With 101 easy and inexpensive activities to do on school grounds, Schoolyard Science can help students develop their observation and inquiry skills as well as an appreciation of their outdoor environment. Covering topics such as lower plants, gardens, insects and other invertebrates, energy, and Earth science, Thomas Lord and Holly Travis provide activities that will help teachers become more comfortable with incorporating the outdoors into their curriculum. The activities have been tested successfully in K–12 classrooms, youth camp programs, and science education classes in teacher preparation programs, so teachers can feel confident when using this book in their classrooms.

The book’s teamwork focus will allow students to improve their critical-thinking skills and ability to work with other students. Each activity includes a list of the relevant standards and the suggested grade levels; however, the activities can be adapted to other grades as well, allowing teachers to think outside the box. The activities mostly make use of easily accessible materials, but Lord and Travis note any non-schoolyard materials that will be needed in a particular activity. Engaging and thoughtful activities make Schoolyard Science a great starting point for teachers as they inspire students to appreciate learning in their own schoolyard.

Grades K–12
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Change in societal values is similar to environmental change: Both happen slowly but constantly over time. Who could have predicted that we would be able to call friends miles away with a tiny phone we carry with us or that we would have miniature boxes in our pockets that play music, calculate equations, and keep a grocery list? While these technological advances are miraculous, they are not without their disadvantages. Store clerks can no longer make change without their computers, people become quickly frustrated when information is not available instantaneously, and children do not play outdoors as much as they used to.

With continued advances in electronic technologies over the decades, people of all ages are spending more of their time working and playing in front of a computer and less time enjoying the outdoors. Correlating with these disturbing trends, rising rates of obesity, hyperactivity, and stress, as well as general health problems, have affected our society. Mounting evidence points to the need for children and young adults to be reintroduced to nature. If the studies are correct, the nation’s teachers will become instrumental in reversing these disturbing trends away from nature. Education associations throughout the nation have begun to rally behind the idea that schools can help improve the situation, and these groups are encouraging teachers to use the outdoors as much as possible when teaching their classes. Teachers in elementary, middle, and senior high schools are eager to respond but often are unable to find accessible information to help them in this critical endeavor, especially with dwindling funding and resources.

The ideas presented in this book are designed to give teachers an incentive to use the environment around their school in science lessons. The activities have been piloted with various students in classrooms, youth camp programs, and science education classes in teacher preparation programs. We are certainly cognizant of the obstacles that must be surmounted when taking students to natural environments, such as woodlands, parks, and environmental learning centers, which are located away from the school property. We have therefore designed this book to be used in outdoor sites on the school grounds.

We also designed this book for teachers who have limited background in scientific nomenclature. Names of plants and animals or anatomical structures they possess are not necessary for teachers to use this book effectively. Instead, the intent of this book is for students to develop observation skills and an appreciation for the environment,
and for teachers to feel comfortable using natural resources available in the schoolyard. All activities align with one or more of the National Science Education Standards, use student-centered inquiry in their approach, and are noncompetitive. Finally, all activities in this book are developed around easily obtained and inexpensive materials.

This book focuses on teamwork, with most activities using teams composed of students of different genders and ability levels. The challenges presented to the student teams involve observing, constructing, or locating items in general ways. For example, students find five different types of red flowers; when the class has accomplished this task, teams come up with three advantages this color might confer on the plant that bears the flowers. The importance of these kinds of questions lies not in having the correct answers, but rather in improving students’ critical-thinking skills and ability to work as a team to find the answers. Sharing results with other students is also an important goal of this type of teaching. (A list of references that discuss the importance of inquiry and student-centered learning can be found at the end of this book.)

Appropriate grade levels are included with each activity, but these are only guides. Any of these activities can be adapted to work with older or younger students. In addition, we have included a list of unusual or unique materials required for each activity. Please note that common materials such as pencils and paper are not listed because most classrooms have access to these items.

We hope this book will inspire teachers not only to use the activities described throughout but also to design additional activities and projects that build on the skills students develop as they spend time outside. No matter what age group teachers work with, they will find the activities in this book appealing and useful for young science students.
Acknowledgments

The authors would like to acknowledge the hundreds of science education majors at Indiana University of Pennsylvania over the past decade who gave suggestions and encouragement and helped pilot the activities in this book. It is through their persuasive support and insightful ideas that this book was conceived and developed.
About the Authors

After obtaining his doctorate degree from Rutgers University, Tom Lord began teaching at postsecondary institutions in and around Philadelphia; he eventually settled down at Indiana University of Pennsylvania, where he currently teaches biology and science education courses to undergraduate and graduate students. A disciple of open-ended inquiry instruction, Tom was presented with the Distinguished Educator Award at the university and earned recognition for Innovative Instruction and Pedagogical Research by the Center for Teaching Excellence. He was also honored with the Outstanding Researcher/Educator award from the National Association of Biology Teachers (NABT). Active in his profession, Tom has presented dozens of talks, seminars, symposia, and panels at national professional meetings and has directed several half-day and daylong science workshops at NABT and NSTA, as well as the NSF-sponsored Chautauqua short course program. He has written more than 100 peer-reviewed science and science education articles in reputable journals, 2 monographs, and 5 books on science and science education topics; he has also contributed chapters to several books.

Tom has just completed a two-year term as president of the Society for College Science Teachers, where he wrote a monthly column in the Journal for College Science Teaching. Over that time, he also served on the Alliance of Affiliates of NSTA Executive Board and was on the JCST editorial advisory board. Not yet ready to retire, Tom recently accepted the challenge of the office of president of the Four Year College Division of NABT.

