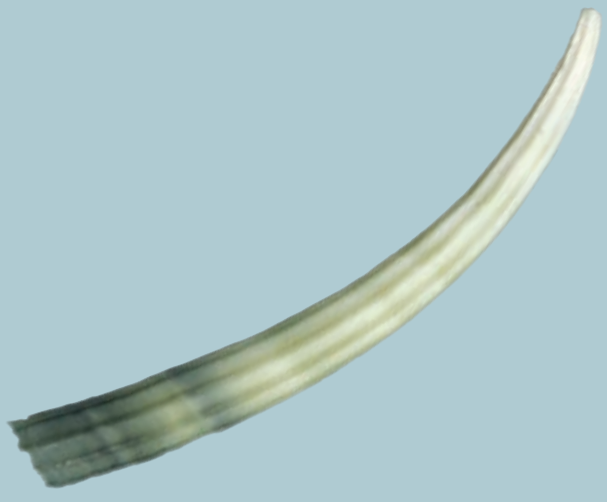
SHAPE
round

SIZE
medium

TEXTURE
smooth

MATERIAL
plastic

DESIGN
decorative, random pattern of stars on dark-blue background; two holes



A COLLECTION OF NATURAL OBJECTS

KINGDOM
Animalia

PYLUM
Mollusca

CLASS
Polyplacaphora

GENUS
Acanthopleura

SPECIES
Acanthopleura echinata

COMMON NAME
chiton

The shell of the chiton (pronounced KITE-un) is a series of canoe-shaped plates. The chiton uses a powerful "foot" to cling to underwater rocks.

KINGDOM
Animalia

PHYLUM
Mollusca

CLASS
Bivalvia

GENUS
Ischadium

SPECIES
Ischadium recurvum

COMMON NAME
hooked mussel

Like all bivalves, the mussel uses a muscle to open and close its two hinged shells (or valves). The most muscular bivalve is the giant clam. Its pair of shells can grow 4 feet long and can weigh 500 pounds.

KINGDOM
Animalia

PHYLUM
Mollusca

CLASS
Cephalopoda

GENUS
Allonautilus

SPECIES
Allonautilus scrobiculatus

COMMON NAME
umbiculate nautilus

The class Cephalopoda includes the octopus and the squid. Like those animals, the nautilus has tentacles—as many as 90. It is the only cephalopod with a shell.

KINGDOM
Animalia

PHYLUM
Mollusca

CLASS
Gastropoda

GENUS
Perotrochus

SPECIES
Perotrochus charlestonensis

COMMON NAME
Charleston slit shell

The class Gastropoda includes 65,000 species, most of which, like the slit shell, are snails. Snails live everywhere in the world, from the depths of the ocean to the tops of trees.

On the cards are five categories of the Linnaean system for classifying living things. It was the idea of Swedish naturalist Carolus Linnaeus (1707–78) to give each thing a two-part scientific name to represent its genus and species. These Latin names and this system of *binomial nomenclature* are used around the world today. One of the mollusks here, *Dentalium elephantinum*, was named by Linnaeus himself in 1758. The Charleston slit shell, *Perotrochus charlestonensis*, was discovered and named as recently as 1988.

Linnaeus named more than 12,000 organisms and estimated that the world held 30,000 more. He was a true *Homo sapiens* (Latin for "wise man"), but his numbers were off. According to today's estimates, there may be as many as 100 million species of living things.

KINGDOM
Animalia

PHYLUM
Mollusca

CLASS
Scaphopoda

GENUS
Dentalium

SPECIES
Dentalium elephantinum

COMMON NAME
elephant tusk

The elephant tusk uses its shape less like a tusk than like a snorkel. It burrows into the seabed with its wide end and breathes water through its upright slender end.

A COLLECTION OF ARTIFACTS

This lesson addresses early-grade math standards for sorting and classifying, one-to-one correspondence in counting, counting by twos and fours, graphing, multiplication, and measurement.

You'll need a collection of buttons of various sizes, shapes, colors, and materials (perhaps twenty-five to fifty buttons for very young students; up to a hundred for an older class). On page 5 are cutout "button cards" that you can use to demonstrate some of the ways that the collection can be sorted. (The images are larger than actual buttons, which will make it easier for the class to see characteristics like color and number of holes.) On page 11 are three graphs. A full-page version of each is available for downloading at **SmithsonianEducation.org/educators**.

