

**Auntie Clementine's Guide to Fossils:
A Children's Book**

Lila K. Battis
Senior Integrative Exercise
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Table of Contents

ABSTRACT	
INTRODUCTION	1
PURPOSE	1
SCIENTIFIC LITERACY IN AMERICA	2
WHY FOSSILS?	3
PALEONTOLOGY: THE GATEWAY SCIENCE	4
CREATING A CHILDREN'S BOOK	5
THE STORYLINE	5
DEVELOPING A CURRICULUM	10
REFLECTIONS	11
ACKNOWLEDGEMENTS	11
REFERENCES	12
APPENDIX A	13

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Advisor:
Mary Savina, Carleton College Department of Geology

ABSTRACT

Something is wrong with science education in modern America. Adult scientific literacy rates are frighteningly low, children are not meeting academic standards, and students grow to like science less and less with each year of schooling. In order to address these problems, I have developed a children's book and sample lesson plan aimed at rejuvenating both student and educator interest in science through the study of paleontology. This report details my research on elementary science education and the processes and challenges of creating a book and lesson plan.

INTRODUCTION

Much of the inspiration behind this project stems from personal curiosity—I've long been passionate about paleobiology and book arts, and over the past year I've developed an interest in educational studies as well. Thus, I decided to create a children's book and corresponding lesson plan about fossils. This report details some of my research into elementary science education, the rationale behind the project, and the process of creating a children's book that is both educational and engaging.

PURPOSE

American science education today is in shambles. The majority of adults are classified as scientifically illiterate, the majority of children are not meeting national standards for science comprehension, and perhaps most alarmingly, students have been shown to gradually develop a dislike for science as they get older (Sullivan & Weiss, 1999; Miller, 2004). It is apparent that major changes need to be made in order to reverse these trends and raise a new generation of students who understand basic concepts and appreciate the value of a strong science education. The first step towards overarching change is making small shifts within individual classroom environments. In order to address these problems and begin to remedy them, I have created a book and sample curriculum that focuses on basic paleontological topics while integrating skills and concepts from other disciplines. I hope that these interdisciplinary lessons will make science more appealing and applicable to both educator and student, and thus provide a point of access for students to explore and develop their knowledge and interest in the sciences.

SCIENTIFIC LITERACY IN AMERICA

At first glance, science literacy may not seem terribly significant—after all, not every nine-year-old will become a geophysicist. However, having a strong foundation in science is increasingly vital to success in today’s world. Knowledge of science “enables people to use scientific issues and processes in making personal decisions and to participate in discussions of scientific issues that affect society,” according to the National Science Education Standards (National Committee on Science Education Standards and Assessment, 1996). Science education not only endows students with an understanding of the world around them, it fosters critical thinking and inquiry skills that will have lifelong applications.

Unfortunately, schools in the United States today are turning out poorly prepared students with a distaste for science. According to a study by the National Center for Education Statistics, approximately 71% of fourth graders perform below grade level in the sciences. By 12th grade, this number has increased to 79%. Only 18% of high school seniors demonstrate science proficiency appropriate to their age level, and in an equally disturbing trend, almost 80% of American adults are scientifically illiterate (Sullivan & Weiss, 1999; Miller, 2004; Hobson, 2008).

Studies show a correlation between aptitude and positive attitudes toward science, so it stands to reason that the development of a scientifically literate society depends upon creating positive learning experiences and fostering enjoyment of science for students of all ages. In general, higher performance is seen amongst students who consider science interesting and enjoyable and identify themselves as being good at it (Sullivan & Weiss, 1999). Therefore, it is crucial that students be allowed to pursue

scientific topics of particular interest, be exposed to real-life applications and hands-on experiences, and have numerous opportunities to succeed if they are to be proficient later in life.

WHY FOSSILS?

If the number of books, Discovery Channel programs, and museum exhibits are any indicator (not to mention the appearance of Stephen Jay Gould on an episode of *The Simpsons*), it appears paleontology has become something of a cultural phenomenon. The study of ancient life is unique in the sciences in that it is not only interesting, but also accessible, even to those with no scientific background whatsoever. Basic concepts of evolution, extinction, and geologic time can be easily understood without any knowledge of the periodic table, or even multiplication tables. No special vocabulary is required, and the topic is both fascinating—strange extinct creatures that exist only as fragments of stone!—and relevant—where would our knowledge of evolution be without a fossil record?