Holly Travis is a faculty member in the biology department at Indiana University of Pennsylvania, where she teaches biology and science education courses and coordinates the biology education program. She shares her office with numerous insects, arthropods, and reptiles, including Madagascar hissing cockroaches, African giant black millipedes, several species of stick insects, and assorted lizards and snakes. Throughout the year, Dr. Travis works with a variety of school and camp programs, including the Junior Naturalist Outdoor Adventure Camps and Crooked Creek Environmental Learning Center, to share her collection of critters and love of the outdoors. She was the recipient of the Armstrong Conservation District Outstanding Educator Award in 2008. Dr. Travis also serves as the science coordinator for the IUP Upward Bound Math and Science Program, where she is responsible for the design and implementation of science programming, including content, research opportunities, associated writing and mathematics skills, and field activities for
30–50 Indiana County high school students in grades 9–12. In addition, she serves on numerous college and university committees for assessment and teacher education.

Dr. Travis has presented dozens of talks and seminars at local, state, and national professional meetings; published several peer-reviewed science and science education articles; and contributed chapters to two monographs. She is a co-author of two books and serves as a reviewer for both science and education journals. In addition, she serves as the coordinator for the Jefferson County (PA) Animal Response Team and is a frequent volunteer for Groundhog Day activities in her hometown of Punxsutawney, PA.
In 1983 the National Commission on Excellence in Education (NCEE), initiated by then-President Reagan, released its findings on the state of education in America’s schools. The document, *A Nation at Risk*, presented the United States with a wake-up call concerning the deterioration of learning in America’s youth (NCEE 1983). The study found that our students’ gains in knowledge are not keeping up with children of equal ages in other developed countries. Distressed by the report, the federal government increased the financial commitment to education, which led to further research on student learning and the teaching methods used to educate children. Despite these efforts, student learning assessments have found that not much has changed in the past 30 years. Children in the United States today are not learning as much as U.S. students did three decades ago; students in other countries also learn more than U.S. students today.

One of the methods suggested by the research, however, did demonstrate pupils’ learning gains—a philosophy called *constructivism*, which used the inquiry strategy for learning. With inquiry, students meet in small groups to discuss, plan, and develop solutions to questions. In this student-centered approach, open-ended questions designed by the teacher before the class replace a didactic description of the subject matter presented directly from the classroom teacher. By working together to direct the processes of science, students gain a deeper understanding of the information. Research shows that if a lasting increase in knowledge is to be obtained, understanding how science is truly done is as important as the actual content itself.

If teachers visit schools comparable to their own in other developed countries, the differences become very apparent. Rarely do students ask their teacher to tell them what they need to know, then become distraught if they are not told. Rarely does one see students verbally repeating descriptions of the content that the teacher has presented. The visitor sees students describing the content in their own words or using the content in a different way than it was provided by the teacher. When students can answer questions and apply information in their own words, rather than reciting facts verbatim, the teacher can be more or less assured that the student understands the content. The best teachers in this country also teach this way, but many instructors still rely on presenting what students need to know to pass the class.

Lectures and cookbook lab exercises, by themselves, rarely reach the level where students truly understand information. When students can recite content information, teachers accept this as proof that students know the material. When pressed on what they understand, many students either have no adequate explanation or provide a plausible but erroneous grasp of the material. Unfortunately, many teachers do not pursue the issue when this happens; lack of understanding and misconceptions are then perpetuated.

This complacency is common and troublesome to the nation’s education. More teachers are relying on textbooks and laboratory books to direct learning. Publishers are happy to provide well-written materials with fancy, slick, colorful graphics. Unfortunately, contemporary textbook publishers are providing teachers with exactly what they need to
teach for students to see what they need to know to pass the course. To carry it a step further, a side industry has developed in America where the materials needed to perform a particular exercise are packaged in shoe box–size containers and shipped to schools each week so each student group can do their lab. This service removes the client from getting involved in the learning. This has further instilled a “tell me what I need to know” attitude not only in students but in teachers as well.

About This Book
Closely following the inquiry model of open-ended question design, this book offers ideas that can be done easily outside the classroom. Set within general categories, numerous rich and fascinating environmental science activities that excite student learning and understanding are presented. Driven by current research that finds science learning is enriched for students when the learning takes place in a natural setting, the book describes activities that can be performed on the school grounds easily and inexpensively. By investigating science locally, student learning can take place without the need for parental permission slips, costly additional insurance, or expensive bus transportation.

This book is not a series of lessons that describe what a teacher must do. Rather, we provide a series of educationally rich suggestions and ideas that a teacher can adapt to create lessons in a manner compatible with his or her background and resources. A teacher might have to consult additional sources to brush up on background information or improvise an activity. However, teachers are adept at adapting others’ suggestions based on their own research and needs; this process is what quality educators use to create novel, stimulating learning experiences for their students. The teacher also develops assessments for the activities. While some suggestions are offered throughout the book, the teacher will want to relate the assessments to his or her own standards and classroom needs based on how the teacher uses the activities. In this way, the authors hope that teachers are also developing skills and satisfying their own curiosity as they use this book, rather than following cookbook instructions and doing rote experiments.

For teachers who do not have much outdoor experience or background, we have included a list of resources at the end of this book. These books and websites are an excellent starting point. Information about plants, insects, and animals in the area around the school is also available through state and local extension agencies. These agencies often provide guest speakers and lists of local experts in various topics for educational programs.

Two common assessment tools for outdoor activities, nature journals and field reports, are discussed below. These can be adapted for various age groups and activities but are certainly not the only way to evaluate student learning. Presentations, research reports, creative writing assignments, and models are among the options for teachers to assess student learning. Each teacher will determine what works best for his or her curriculum and learning goals.
Nature Journals
We recommend students work through activities from this book by keeping modest records of their experiences in a field book or journal. The nature journal should include observations, opinions, personal reflections, and sketches. Students also may include pressed leaves or flowers from an activity, stories or poems written about their experiences in the natural world, and other creative or informal assignments. One way to make the journals unique is to use the paper-making activity and have each student create a cover for his or her nature journal. Teachers might use the nature journals as a form of assessment by grading a specific entry, which could be another application of an observed concept or an explanation of the scientific processes involved in the activities that students completed.