Though the instructions call for class activities, consider conducting the lesson in smaller groups, so that all students stay active and engaged.

Among the 3.2 million objects in the National Museum of American History are many that were part of personal collections donated intact to the Smithsonian. This display of buttons collected by a young girl in the 1930s came to the Smithsonian in 1974.

"In a way, all museums are treasure houses, places where valuable things are guarded and preserved," write curators Steven Lubar and Kathleen M. Kendrick. "But what makes something a treasure? People invest different kinds of value in artifacts—aesthetic, historical, personal, spiritual. Value is, after all, in the eye of the beholder, and the treasures we Americans have placed in the National Museum of American History reveal a great deal about who we are, as individuals and as a nation."

STEP ONE

Begin with a game. Before showing students the buttons or telling them anything about the lesson, describe a single button from the collection. For example: *This thing is small, round, blue, made of plastic, and smooth to the touch. It has four holes and can be used to hold something together.*

When students guess that the object is a button, display the collection (spread across a flat surface). Ask them to identify the button that most closely matches the description, and to explain the reasons for their choice.

STEP TWO

Allow students a few minutes to look closely at the collection, and then ask them to get into pairs. Give each pair five to ten of the buttons. Explain that the partners will take turns describing a button and guessing which one it is.

Encourage students to use words that describe size, shape, material, and texture. They might also make speculations about the age of the button, the clothing item that it came from, the kind of person who wore the clothing, etc.

STEP THREE

For the first sorting activity, work again as a class. Use Graph A on page 11 to focus on the attribute of color. Lead a discussion in which the class sets the rules for sorting. (For example, a button with more than one color might automatically go under the Multicolor heading or it might go under the heading that best describes its predominant color.) Ask students to count the number of buttons in each category and to record the results on the graph.

STEP FOUR

Now ask the class to sort the buttons by the number of thread holes in each. It is likely that the categories will be one, two, and four holes. Pose a question: *If we wanted to know the total number of holes in buttons from each category, how would we find the solution to this problem?* Strategies might include counting each hole in every button in a category, counting by twos or fours, or multiplying the number of buttons by that category's number of holes.

Students can record the strategies and their results on copies of Graph B. Ask them to represent each button type (one hole, two holes, four holes) with a drawing in the first column.

STEP FIVE

Give each student five buttons of various sizes and colors. Explain that each will arrange the set by size, from the smallest to the largest, and will then measure the buttons, using the centimeter side of a ruler for better accuracy.

Ask students to record the data on copies of Graph C, identifying the buttons by color. Each student will then exchange the set of buttons and the graph with a partner, who will check the measurements.

Collecting data from objects can be done in any number of ways. In a class discussion, ask if this way of organizing (in a series or continuum based on size) contributed to the students' ability to measure the buttons or to check their work.

BUILD AN EXHIBITION (AND VOCABULARY)

Buttons come in many shapes and sizes, and *button* itself is a broad term. Some buttons are merely decorative. Some buttons show support for a political candidate or a cause. We push some buttons to turn on a machine. Some machines, like a TV remote, are virtually all buttons.

To demonstrate that words can have multiple meanings, and that very different things can go by the same word, share examples of these other kinds of buttons. Then ask the students to bring in some examples of their own (or pictures of them) for a class collection. Each student can create a text label that describes the object.

All decisions on the organization of the collection should be based on class discussions. Invite other classes and parents to visit the exhibition that results from the activity. At SEEC, the collections are temporary; the objects are always returned to their owners.

A

	Red	Blue	Yellow	Green	Orange	Purple	Brown	Black	White	Silver	Multicolor
15											
14											
13											
12											
11											
10											
9											
8											
7											
6											
5											
4											
3											
2											
1											
0											

B

Draw a picture of button type	Number of holes in one button	Number of buttons in group	Total number of button holes	How did we get the total?

C

Button Color					
Diameter (centimeters)					

A COLLECTION OF NATURAL OBJECTS

Here students work with a collection of fifty to a hundred seashells of various kinds. They draw on the skills of observing, collecting data, and sorting and classifying. Along the way, they build their vocabulary and learn a bit about scientific classification.

The lesson might also serve as an introduction to the concept of symmetry.

Seen here are a few of the 35 million specimens in the Smithsonian's U.S. National Invertebrate Collection.

STEP ONE

Begin by showing the class one of the largest of the shells and passing it around the room. Ask that each student, while holding it, use one word to describe a characteristic perceived by sight, touch, smell, or (if it's the right kind of shell) hearing.