Certainly my own interest in prehistoric life was a major contributing factor in the decision to make it the focus of this project. However, that interest in and of itself is a testament to the subject's approachability—as a longtime self-professed science hater, it was paleobiology that first made science seem less scary, and eventually led me to major in geology. It is my hope that this book will make general science accessible to children and educators in much the same way as that paleobiology class made it accessible to me.

PALEONTOLOGY: THE GATEWAY SCIENCE

Children seem to be naturally drawn to the world of fossils. As evidenced by the abundance of trade books on the subject, it appears their affection for ancient life is near universal. However, in traditional elementary science curriculums, learning about fossils is merely a tangential distraction—something fun to study on a rowdy Friday afternoon (Ebenezer & Connor, 1998; Gega & Peters, 1998). Paleontology is often seen as domain-specific knowledge, when in fact an interdisciplinary approach to the study of fossils offers opportunities to develop skills in other subject areas as well. By neglecting to channel children’s passion and curiosity for paleontology, educators are missing out on an opportunity to use ancient life as a stepping stone to further learning, both in the sciences and in other disciplines. Through the study of fossils, students can discover classification and sorting, practice deductive reasoning, develop language and writing skills, make comparisons, and understand the scientific method.

Students who are interested in the topic at hand are intrinsically motivated—they pursue learning opportunities, ask questions, and generally find success without the promise of an external reward. They pursue learning for learning’s sake, and “experience...more positive functioning in terms of their classroom engagement, emotionality, creativity...conceptual understanding, academic achievement, and persistence in school” (Reeve & Jang, 2006). Framing traditional elementary learning objectives within the context of a subject many children find compelling not only gives them a greater chance of academic success, it also creates a positive experience for the child in the realm of science, thus increasing the likelihood of continued study and scientific literacy later in life. By approaching paleontology as an interdisciplinary

subject, teachers can help their students set strong foundations in science without neglecting other areas of learning.

CREATING A CHILDREN'S BOOK

Before delving into the writing process, I first had to reacquaint myself with the world of children's literature. Though fossil books were relevant to the subject itself, I found the most useful method was to find books that held great appeal to children and incorporate some of the common elements into my own work. Quirky characters and humor seemed to be well-liked, as evidenced by the success of the Magic School Bus series, but the books that really stood out in my mind were those that also had an element of discovery—opening pockets and peeking under flaps makes the reading process more active, and allows various elements of the book to stand alone, independent of a linear storyline. I wanted to mimic this kind of dynamic reading experience in my own book, while at the same time keeping the material cohesive and educational, so I decided to create a scrapbook-style format. In this way, each page has multiple areas to be discovered, but the information in the text is not overshadowed by novelty elements.

THE STORYLINE

The content itself is nonfiction told through a fictional lens: the material teaches children about geologic history and paleobiology under the premise of a kooky geologist writing to her grandniece. This method opens the book up to a wider audience, no matter whether the child prefers fiction or non-fiction. . Small details such as taped-in photographs and notes in the margins humanize material that might otherwise be dry and inaccessible to the reader. Though the choice of characters may seem haphazard, the

intent was to create an intriguing female protagonist/narrator who might challenge the reader's conception of scientists as white-haired men in lab coats. Among students with sufficient preparation in math and science, men pursue science majors at approximately three times the rate of women, and some speculate that a lack of female role models in the sciences and the prevalence of the male scientist stereotype are partially to blame (Shakeshaft, 1995). It is my hope that, in some small way, Clementine Bascom will challenge that stereotype and show young readers that science is accessible to anyone

In contrast to many elementary fossil books on the market, this book does not focus on dinosaurs. The reasons for this are twofold. Most importantly, I wanted the book to be useful to the child. The chances that your average seven year old will wander into her backyard one day and find an exposed plesiosaur femur are slim to none. For many kids, however, finding fossils of marine invertebrates is not out of the question, and this book could be used as a reference to help a child learn more about a recent find.

Secondly, the staggering number of dinosaur books on the market means that any child with a remote interest in paleontology will already be pretty well informed when it comes to terrible lizards. Ammonites and brachiopods, however, don't usually enjoy the same kind of stardom, so it's more likely that a child reading this book might actually learn something new.

The book begins with a letter from the author—Dr. Clementine Bascom—to her grandniece, Penelope. The letter implies Penelope has inquired about some fossil or other, but rather than give her a simple, straightforward answer, Auntie Clem has decided to present her young relative with an introductory lesson in paleobiology.