Field Reports
Field reports are different from nature journals. Journals are written diaries of the field experiences, but field reports are accurate records taken at the site. Field reports generally include materials used and expected outcomes. Data such as the amount of rainfall that fell during the lab or the fluctuations in temperature over the work session would also be recorded. What sampling was done and any data that were collected should be part of the report, along with specific items discovered and measured. From the information recorded in the reports, students draw conclusions, discuss outcomes, and plot or graph results.

Please note that science should not be done in isolation from other key subject areas. Integrating creative writing, descriptive writing, oral and visual presentations, measuring, counting, or graphing as a part of the lesson (see Tables 1.1 and 1.2 [p. 6]) not only helps create varied assessments of student learning but also makes it easier to find time to do science activities while not taking away from other key content areas.

How to Use These Ideas
Because the ideas in this book are not designed as step-by-step lesson plans, we offer two examples of how these activities might be incorporated into the classroom curriculum. The lessons found in Tables 1.1 and 1.2 are presented using the 5E Instructional Model of lesson plan development, first described by Trowbridge and Bybee (1990), because this model makes it easy to create student-centered lessons that focus on questioning and inquiry. The examples in Tables 1.1 and 1.2 are based on Activity 36, Seed Dispersal Techniques (p. 43), and show how a single idea from this book can be adapted for various ages and classroom needs.

Practical Fieldwork Considerations
Keeping the materials needed for an activity close at hand makes the time spent outside more productive and less stressful for both the teacher and the students. It is also faster and easier to collect all the equipment at the end of the activity if everyone knows where to put all of the items. For this reason, field containers and field bags should be used.
### Table 1.1.

5E Description and Sample preK–3 Grade-Level Lesson Based on Activity 36, Seed Dispersal Techniques (p. 43)

<table>
<thead>
<tr>
<th>Description</th>
<th>Example</th>
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<tbody>
<tr>
<td><strong>Engage</strong></td>
<td>A brief activity, question, demonstration, or film “snippet” that whets the students’ appetites and focuses their attention on the topic. Bring in a dandelion that has gone to seed and ask students what happens when they blow on it or when the wind blows. If dandelions are not available, substitute a brief film clip showing the same thing (e.g., <a href="http://www.youtube.com/watch?v=u8_gDqZGSq4">www.youtube.com/watch?v=u8_gDqZGSq4</a>).</td>
</tr>
<tr>
<td><strong>Explore</strong></td>
<td>An activity in which the students develop questions and attempt to answer them, or challenge questions that encourage the students to think in depth about the topic. Once the class is outside, ask students to work in small groups to locate five different types of seeds from flowers, trees, and shrubs in the schoolyard. When they have collected the seeds, have students determine how the seeds are likely to move around. You might offer suggestions as necessary, including wind, animal fur, and water, or as a food source.</td>
</tr>
<tr>
<td><strong>Explain</strong></td>
<td>Groups share their results, whether they have done an experiment or worked through a question. At this point, the teacher can also clear up misconceptions and misinformation to ensure that students understand the material. Groups will share their seeds and dispersal ideas with the rest of the class. Have students compare the similarities and differences of the seeds collected. Throughout this discussion, the teacher will clarify ideas and clear up misconceptions about what is or is not a seed, how seeds move, and so on.</td>
</tr>
<tr>
<td><strong>Elaborate</strong></td>
<td>Groups might do further laboratory work, do research, give presentations, or simply discuss more complex questions within their groups, allowing them to build a deeper understanding and to relate this information to other material covered in class. Have each group (or each student) design a seed. They can use paper, string, glue, crayons, and other craft supplies. Older students might be given a pumpkin or sunflower seed and asked to devise a new “pod” to help it spread to other areas. Take the models outside to see how they work. In their nature journals (if age-appropriate), each student can write an entry describing his or her seed and dispersal method. They can also include what they might change after their trials.</td>
</tr>
<tr>
<td><strong>Evaluate</strong></td>
<td>Evaluation can take numerous forms, including standard quizzes or tests, written assignments, oral presentations, student self-evaluations, or observation of student participation in group activities. Have students do a creative writing assignment in which they describe the life of the seed, how its structure helps it move from place to place, and what the seed might observe as it moves to a new germination spot. Younger children can draw a picture showing where their seed ends up or what it looks like when it becomes a plant. Close the lesson by reading a book such as <em>The Tiny Seed</em> by Eric Carle or <em>A Dandelion’s Life</em> by John Himmelman (see Resources on p. 127 for publication information).</td>
</tr>
</tbody>
</table>
### Table 1.2.

5E Description and Sample 4–8 Grade-Level Lesson Based on Activity 36, Seed Dispersal Techniques (p. 43)