Work as a class to create headings under which the words can be grouped. These headings might include the attributes of color, pattern, shape, and texture.

STEP TWO

Ask the class to get into small groups. Distribute ten to twenty of your shells to each group. Explain that the groups will sort the shells according to color, pattern, shape, or texture. If, for instance, a group chooses texture, the shells might be arranged into smooth, rough, and ridged.

Encourage the students, if they are considering shape, to look for symmetry or the lack of it. With very young students, introduce the concept of symmetry by showing a shell (a scallop, perhaps) that would fit together if it could be folded it in half. With older students, point out other kinds of symmetry. The slit shell on page 7, for instance, has a rotational symmetry: the shape is repeated around a central point.

Each group should try to come to unanimous decisions on the way to organize the collection. Appoint representatives from the groups to tell the class about the work.

STEP THREE

Have the groups sort their shells according to three size categories: small, medium, and large. When they are finished, ask the class: *Was this difficult? With some shells, did you have a hard time deciding on the category?*

The groups will now use a more exact method of sorting the collection: they will measure the length of each shell in centimeters. (Explain that scientists use the metric system for such measurements.) Allow each group to determine the criteria for small, medium, and large. A group might decide, for example, to classify shells shorter than two centimeters as small, those two to five centimeters as medium, and those longer than five centimeters as large.

The groups might also measure the width of the shells and then follow the same steps for weight, using a kitchen scale. As a class, think of ways of graphically representing the data you've collected. A Venn diagram, for instance, can show how the categories of size and weight relate to each other.

STEP FOUR

Cut out the cards on page 7 and display them, picture side up, on a table. Working as a class, refer to the scale bars that accompany the pictures to discover the actual size of the five shells. Arrange the cards from smallest to largest shell.

Have each student place one shell from the collection near the picture of a shell that it most resembles. Lead a discussion by posing questions: *What do the shells in each set have in common? How are the sets different from each other? Why do you think that there are more of our shells in some sets than the others?*

Use the information on the backs of the cards to introduce students to the mollusks who once lived in the shells. Ask students to examine the Linnaean classifications on the cards to see what the five mollusks have in common (kingdom and phylum) and what is unique to each (class, genus, and species).

SHELLS OF THEIR FORMER SELVES

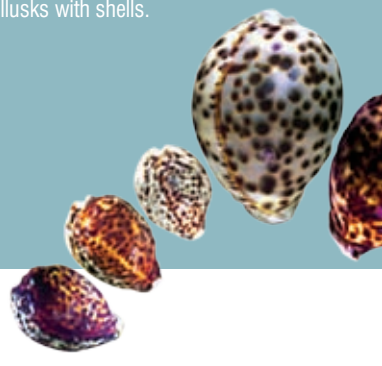
Seashells are the external skeletons of the soft-bodied animals in the phylum Mollusca (from the Latin *mollis*, meaning "soft"). A mollusk produces its shell by secreting calcium carbonate through its mantle, a wall of flesh surrounding the body. The process continues for a lifetime, so that the shell grows with the animal. After the animal dies, the shell might remain for thousands or even millions of years. Sometimes other kinds of animals take up residence.

"Scientists look at shell shape and pattern to group mollusks," says Yolanda Villacampa of the Smithsonian's National Museum of Natural History. "But we also look at the anatomy of the animal itself, as well as conduct DNA studies to determine which groups they are closely related to, and if they have a common ancestor."

The cards on page 7 represent five classes of mollusks, all with distinct kinds of shells. Bivalves have two shells joined by a hinge. Gastropods have a one-piece shell, usually in a coil shape that reflects the coiled body within. Scaphopods, too, have a single shell, but of a long, tapered shape. The nautiluses of the class Cephalopoda have a *planispiral* shell—coiled, but on a single plane—with a large opening. The chitons of the class Polyplacaphora have a series of eight overlapping plates—a shell that is more like a suit of armor than a house.

A shell's color and pattern serve as camouflage, but can also result from the circumstances of the individual animal's life. Injuries to the mantle, for instance, can cause discoloration. Variations of diet can cause variations of color.

It's likely that most of the shells in your collection are bivalves and gastropods. These are the classes most common in shallow waters, and their shells are the ones most commonly found on beaches. Throughout the world, bivalves and gastropods make up the majority of the 100,000 species of mollusks with shells.



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