For every geology student, the first step in understanding the earth is learning the geologic timescale, so naturally any earth science book worth its salt will include one. However, for young students who are only beginning to familiarize themselves with numbers, a billion means nothing. In order to help children understand the staggering magnitude of the earth's age, and how relatively insignificant humans are, I created a string timeline of Earth's history. I had never encountered a concrete representation of the geologic timescale until *Introduction to Geology*, and I remember it being something of an "a-ha!" moment, so I wanted to replicate that experience for the reader. Long strings of zeroes are difficult to conceptualize, but when a reader can hold a string in their hands and see that humans have only been around for the width of a fingernail, understanding the scope of time is almost unavoidable.

Though I wanted to explain a bit about evolution, my concern was that too much depth would considerably limit the age range of the audience, and likely lose the attention of even the most devoted reader. Since my research helped me understand the importance of inquiry and discovery learning in science, I was reluctant to throw lists of facts and dates at a child who would probably be more interested in learning about trilobites than knowing the specifics of when the first eukaryotic photosynthesizers appeared. Nonetheless, I did want to touch on the idea that different forms of life emerged at different points in geologic history, so I included a condensed, simplified summary of the evolutionary history of life on earth to be paired with the labeled timeline.

Before I could delve into descriptions of specific creatures, I needed to ensure the reader had a clear understanding of what a fossil actually was. Obviously a definition was necessary, but I thought including a list of things that are not fossils could provide some

contrast—not to mention an opportunity to liven things up a bit. It was important to me that the book maintain a sense of whimsy and humor, even in the midst of Very Serious Scientific Learning, and I wanted Auntie Clem’s personality to shine through, so I used the “Things That Are Not Fossils” section to draw focus back to the narrative voice.

The main focus of the piece is the section on marine invertebrates, which opens with a brief explanation of what a marine invertebrate is and why they’re important—in particular, their role as index fossils. Though I don’t expect children to memorize a list of extinction events, my hope is that after reading this book, a child could stumble across a trilobite in the field and remember that the presence of a trilobite gives us clues about the age of the surrounding strata.

The selection of the fossils to be included was predominantly based upon personal interest. In order to keep the book to a manageable length (for both the author and the reader’s sake), I was limited in the number of fossil groups I could cover. I knew I wanted to focus on marine invertebrates because of their importance to geologists and biologists alike, and I chose to present only those specimens that I thought would be both interesting and easily identifiable to a child.

DEVELOPING A CURRICULUM

Initially, the scope of my project was limited to the creation of a children’s book. As I began my research, however, I realized it was necessary to not only provide students with the information, but also to show teachers how a seemingly tangential topic in science could be applied in the classroom and integrated into a broader curriculum. In order to do this, I developed a short sample lesson plan, meant to be applied in the classroom alongside the children’s book. Unlike many lesson plans included with

nonfiction children's books, these lessons do not depend upon knowledge of the book—rather, the two should be viewed as parallel teaching tools. I wanted to emphasize that rather than keeping “science time” separate from reading, math, writing, or art, teachers can apply skills learned in other domains to science lessons, and vice versa, and thus reinforce students' understanding of knowledge as an interconnected web, rather than simply independent collections of facts and rules. Too often teachers make the mistake of presenting science as an endless series of formulas and facts to be memorized, when in fact, science at the most fundamental level is simply a process of inquiry and discovery. These lessons try to highlight the students' success in learning to approach things scientifically, thus, I've tried to stay away from traditional methods of evaluation. While it's true that science may often have a right answer and a wrong answer, there is no faster way to scare a child off science forever than returning page after page of assignments covered in red ink. Particularly in elementary school, when students are creating foundations for further learning, more emphasis should be placed on exploration, application, analysis, and synthesis of ideas rather than simple rote memorization of dates or facts, and it is the development of these higher-order learning skills that I've tried to emphasize in these lessons.

REFLECTIONS

Though I have experience with children, knowledge of fossils, and generally solid writing skills, combining the three to create an effective teaching tool was not an easy undertaking. When I set out to create this project, I knew only that I wanted to create an aesthetically pleasing, clearly presented nonfiction book that a child could understand. Throughout the process of writing the text, I was forced to simplify complex geologic concepts and leave out details in order to streamline the material and avoid confusing the reader. I struggled with this aspect, in large part because I was hesitant to gloss over important details, but in the end I decided the book would be more effective if it were understandable, even if the full truth about, say, the history of evolution was not described in explicit detail.