<table>
<thead>
<tr>
<th>Description</th>
<th>Example</th>
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<tbody>
<tr>
<td><strong>Engage</strong></td>
<td>A brief activity, question, demonstration, or film snippet that whets the students’ appetites and focuses their attention on the topic</td>
</tr>
<tr>
<td></td>
<td>Show a brief video clip of seed dispersal, such as <a href="http://www.youtube.com/watch?v=u8_gDqZGSs4">www.youtube.com/watch?v=u8_gDqZGSs4</a>. Ask students (or groups of students) to list at least six different kinds of seeds. For each seed, have students describe how it is dispersed. Have groups share the example they feel is most unusual.</td>
</tr>
<tr>
<td><strong>Explore</strong></td>
<td>An activity in which the students develop questions and attempt to answer them, or challenge questions that encourage the students to think in depth about the topic</td>
</tr>
<tr>
<td></td>
<td>Take student groups outside and ask each group to find 10 different seeds. Determine the dispersal mechanism for each, and evaluate the effectiveness by counting the number of each kind of seed students find and the average distance from the parent plant. They may need to use field guides to identify the parent plant for each seed. (The Peterson and Audubon Field Guides [listed in Additional Resources on p. 128] include pictures of seeds or fruits from many common plants.). If necessary, include time to research their seeds online or in the library.</td>
</tr>
<tr>
<td><strong>Explain</strong></td>
<td>Groups share their results, whether they have done an experiment or worked through a question. At this point, the teacher can also clear up misconceptions and misinformation to ensure that students understand the material.</td>
</tr>
<tr>
<td></td>
<td>Have each group share their results, looking at which seeds were moved farthest away from the parent plant. Have students offer suggestions about which characteristics seemed to be most effective and which ones did not work as well for seed dispersal.</td>
</tr>
<tr>
<td><strong>Elaborate</strong></td>
<td>Groups might do further laboratory work, do research, give presentations, or simply discuss more complex questions within their groups, allowing them to build a deeper understanding and to relate this information to other material covered in class.</td>
</tr>
<tr>
<td></td>
<td>Groups will choose one type of plant and design a research project to test their observations from the Explore activity. It may be most effective to use those that are wind-dispersed, but that can be left up to the teacher, based on what students find in the schoolyard. These research projects will include a hypothesis, experimental design, data collection and analysis, and conclusions. Have the groups carry out the research projects to check their hypotheses.</td>
</tr>
<tr>
<td><strong>Evaluate</strong></td>
<td>Evaluation can take numerous forms, including standard quizzes or tests, written assignments, oral presentations, student self-evaluations, or observation of student participation in group activities.</td>
</tr>
<tr>
<td></td>
<td>Students will write a formal lab report using the data they collected and graphing results. Conclusions should include discussion of how the adaptations of that plant improve the effectiveness of seed dispersal and a critique of the experimental design used, including changes that could be made to improve the accuracy of their results.</td>
</tr>
</tbody>
</table>
Field Containers
We encourage teachers to establish a container that holds common materials students will need for their investigations. This may be a large cloth bag, a plastic storage box or tote, or a laundry basket. It should be sturdy, easily portable, and large enough to hold several basic items that will be used frequently as students explore the schoolyard environment. These items may include magnifying glasses, scissors, rulers, various plastic containers, string, and pencils that can be taken into the schoolyard on the days the students work there. The container can also hold any field guides or other reference materials students will use as they observe plants and animals in the area. A basic first-aid kit should also be included so it is readily available if needed.

Field Bags
Each student or team should have a small bag that will hold the essential items for the activity they will be doing on any given day. For example, students may need magnifying glasses, rulers or measuring tape, notebook paper, and pencils one day. They may need safety goggles, vinyl gloves, plastic bags, identification guides, and thermometers another day. Students can easily keep track of their supplies if they have a handy place to keep them while they are outside.

Some Notes on Outdoor Safety
Concerns about safety should not prevent teachers and students from spending time outdoors, but using common sense and some simple guidelines will ensure that the activities are enjoyable for everyone. Teachers should always consider their students’ ages and the teaching environment when determining what safety precautions are necessary. The following list, taken in part from Exploring Safely: A Guide for Elementary Teachers (Kwan and Texley 2002) and Inquiring Safely: A Guide for Middle School Teachers (Kwan and Texley 2003), provides some basic considerations. These can be adapted to fit your school and class requirements. These guidelines will not all apply to all the activities identified in this book, and some additional safety precautions have been noted in specific instances.

1. Link field trips and field studies to curriculum goals.
2. Preview the site and abutting properties before planning your field study.
3. Determine proper clothing and footwear for the site and activities planned.
   (Please note that this might include vinyl gloves, aprons, and protective eyewear, as noted in several of the activities.)
4. Meet with cooperating resource people to plan activities.
5. Orient and train all chaperones in your planned activities and in safety precautions.
6. Review Material Safety Data Sheets (MSDS) for any chemicals that will be used and use appropriate safety precautions.
7. Always have students wash their hands thoroughly with soap and water after doing outside activities, especially those involving animals, soils, and water.
8. Consider student allergies (peanut butter, latex, bee stings, etc.) and medical conditions before doing activities that might trigger reactions.

9. Follow common safety rules that apply in and out of the classroom. These include, but are not limited to,
   - modeling proper use of equipment;
   - using only nonmercury thermometers;
   - reminding students to use equipment such as magnifying glasses, scissors, and knives in a safe manner; and
   - having additional adult supervision when warranted by the complexity of the activities or setting.

Final Thoughts From the Authors

It is essential for the health and well-being of both our children and our environment that we allow children to experience nature. Numerous studies have shown that spending time outside leads to healthier children, both physically and mentally. This book was designed to provide ideas that allow teachers to do exactly that, without the need for complex equipment and extensive funding. These activities are offered as a starting point, and teachers can mold and adapt them as necessary to meet varied curriculum needs and assessment goals. As any teacher knows, additional work will be involved in developing these ideas into lessons that are appropriate for a particular class in a particular location. The internet offers many resources that allow teachers to access quickly and easily the background information they need to feel confident with their students. Libraries will have books and field guides that can provide expertise. These lessons are also a great way to involve community experts who can work with students on a special topic or project.

The most important objective of this book is to keep teachers and students actively learning and spending time outside in the natural world.

