Inquiring Safely

A Guide for Middle School Teachers

By Terry Kwan and Juliana Texley
With John Summers, Contributing Editor

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Preface

Before last year's publication of *Exploring Safely: A Guide for Elementary Teachers*, it had been many years since the National Science Teachers Association had released a laboratory safety guide for teachers. In that time, many things have changed. We have more to teach, and the concepts are more complex. Technology has permitted us to gather and transmit information with increasing speed. We have access to new research and data about toxicity of materials and dangers in methods that were not apparent years ago. Social conditions have changed too. Today's teachers work with increasingly diverse student populations, including many students with special needs and sensitivities for whom they must design lab and field work. High-stakes tests have narrowed our focus and sharpened the scrutiny of our communities. The public is more litigious, increasing teachers' concerns about liability.

But today's students need hands-on experience in science more than ever. They need to observe and investigate, practicing the skills which will enable them to make good decisions and to work in the complex world of the twenty-first century.

The good news is that we now have information about alternatives and options that we never had before. We can still provide the investigative and observational activities that are essential to helping students understand the content and the methods of science. We can still set the scene for the discrete events that produce the "Aha!" so essential to engendering true understanding and love of the scientific endeavor.

Teachers today can implement exciting curricula based on the National Science Education Standards in a safe learning environment if they have background knowledge and good sense. To do so requires planning and preparation, but it's well worth the effort.

This book is the second in a series of three intended to offer positive options as they raise awareness of potential hazards. *Inquiring Safely* is the guide for middle school teachers. *Exploring Safely*, published last year, is for elementary school teachers, and *Investigating Safely* will be for high school teachers. We've included many anecdotes to highlight and reinforce ideas. Although we have changed the names and made some other modifications, all the stories are based on actual events.

The traditional safety manual tends to be a compilation of safety rules, regulations, and lists, but this book takes another path. We offer a more narrative style, providing discussions of safety concepts in the context of commonplace situations in real classrooms. We hope this approach makes these books enjoyable to read as well as to reference. Because we recognize that another way to use the book is to look for specific topics, we have included a detailed index to help you locate the information you need. You will also find that some of the same information is repeated in several sections. This is done to minimize flipping back and forth to find the information you need.

We hope the books are thought-provoking. No single publication can cover every eventuality or all the specific policies and rules promulgated by federal, state, and local authorities. There could never be a definitive list of *everything* that is unsafe, or a list of activities that would *always* be safe. We encourage you to make connections and generalize from the ideas presented, using informed common sense. Our goal is to provide you, the teacher, with examples of safe practices and to help you become more alert to ways of ensuring safety when you teach science in your classroom and in field studies. Above all, we encourage you to use common sense and stay up to date with best practice, state law, and district policies.

We believe creating a safe environment for teaching and learning science is a group endeavor, led by the teacher, but joined by the entire school community. As you read this book, we hope it helps you see your physical environment and your procedures through a safety-conscious lens. In so doing, you will be able to give your students habits of mind that will last a lifetime.

Acknowledgments

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Author Biographies

Terry Kwan taught middle school science before becoming a science supervisor and teacher trainer. For the past 15 years, she has been an independent contractor, collaborating with private and public institutions to develop science programs, train teachers, and design science facilities. She has been a school board member in Brookline, Massachusetts, since 1985 and a community representative to Institutional Biosafety Committees for the Harvard Medical School and the Dana Farber Cancer Institute.

Juliana Texley has taught all the sciences, K to 12, for 25 years and spent nine as a school superintendent. She was editor of *The Science Teacher* for 12 years and an officer of the Association of Presidential Awardees in Science Teaching. She currently teaches college biology and technology and develops online curricula for students and teachers.

About the Contributing Editor

John Summers has taught environmental sciences, biology, and chemistry for many years and continues to be actively involved in programs to support teaching and learning of the sciences at the precollege level. A presenter at numerous NSTA and American Association for the Advancement of Science conferences, he is also mentor to Toyota TAPESTRY grant winners and serves on panels to structure and review frameworks, assessments, and systemic initiatives in the state of Washington. His special interests include using science-oriented outdoor experiences to challenge and connect with at-risk students.

How can you and your students avoid searching hundreds of science websites to locate the best sources of information on a given topic? SciLinks, created and maintained by the National Science Teachers Association (NSTA), has the answer.

In a SciLinked text, such as this one, you'll find a logo and keyword near a concept your class is studying, a URL (*www.scilinks.org*), and a keyword code. Simply go to the SciLinks website, type in the code, and receive an annotated listing of as many as 15 Web pages—all of which have gone through an extensive review process conducted by a team of science educators. SciLinks is your best source of pertinent, trustworthy Internet links on subjects from astronomy to zoology.