Without a doubt, creating the lesson plan was the most challenging part of this project. When I learned paleobiology, it was in the context of a college classroom. Not only did I have countless texts available for reference, I had a knowledgeable professor, multiple field trips, and drawers full of fossils to aid my learning, so at first I was a bit stumped as to how one could properly teach the subject without such extensive resources. In the end, I decided a small collection of fossils—which can be borrowed or purchased inexpensively at a scientific supply company—was not an unreasonable request to make of a teacher.

In addition, I found it difficult to gauge whether the lessons I created were truly age appropriate. I referenced third grade science standards and read other lesson plans geared towards the same age group to narrow the field, but in the end, I still couldn't be certain how successful the lessons would be. Grade level alone does not fully determine

where a student is, and a third grade class in Northfield might have a completely different experience than a class in Minneapolis when applying these lessons. Ultimately, the success of the abbreviated paleontology unit depends upon an educator's knowledge of his or her students and ability to modify lesson plans to better suit the classroom environment.

Were I to do this project again, I would do considerably more testing—of both the lessons and the book—before turning in the final product. Speculation can only take one so far, and without implementing the book and the curriculum in a classroom environment, I can never really be sure how they would fare as teaching tools. Ultimately, however, I learned just as much from the process as I might from the execution—I faced the challenges of lesson planning, the difficulty of balancing fun, engaging activities with real learning, and the uncertainty that any new teacher would have in creating a new lesson plan. While there are still elements of both my process and the final product that I would change, overall, I'm quite satisfied, and all the more prepared for the next educational undertaking.

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APPENDIX A

Lesson Plan: An Interdisciplinary Approach to Paleontology

Integrating Science

Beginning in elementary school, students are taught—though perhaps inadvertently—that school is a series of disjointed, unrelated lessons. Math is squished between recess and reading. Art is on Mondays, science always comes before lunchtime. The reality, however, is that the first chair violinist uses math on a daily basis, and scientists and mystery writers both rely on their communication skills to stay afloat in their fields. By applying a science curriculum that incorporates skills from other disciplines, educators can help students make connections between varied bodies of knowledge and understanding, therefore offering greater opportunity for real-life application and preparing students for a lifetime of integrated learning.

Paleontology is inherently an interdisciplinary science, incorporating both geology and biology, but more than that, it provides an avenue through which teachers can introduce other important concepts—classification through cladograms, description through examining specimens, language and writing skills through daily exercises tracking their knowledge of fossils. Students can practice mapping and making graphs by going on a fossil dig, work on measuring and math skills by creating a large-scale geologic timeline, and apply poetic devices to the examination of a specimen. Discussions as a class help students develop skills of scientific inquiry and communication, and hone those skills in writing about their learning. Far beyond simple memorization of dates and phyla, paleontology can be applied as a tool in helping students begin to develop higher-order learning skills, all the while educating them about the history of life on earth.

Learning Context

This lesson plan is geared towards students in the third grade, though lessons can be modified to suit other age groups as needed. Some of the material is fairly advanced, and it assumes children have prior knowledge of fossils in addition to basic skills in measuring, classifying, and exposure to basic poetic devices, to name a few. Because many of these lessons depend upon cooperative learning as a whole class, they are best suited to classes of twenty students or less. Though the lessons are presented here as a group, they are intended only as snapshots of a larger unit, and may be rearranged or altered to best suit the needs of the class.

Third graders are typically in the midst of Erik Erikson’s “Industry vs. Inferiority” stage. At this age, it is imperative that students be given many opportunities for success and that they be praised for their efforts. In keeping with this, evaluation methods in this unit stress participation, inquiry, and discovery over complete mastery of scientific concepts. The near-constant incorporation of writing, drawing, and discussion allows students with a variety of strengths to demonstrate their knowledge, and the production of a cumulative Fossil Book allows each child to walk away from the unit with a sense of accomplishment and concrete proof of their learning.