References


* An Additional Resources section on page 128 can be used as a starting point when looking for information for both teachers and students.
Introduction to Nature
### Activity 1. Exploring the Human Senses in Nature (preK–8)

**NSES Science Content Standards**
- Unifying concepts and processes in science
- Science as inquiry
- Life science
- Science in personal and social perspectives

Additional materials: jars with lids (1c), small paper bags (1b, 1d, 1h)

Most students can recall the pleasant smell of flowers or the awful smell of rotting garbage. Some can remember the fresh smell of the air after a thunderstorm and the frightening sound of thunder that accompanies the storm. We use our senses continuously during the day, much of the time in such subtle ways that we are not cognizant of their presence. To encourage students to recognize how important the five senses are to their everyday lives, have the class sit quietly in the schoolyard for a brief time and list in their nature journal what senses they experience. While texts often suggest students will experience five senses (sight, smell, hearing, taste, and touch) when quietly experiencing nature, they will actually come up with many more sensing experiences. They will feel the breeze pass through their hair and the pain of a pebble in their shoes. They will feel the heat of the Sun on their faces and the cool skin on the back of their necks. They may sense an air pressure increase when the wind picks up, and they will experience weight on their knees folded under their bodies. Students enjoy this experience in a special way, for it incorporates many of the same principles as meditation.

<table>
<thead>
<tr>
<th>a. Sensory hike (preK–3)</th>
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<tbody>
<tr>
<td>A more active offshoot of the above activity is to have students discuss the senses they are experiencing with each other as they walk around the school grounds. This activity is generally preferred by teachers of younger children.</td>
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<table>
<thead>
<tr>
<th>b. Identifying natural objects when hidden from view (preK–3)</th>
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</thead>
<tbody>
<tr>
<td>In this fun activity, students collect in a small bag items from a walk. The next day, they use their senses to identify the objects when they are blindfolded or when the item is placed in a sock. Students can use any sense except sight and taste (i.e., touch, smell, hearing) to identify the item.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>c. Capturing smells in a jar (preK–3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Believe it or not, a person can capture smells in a jar! Air from a specific location holds odor molecules from various items in that specific region. Scent molecules from flowers, grasses, soils, and water are continuously released into the air and can be captured in a jar for a short period of time. This is particularly noticeable in still air or freshened (ozone-</td>
</tr>
</tbody>
</table>
air after a thunderstorm. Have groups capture air from various parts of the schoolyard in a medium-size jar, such as a mayonnaise jar, and rendezvous with other groups to share the smells they have collected.

d. Identifying flowers and fruits by their smells (preK–3)
This activity is similar to the capturing smells exercise above, but this time student teams locate 10 different kinds of flowers or 10 different kinds of fruits in the schoolyard and place each in a separate paper lunch bag. After a short time, the teams return to a location and present their findings to another team. Challenge each team to identify the 10 fruits or flowers gathered by another team by using only a sense of smell.

e. What is that sound? (preK–8)
There are many ways to experience how much sound impacts our lives. For example, we can hear a sound somewhere around the school and determine where it came from and what created it (e.g., chatter of a squirrel or chipmunk, warning calls of birds, hoot of an owl). Students come up with a variety of opinions for what made one sound.

f. Draw what is described. (preK–8)
Another way to compare students’ interpretations entails having one student describe something he or she has seen in and around the school but that is not visible. The remainder of the class attempts to draw what is being depicted without consulting other students. Students are surprised that most of their classmates do not draw the same thing.

g. Listen to nature. (preK–8)
Still another fun way to explore hearing is to have students identify items by the way they sound when wind blows through them. It is possible to distinguish large trees from small trees, as well as determine whether the wind is blowing through leafy or bare branches, if the wind is sending leaves into a whorl or blowing dust against a wall, or whether someone or something is approaching.

h. Identifying natural objects by touch (preK–3)
Exploring the sense of touch can be very revealing. Tactile nerve endings in the fingers and palm respond to what is being felt and send impulses to the brain’s parietal lobe for interpretation. A good way for students to realize the sensitivity of touch is to have them identify items without seeing them. Each team finds 10 small items (less than 2 in.) around the schoolyard and places them in a paper bag. Assemble the bags and redistribute them to different teams. Challenge the teams to identify all the items in the bag using only the sense of touch. *Caution students not to collect trash, sharp objects, moldy items, or other items that can cause harm.
Activity 2. Animal Signs (preK–8)

NSES Science Content Standards

- Unifying concepts and processes in science
- Science as inquiry
- Life science
- Science in personal and social perspectives
- History and nature of science

Additional materials: animal silhouettes (2e), pictures of animal beaks, feet, eyes, skin, etc. (2f)

Footprints, droppings, scents, skins, hair, feathers, cocoons, galls, nests, paths, scratch or rub marks, bones, chewed leaves, chewed bark, songs, chirps, growls, slime, shedding, corpuses, wallows, holes in trees, tail drag, and matted-down patches of grass are common animal signs.

Periodically, a student will spot a colorful feather or an animal footprint on the way to school, but numerous signs of animals throughout the environment go unnoticed. Students do not pay as much attention to their surroundings as children did a half century ago. Ask student teams to open their eyes to nature and try to locate eight different signals or signs left by animals in the schoolyard.

a. The stories that animal signs can tell (preK–8)

When animal signs are found together, it is fun to tell stories of events that could have taken place when the signs were created. For example, when large footprints are found next to the same type of small footprints, students could imagine that an adult and a young animal were walking next to one another. If a large set of footprints was found behind a small set of footprints from a different animal, however, students could imagine that the small animal was trying to escape the large one (and if the small series of footprints disappears but the large ones continue on, students could imagine that the large animal caught the small one). Challenge student teams to locate different animal signs near each other on the school grounds and come up with a story that might explain these signs.

b. Creating animal signs that can go with a story (preK–3)

Sometimes students cannot find animal signs to use to make up a story, especially if the weather has been hot and dry. To compensate, students can construct their own animal signs from modeling clay, cotton balls, stems, and leaves. After several minutes of making signs, students can find locations around the schoolyard to set up their animal signs in a pattern to tell a story. Allow students to visit each other’s story site so the story creators can share their tales.

c. Animal acting (preK–3)

This is a great activity for young students who seem to especially enjoy playing pretend. Each student finds information on the habits and behavior of a specific animal found...
in the schoolyard. When it is time to go outdoors, students walk to a rendezvous site as quietly as they can so they do not scare the wild animals. At the site, each student demonstrates his or her animal without telling the others which animal they are imitating. When the student finishes acting, the other students guess what animal the student was pretending to be. Once the class has guessed the animal, each student can describe unique characteristics of his or her animal to classmates.