Instructional Objectives

- Students will, as a class, establish a definition of a fossil. They will create a set of criteria that a fossil must fulfill. They will be asked to evaluate various specimens and determine whether or not they are fossils, and edit their definition based on new information and discoveries. Individual students will demonstrate understanding by explaining why or why not a chosen specimen is a fossil.
- The class will know the approximate age of the Earth, and begin to understand the scope of geologic time by creating a timeline as a class. They will demonstrate understanding by writing about what they learned in their journals.
- Students will learn the difference between cast and mold fossils by replicating the processes using clay and plaster.
- Students will demonstrate knowledge of similes and metaphors by incorporating these poetic devices into a descriptive poem about a fossil.
- Children will develop classification systems for different types of candy, and understand that scientists use similar classification methods to group organisms with common traits.
- Students will develop an understanding of how a paleontologist works by conducting a sandbox excavation and identifying the fossils found and the corresponding period of geologic time.

Instructional Materials

In order to truly study paleontology, it is imperative that the class have access to a variety of specimens. These may be borrowed from the collection of a local university or museum, or purchased from a scientific supply company. In addition, the activities herein require various art supplies, clay, plaster of Paris, paper cups, two colors of sand, small trowels, paintbrushes, string, and an overhead projector. The excavation project calls for

a large sandbox, but the project may be conducted on a smaller scale substituting large, shallow plastic bins, or even disposable aluminum pans.

Unit Project: Fossil Book

In order to keep track of students' understanding and progress within the unit, each child will keep a fossil book. This can be a simple stack of paper folded in half and stapled, with a manila envelope as the cover. Students can decorate the covers themselves with drawings of their favorite fossil or prehistoric creature.

What is a Fossil?

At the beginning of class, have students write a few sentences describing what they know about fossils. On the next page, have them write down some of their questions—things they don't know but are curious about.

Ask the class what a fossil is. Write some of their ideas on the board or projector. Divide the class into groups, and have each group come up with a definition for the word "fossil." Assign roles within the group: a recorder to write the definition on the board, a presenter who will read it to the class, and speakers who will explain how they came up with the definition and why they think it works.

After each group has presented their definition, students should work together as a class (with the teacher playing devil's advocate) to come up with a group definition of a fossil, picking their favorite elements from individual group definitions. What are some things all fossils have in common? Establish an area where the definition can remain, clearly visible to the class, so students can periodically reevaluate and refine their definition as they learn more about paleontology.

Have the class sit in a circle and pass around several objects, one at a time: a trace fossil, a modern bone or shell, and one or two body fossils. One by one, ask the students about each object. Why might scientists say that burrows or footprints are fossils? Why are ancient shells fossils, but not modern shells? What about a chicken bone? As a class, reexamine the definition you have come up with. Does it fit burrows and footprints? What about fossilized plants?

Individual Work:

Send students back into their small groups. Give each group a natural object of some sort—it may or may not be a fossil. Each group can discuss whether or not the object is a fossil, and then students should write a short paragraph explaining what it is about the object that makes them believe it is (or is not) a fossil.

Understanding Geologic Time

Begin class by having the students share estimates about the age of the earth.

Explain that Earth is 4.54 billion years old, or 4,540 million years—decimals and large numbers can be tricky for kids at this age, so show several different ways of writing this same number—and that geologists have divided the history of the earth into sections in order to make it more manageable.

Tell them the class is going to create an outdoor timeline of the Earth’s history. In this activity, one foot (you can also modify the activity for metric, but I’m using feet and inches here since kids are generally more familiar with the US system) will be equal to 100 million years. Have each student pick a “job title” out of a jar. Jobs should include titles of important events in Earth’s history: formation of the Earth, present day, extinction of the dinosaurs, first fossils, etc, as well as when each event occurred.

Begin indoors, with a relative timeline. Write all the major events on the board and have the students try to arrange themselves in order. Be present to answer questions (or ask leading questions—have humans and dinosaurs ever lived together?), but don’t offer correction until the students are satisfied with their timeline.

Once they have themselves in correct relative order, move class outside. Explain that the class is going to create a scaled timeline of Earth’s history. Have them recreate the order of their relative timeline, then walk the students through the history of the earth using chalk and a measuring tape, beginning with Earth’s formation. Each student is responsible for measuring the distance from the previous major event to his or her place on the timeline. In addition to the formation of earth and the present day, other events could include the first fossils, first mammals, extinction of the dinosaurs, and the appearance of humans, but the total number of events depends on the size of the class.

Approximate distances for a few events are included below:

If 1foot = 100,000,000 years and 1.2 inches = 10,000,000:

Earth formed: 0 feet

First life on Earth: 10 feet, 5 inches

Hard-shelled creatures: 40 feet

First Dinosaurs: 42 feet, 8 inches

Mammals: 42 feet, 10 inches

Extinction of Dinosaurs: 44 feet, 11 inches

Humans: 45 feet, 5 inches

Present Day: 45 feet, 5 inches

Return to the classroom and have each student draw a timeline in their fossil books. These do not have to be marked out and measured accurately, just drawn with whatever events they remember. They should label their timelines and write a sentence or two about the class activity and what they learned. What did they already know? What surprised them?

Creating a Fossil

In this activity, students will create models of two kinds of fossils. First, demonstrate the process for the class, and have a completed example to show students.

Have each student bring in a small, hard object to use in making his or her “fossil.” Without showing the other students, they should press the object into a disc of modeling clay. Next, each child should paint a light coating of oil on the clay and place the disc, impression-side up, at the bottom of a paper cup. Pour plaster of Paris into the cup—just enough to cover the clay. When the plaster dries, the paper cup can be peeled away and the student will be left with both a cast and a mold of the object. Label the plaster casts with students’ names, then have them exchange casts. Each student should create a hypothesis of what the original object was and what it might have been used for, and draw a picture of the object.

Once students have completed their drawings, arrange the class in a circle. Going around one-by-one, each student will show the cast they observed, their drawing of the original object, and say what they think the object was. The rest of the class can then add additional hypotheses before the student who created the cast reveals the original object.

After guesses have been made, each student should be paired back with their original cast. Using paint, glitter, permanent markers, fabric trim, and any other available craft materials, students can create a “fossil” paperweight to display on their desks!

Paleontology and Poetry

Provide each table of students with a few different fossil specimens. Have each student select a specimen and list words that describe the object’s shape, color, texture, weight, size, etc. Model this as a class beforehand so students have a clear understanding of the assignment. On the next page, each student should choose a few of their descriptive words and write complete sentences describing the object.

Explain the concept of similes and metaphors to the students, and show them a few examples. Next to each of their descriptive words, have them come up with something else that word could be used to describe (i.e. rough/sandpaper, grey/thundercloud, jagged/shattered glass). In their fossil books, each child should create a picture of their fossil using paint, markers, collage, or another medium, and write a poem containing a few similes or metaphors describing it.

EXAMPLE:

The fossil was
 as rough as sandpaper
 as grey as a thundercloud
 as jagged as shattered glass.

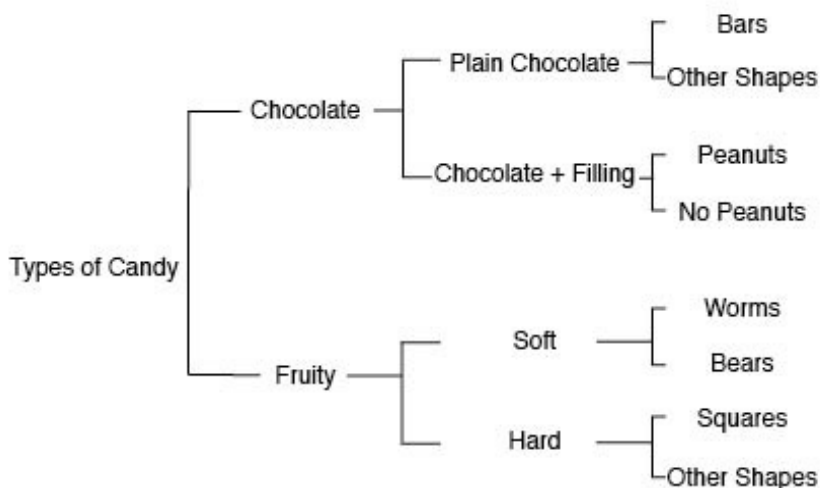
Once the students have finished their poems and pictures, have them compare their specimen to a selection of labeled fossils. Can they identify which fossil looks the most like theirs? Are there any differences? Students should jot down a hypotheses about which kind of fossil they think is theirs, and how they came to that conclusion.

Understanding Classification

Place a variety of candies in a pile at the front of the room (chocolate bars, Kisses, Snickers, Milky Way, gummy bears, gummy worms, Lifesavers, and Jolly Ranchers, for this example). On the board, write “Types of Candy.” Ask the students for suggestions as to how we might sort these candies: size? shape? color? flavor? What if we want to classify all the candy we have here into two main groups?