d. Animal stalking (preK–3)
Students generally love to sneak up on things. Some have learned that if they walk slowly, stepping on the outside of their feet and rolling them inward to the toes, they can walk silently. This takes practice, and in this activity they will see how difficult it can be. Challenge small groups of students to walk quietly like a cat or fox, and see how close they can get to a wild resident of the schoolyard (e.g., a squirrel, rabbit, or bird). *Caution students to stay a safe distance away from wild animals, and do not surround or corner them. Stay clear of animals exhibiting bizarre or unusual behavior.

e. Identifying animal silhouettes (preK–3)
It is fun to try to identify wild animals by their shadows or silhouettes. The task can be made easy for younger students by selecting schoolyard animals that are not closely related (i.e., rabbits and skunks) or can be made more difficult for older students by selecting shadows of animals in the same family (e.g., different birds). Challenge students to try to identify most of the animal shadows the teacher presents.

f. Identifying animals by parts of their anatomy (4–8)
Most students can tell the difference between the foot of a duck and the foot of a deer, but when the animals are closely related (e.g., foot of a dog and foot of a cat), the task can be really challenging. This exercise can be done with impressions or pictures from animals that reside around the school or in habitats away from the school. When students have had some practice, try using animal eyes, bird beaks, frog patterns, and snake skins.

Activity 3. Camouflage in Nature (preK–8)

NSES Science Content Standards
- Unifying concepts and processes in science
- Science as inquiry
- Life science

Additional materials: assorted stuffed or plastic animals

Animals in nature are masters at using camouflage to aid their survival. Students can hunt for these organisms, taking pictures to share with classmates.
later. Each group can put together an “I Spy” type of game, letting other groups or even other classes in the school find the hidden animals.

- **Find four examples of insect camouflage.** Grasshoppers, several moth species, katydids, stick insects, and praying mantises are just a few examples of great camouflage found in insects. Have student groups look in different types of habitats around the school—such as grassy areas, leaf litter, on trees or in shrubs, or near flowers—to find a wider variety of examples. *Use caution in working around leaf litter or grassy areas—these may contain mold, ticks, and other health hazards.*

- **Find four examples of animal camouflage.** For younger children, you can set up a hide-and-seek game using various stuffed or plastic animals in natural and artificial colors. Hide the animals ahead of time and have students walk through the area, seeing how many stuffed animals they can find. By using some that blend in and some that stand out, students can see the value of camouflage for animal survival. Older students can look for real examples of animal camouflage. Lots of common animals that use camouflage—such as squirrels, chipmunks, and birds—can be spotted almost anywhere.

- **Find four examples of predators using camouflage.** Once students have had the chance to observe several examples of camouflage in nature, they can look at the different ways animals use their camouflage. Challenge students to find examples of predators that use their ability to blend in to catch their prey. How does this help the predators become better hunters?

- **Find four examples of prey camouflage.** On the flip side, how does camouflage help animals avoid being eaten? What are some ways that insects and animals of all types make themselves less obvious to predators?

### Activity 4. Nature Walks (preK–8)

#### NSES Science Content Standards

- Unifying concepts and processes in science
- Life science
- Earth and space science
- Science and technology
- Science in personal and social perspectives
- History and nature of science

In all parts of the country, nature in the schoolyard changes through the seasons. In some regions, environmental fluctuations are subtle, the levels of wind and rain being the primary variations. In other regions, the changes are more obvious, as large fluctuations in temperature affect not only the winds and precipitation but also the plants and animals. Despite the apparent changes, many students are unaware of what is occurring around them.
and sometimes even within the schoolyard. Students should walk around the schoolyard in different seasons and identify the effects the changing climate has had on nature. For example, students may notice the changing colors of the leaves in northern states in autumn but tend not to see how the changing weather affects seed dispersal patterns or insect egg-laying. Students also may not be aware of such spring occurrences as territory establishment, variation in sunlight patterns, changes in wind patterns, accelerated herbaceous growth, and animal rearing patterns (particularly insects).

To improve their understanding of seasonal changes, students can collect objects in the schoolyard throughout the year and place what they find in different shoe boxes labeled with the season's name (e.g., autumn box, winter box) or develop a seasonal scrapbook comparing various items they collected (e.g., a maple leaf found in each of the seasons) throughout the year. By studying these changes, students can compare adaptations and unique characteristics of plants and animals.

Changes that occur over the seasons in the evening sky are also poorly understood by students. Activities that direct students’ attention to seasonal patterns of stars are always well-received additions to a school's science program.

As an interesting alternative to the nature walk, students can take an unnatural walk. Sometimes it is beneficial for students to walk along a trail that has been grossly disturbed with cans, papers, and other junk. If needed, set up the trail ahead of time by strewing different types of litter along the sides or on a path. Challenge students to find as many examples of litter as they can as they walk from beginning to end. *Students should be cautioned not to touch or pick up litter without hand protection, such as vinyl gloves.*

### Activity 5. Magnifying Nature Items (preK–8)

**NSES Science Content Standards**

- Science as inquiry
- Physical science
- Life science
- Science and technology

Additional materials: binoculars (5a), magnifying lenses (5b), telescopes (5c)

Students will enjoy seeing nature items they have never noticed by using binoculars, hand lenses, and telescopes to look at nature more closely.

**a. Binoculars (preK–3)**

Before going into the schoolyard, have students write a word or draw picture of a plant or animal on a 3 in. × 5 in. index card. The students bring their cards with them into the field and affix them to trees, signs, or playground equipment in the schoolyard. Move the class away from the cards and provide binoculars to as many students as possible (you
might also consider asking the students to bring binoculars from home. Allow each student a chance to discover how to use the binoculars by having them locate and focus on the card they prepared beforehand. When all the students have successfully focused and observed with the binoculars, have them repeat the action by observing their classmates’ cards. You might even place a mystery card or two that you have designed around the yard. Because identifying words is more difficult for students, you might break this activity into two parts, practicing first with pictures and then using words.

Observing closely related items on cards: To stimulate excitement about using binoculars, you can organize an identification walk using 3 in. × 5 in. index cards. For this activity, tack a series of different animals of the same family, such as birds, to trees along a walk around the school grounds (obscuring some with shrub branches) before the class begins. During class, have students keep track of the kinds and number of birds they spot on the trip and discuss them in their nature journals.

Observing live organisms: The fun part of this exercise is locating and observing living organisms such as birds, squirrels, and plants through the binoculars. It is surprising to see the concentration and time that students (particularly older ones) spend on this exercise.

b. Magnifying lenses (preK–3)
Looking at nearby objects through small, handheld magnifiers can be just as exciting for students as seeing distant objects through binoculars. Introduce the correct use of magnifiers by having students observe words in their nature journals or grains of soil held in their hands. Once students are comfortable with the magnifiers, they can explore nature by looking through the lenses at items around their school. Magnifying items such as the parts of flowers, mouthparts of insects, undersides of ferns, and the skin of earthworms will stir excitement in even the most disinterested students. *Remind students never to observe the Sun through a magnifying lens, as doing so can cause serious eye damage.*

c. Telescopes (preK–8)
If students hold two different-size magnifying glasses in line with one another at opposite ends of a cardboard cylinder, they will create a telescope. When students do this, they should have the smaller lens nearer their eye and the larger one farther out. Have them look toward the object they want to magnify on the school grounds, which likely will be out of focus. Move the magnifying glass closest to the eye forward or backward until the image comes into focus. The image will appear larger but upside-down. Have a second student measure the distance between the two lenses. Cut a slot using scissors or a knife in the cardboard roll about an inch from the end to hold the large magnifying glass (being careful not to cut the roll entirely in two). Now cut another slot for the small magnifying glass at the same distance as the in-focus image appeared (recorded in the nature journal by the second student). Secure the two lenses in their positions with tape and cut off the excess length of tube. The image that was viewed earlier should now be in clear focus.
The telescope can be modified to handle a variety of focus lengths by using two cardboard rolls, one a bit bigger than the other, so the smaller one fits inside the larger one. With the large magnifying glass at the end of one roll and the smaller one at the end of the other, the focus length can be adjusted for various objects simply by moving the two lenses closer together or farther apart in the sliding roll. *Remind students never to observe the Sun through a magnifying lens, as doing so can cause serious eye damage.*

**Activity 6. Weights and Measures (4–8)**

**NSSS Science Content Standards**

- Unifying concepts and processes in science
- Physical science
- Earth and space science
- Science and technology

Additional materials: standard weights (6a), balance scale (6a), glass jars with lids (6c), straws (6c), clay (6c), food coloring (6c)

Most students have seen and used scales to weigh objects, including themselves. Many do not understand the idea behind standard weights or the difference between weight and density until they have a chance to examine these properties themselves.

**a. Standard masses/density demonstration (4–8)**

Students should fill bottles with appropriate amounts of water or sand found around the schoolyard to make a standard mass for use on a simple balance scale. This will familiarize students with different mass amounts. Bottles filled with different substances—such as rice, water, or sand—will demonstrate the concept of density; filling bottles with different
substances so they have the same mass but different volumes provides another way to demonstrate density. Encourage students to make predictions about which substances will have similar or very different masses.

b. Making a simple seesaw balance (4–8)

Once students have created a common weight such as 1 oz., 1 lb., or 5 lbs. in their bottles (as described previously), they can design a simple balance with a flat piece of wood or bark and a rounded rock as the fulcrum. They can find natural items that have the same weight as the standard bottles they created in the previous exercise, such as leaves, twigs, pebbles, or grass. See if they can weigh 1 oz. or 1 lb. of dandelions or other flower seeds. Challenge groups to find the most dense or least dense natural items.

c. Making a simple thermometer (4–8)

Students can also make a thermometer that will measure temperatures between 32 and 212°F (or between 0 and 100°C). Participants need a glass jar with a tight-fitting lid; a long, thin drinking straw; clay; food coloring; and cold water. First, you or the students should make a hole in the lid of the jar as close to the diameter of the straw as possible using a nail or drill. Next, students insert the end of the straw in the lid and seal it tightly with clay. Then they completely fill the bottle to the top with very cold water (no ice). Students screw the lid on, place it in the sunshine on the school grounds, and watch what happens as the water warms up, checking the height of the water in the straw every hour or so. As the temperature increases, the water expands and moves up the straw. To make this happen more quickly, students can place the jar full of cold water into a pan of hot water. *Teachers should make the hole in the lid or closely supervise students to avoid injury. Be careful with water, as water above 120°F may cause burns.*

Activity 7. Biodiversity Activities Within a Small Area on the School Grounds (preK–3)

NSES Science Content Standards

- Unifying concepts and processes in science
- Science as inquiry
- Life science

Students enjoy finding new things in an outdoor environment and are often surprised by the number of different organisms they can observe in a small area. In this activity, student teams check for different natural items within a plastic hoop or string circle. Some items students find on the school grounds include different shapes and types of leaves, different kinds of invertebrates, different types of soil particles, or different kinds and colors of flowers. Comparing, counting, and sorting are all skills that students can develop through these activities.
Activity 8. Biodiversity Activities in a Larger Tree or Shrub Area on the School Grounds (preK–8)