Sort the candy into the main groups students have chosen. For this example, let’s say “Chocolate” and “Fruity.” Explain to the students that we want to narrow down groups by common traits until each type of candy has its own category.

Split the class into two or three groups, and give each group a large sheet of paper and an assortment of candy. Starting with the sorted groups the class came up with, have each group further sort the candies and draw a tree to describe the sorting, like so:



Once the groups have finished sorting their candy, take out a new type of candy and have each student write a sentence or two explaining where it would fit in their tree and why—what characteristics does it share with the other candies in the group? Would a new group need to be made?

Explain that, like we just classified candy, scientists classify animals into different categories. Many fossils that look very different are often classified in the same general group based on other common factors. For example, cephalopods, bivalves, and gastropods are all mollusks, even though they don’t look too much alike.

Fossil Excavation Project

Paleontologists use clues from fossils to make guesses about how an animal probably lived. For this project, everyone in the class is a paleontologist, and we have to determine what creatures we’ve found and how old they are. There will be three groups, and each will be examining and mapping a different section of the area.

To set up this lesson, a large sandbox is needed, along with two colors of sand, sandwich bags labeled with letters, and about three or four types of easily identifiable, sand-caked fossils (for this example, we’ll have bivalves, crinoids, and bryozoans). Pour

half of the first sand down, then scatter some of the fossils and cover them with the rest of the first color of sand. Repeat with the second half. Divide the sandbox into nine squares using string stretched across the top.

Give each student a small trowel and a paintbrush, and each group a large piece of paper. Have them draw a simple outline of the fossil entire site and divide it into squares, the same way the box has been divided. Draw the same map on the overhead, and on the board write “Silurian” and “Devonian.”

Explain that paleontologists have to be very precise in mapping out where they find a fossil, because the location and surrounding rocks tell us more about how a creature lived. The fossil site we will be examining contains fossils from the Silurian and Devonian periods, 444 to 360 million years ago. Explain that the deeper sand is Silurian and the shallower sand is Devonian, and the two can be distinguished based on color.

One at a time, each group will excavate their section of the fossil site. As they find fossils, they should place the fossil in a labeled bag. On the map, they should mark the letter of the fossil (marked on the bag) in the proper quadrant and make a note of the color of the surrounding sand. After a few minutes, students can take their samples back to their table and use the paintbrush to clean off extra sand, and the next group can begin their excavation.

After the fossils have been cleaned off, each group should compare their fossils to a selection of known specimens and attempt to identify what kind of fossils they have found. A designated mapper in each group will be responsible for labeling the fossil locations on the overhead map: blue for Silurian fossils, red for Devonian fossils. A good way to do this is to establish a key—for example, a Devonian crinoid could be a red circle, while a Silurian bivalve would be a red triangle. On the board, a recorder should write the name of each fossil under the Silurian and Devonian headings.

Once all the fossils have been plotted on the overhead map, students will use the projected overhead map to create a large map of the excavation site as a whole. A possible extension of this project would be to make graphs showing numbers of fossils found from each time period, most prevalent kind of fossil overall, etc, but students can also simply discuss the map itself. What observations can the class make? Are there more fossils in one area, or are they evenly spread out? Was there a difference in the number of fossils in the Devonian and Silurian periods? Did you find all the different kinds of fossils in the same area, or were they separate? The instructor can guide these observations by planning out the locations or quantities of the fossils beforehand, if desired.

-The children's life of the bees by Maurice Maeterlinck -Thomas Jefferson for Kids: His Life and Times with 21 Activities by Brandon Marie Miller -Brian P. Cleary, Brian Gable, "Quirky, Jerky, Extra Perky: More About Adjectives" -Fault Lines & Tectonic Plates: Discover What Happens When the Earth's Crust Moves With 25 Projects (Build It Yourself) by Kathleen M. Reilly -Social Skills for.Â Diary of a Wimpy Kid: The Getaway (book 12) by Jeff Kinney Do Not Open This Math Book: Addition + Subtraction by Danica McKellar 50 Wacky Things Animals Do: Weird & amazing animal facts! (Wacky Series) by Tricia Martineau Wagner Sir Cumference and the First Round Table (A Math Adventure) by Cindy Neuschwander, Wayne Geehan The Jungle Books (A to Z Classics) by Rudyard Kipling.