**NSES Science Content Standards**
- Unifying concepts and processes in science
- Science as inquiry
- Life science

When students search through a large area of the school grounds, they greatly expand the variety of items located. Some of the items they commonly find include different kinds of shrub or tree branches; different kinds, shapes, colors, and vein patterns of tree leaves; different types and patterns of tree bark; different types, colors, buds, and thorns on stems; different types of lichen, fungi, or algae on tree bark; different types of grasses, mosses, and ferns; different types of seeds, fruits, and cones; different types, shapes, and colors of flowers; different arrangements of flower components, different indications (tracks, droppings, or shelters) of animals; or different indications of erosion. *Caution students not to pick up animal droppings.*

Activity 9. Biodiversity in a Rotting Log (4–8)

**NSES Science Content Standards**
- Unifying concepts and processes in science
- Science as inquiry
- Life science

Find a rotting log on the school grounds or in a nearby wooded area. Have students predict what they think they will find when the log is gently turned over. A rotting log can be home to numerous arthropods, amphibians, fungi, and ferns. Students can expect to see sow bugs and pill bugs (terrestrial crustaceans), centipedes, millipedes, spiders, beetles, ants, termites, salamanders, snakes, and assorted other organisms. Several types of mosses, molds, and fungi will likely be growing in and on the log, along with other plants. Students can observe the various organisms they find by using resources such as field guides to identify the various organisms. They can also predict the functions of each item they observe, later doing research to determine why each item is there. If possible, students should observe the log several times over the course of the year, noting changes they see each time. This activity could even be continued for multiple years, passing down previous students’ journals as a starting point for the next year’s class. *Caution students to watch out for ticks, snakes, and harmful spiders.*
Activity 10. Comparing Flowers (preK–3)

**NSES Science Content Standards**
- Unifying concepts and processes in science
- Science as inquiry
- Life science

Colorful flowers generally catch the eye of young students and make a nice item to study in the schoolyard. In this activity, students locate a large flower and find at least five different structures on it. Then they compare the structures they found with a labeled drawing of a flower in a reference book. Challenge students to do the following:
- Compare different colors, shapes, smells, and structures of flowers.
- Choose at least five flowers of the same color and compare their shapes, smells, and structures.
- Compare five similar structures in at least three different kinds of flowers, and predict the function of each structure.
- Locate eight different flowers, each with a different number of petals, or eight flowers of the same color but with a different number of petals.
- Locate five flowers that have small green leaves (sepals) directly below the colored petals.

Activity 11. Comparing Features of Trees (4–8)

**NSES Science Content Standards**
- Unifying concepts and processes in science
- Science as inquiry
- Life science

Students generally have seen many different trees but often do not stop to really look at the similarities and differences, and what makes each species unique. These activities highlight specific features students can look for to appreciate the variation found in trees.

**a. Comparing features in different conifer trees: evergreens (4–8)**

It is not uncommon for students to use the term *pine* for all evergreen trees; however, at least six different types of evergreen trees grow in North America. Several of these are generally found around schools. In this activity, student teams examine the different types of evergreen trees in the schoolyard, making a list of the type of leaf, cone, branch, and bark found on each. Challenge the teams to come up with three clear distinguishing characteristics of each type of evergreen tree.
b. Comparing features in different deciduous trees (4–8)

As with evergreen trees, deciduous trees vary greatly from species to species. In this activity, student teams visit different deciduous trees on the school grounds, noting different characteristics of each tree. Challenge students to come up with three clear distinguishing characteristics of each type of deciduous tree.

c. Comparing features in conifers and deciduous trees (4–8)

Most students realize that evergreen trees look very different from deciduous trees, yet they have a hard time answering when asked to describe the differences. In this activity, teams visit several different evergreen trees around the schoolyard and list their similarities; the students then visit several different deciduous trees around the school grounds and list their similarities. Challenge students to come up with five differences between the evergreen trees and the deciduous trees. They can then apply these variations to life cycles and adaptations that improve survival.

Activity 12. Determining the Age of a Tree (4–8)

NSES Science Content Standards

- Unifying concepts and processes in science
- Science as inquiry
- Life science
- Earth and space science

Most students are aware that the number of rings in a cross section shows the age of a tree. However, they may not have taken the time to observe the variations in color and texture that create the appearance of these rings.

a. Determining the age of a tree trunk (4–8)

Plants that live and grow for several years leave evidence of this growth in many ways. This is most apparent in a tree trunk’s continuous increase in girth. Year after year during the growing season, the water-conducting vessels in the trunk slowly become clogged with minerals, so new ones must be continuously produced. During the early part of the growing season the vessels produced by the tree are larger in circumference than the vessels produced in the middle of the summer, and the vessels produced in the autumn are smaller in circumference than those produced in midsummer. During nongrowth periods, the tree produces no vessels. This pattern establishes a contrast between the late autumn vessels and the early spring vessels, which creates the illusion of a ring. Most students have noticed rings on a cut tree trunk but may not have questioned how they are formed. The rings are more apparent when the trunk is wet from a rain and are even clearer when food coloring is applied to the trunk. First, challenge student teams to determine the age of a tree stump in the schoolyard. Then challenge them to determine what happens in a
tree that grows in a tropical area with no differences among the seasons. Will these trees have rings? Why or why not? They can also research weather patterns and natural events that may have affected tree growth, such as droughts or fires, to see if the effects of these events can be seen in the tree rings.

b. Determining the age of a woody twig (4–8)
A tree’s branches and twigs grow the same way as the trunk, but because of their smaller girth they are harder to count. One alternative is to examine the outside of a branch and find (in most trees) the terminal bud scale scar where the branch stopped growing the previous season. The terminal scar completely surrounds the twig and resembles one or more wide lines. Other scars, left from the stem of earlier leaves or branches, can usually be seen on the sides of a woody branch, and tiny dots inside the scars are the remains of the vascular tissue that entered the leaf or branch. Challenge students to determine the age of a young branch from at least five different trees. Did natural events affect the growth of one type of tree more than others? Students can research these events, along with growth patterns of tree species, to improve their understanding of ecosystem interactions.
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