Need more information? Take a tour—http://www.scilinks.org/tour/

Setting the Scene

Basic Rules for a Safer Science Classroom

Six classes, six teachers—just navigating middle school is a voyage of discovery for early adolescents. We offer them a confusing array of choices, many in science. Sometimes it seems we spend too much science class time teaching organization, caution, and control. But these skills—critical to making science experiences exciting and safe—are also important science processes.

Middle School—Home of the Brave

Unbounded exuberance, unchecked enthusiasm, limitless energy, daring spirit—students with the curiosity and emerging reasoning skills that are "the right stuff" for an investigative science program come into middle schools. Early adolescents are exploring their expanded world in new and strange vehicles—growing bodies they have yet to understand, much less control. These years offer wonderful opportunities to capture students' energy and channel it toward the excitement of scientific exploration. But everything we do in our middle school science classrooms must recognize the developmental level of our young scientists and their penchant for risk-taking that we must temper sufficiently to promote safety.

Share the Adventure *and* the Responsibility

An investigative science program requires the distribution, use, and care of much more material and equipment than a textbook/workbook program. Learning through doing engages middle school students, but you and your students need to share ownership of the process to make it successful. The students must join in the responsibility for tracking myriad items and cleaning up the inevitable messes associated with laboratory science. Most middle school students, left to their own devices, do not remember to do things like returning equipment to the correct storage place, washing first and cleaning before leaving the room, or using the safety goggles you told them about just yesterday. It is not that they are unwilling to help; it is that competing priorities make it easy to forget. So, if you are to enjoy a safe investigative venture together, you must specifically plan to make your students full partners in managing the laboratory environment.

1

The Schedule's the Thing

Ideally, science teachers should be assigned their own rooms and have no more than two preparations a day. If science rooms must be shared, they should be shared only with other science teachers. The potential hazards, and the value, of materials and equipment in a science room make its use by a nonscience specialist potentially dangerous. If your principal is unaware of the safety risks associated with using science facilities for nonscience classes, you may need to point them out.

Notes to Administrators: Scheduling a Safer Science Program

- Assign science rooms only to science teachers.
- Avoid assigning more than one teacher to each science room.
- Avoid assigning science teachers to more than one room.
- Provide prep periods in the science room as part of the teacher's schedule between different assignments.
- Provide secure locked storage for prepared science materials.

Moving a science teacher from one room to another for different class periods should also be discouraged. A laboratory science program requires access to materials and equipment and time for preparing them. Ideally, equipment should be stored in appropriate secure facilities at the point of use. Doing this is very difficult if you must move from room to room or switch from one science subdiscipline to another. For optimum safety, time for preparation should be part of the teacher's schedule, and different classes should be separated by a prep.

The Teachable Moment

Many textbooks begin with a general chapter on safety. Although this may be prudent, it doesn't mean much to students if the chapter is abstract and isolated. As with everything else, safety lessons are best remembered when they are associated with real experiences. Although you may want to review and post some general safety rules — hand-washing rules, use of safety glasses—right from the start, the best time to give specific safety instruction is in conjunction with a lesson or activity when the safety procedure is needed. Even though the procedure is one you may have reviewed a number of times, go over it again every time the activity you have planned requires the precaution.

Following the introduction of a new safety procedure, you might have students create signs and posters. This reinforces the point and makes a good authentic assessment. Assign students to place safety reminder signs near the activities that call for reminders. For example, put hand-washing signs near live animal cages and safety goggles reminders near areas where chemicals are used. You will know students have mastered safety concepts when they can explain them to visitors, new students, and returning absentees.

Less Is Better

Although we know an active investigative science program requires lively discussion and movement, some teachers mistakenly believe noisy, bustling students are an indication of successful hands-on, minds-on science. Not only is this untrue, but such activity also may work against your program. Think of your science program as interesting, fascinating, and challenging rather than fun. Learn to distinguish the considerable difference between intense discussion and just plain noise. Moving about to collect supplies and make observations looks and sounds different than jostling, shuffling, and hanging out.

Less is better—less noise, less material, less movement. Carefully storing supplies and materials in a safer, more organized fashion is not the same as accumulating junk. You create a safer environment when you reduce the supplies, the talk, and the movement to only what is necessary.

Tell students to leave outerwear, unneeded books, notebooks, backpacks, and other treasures in their lockers or in a storage area away from the lab work areas. If items are hung over the backs of the students' chairs, the extra weight can cause the chairs to tip over when the student stands up or pushes the chair away from the table. Refer to clothing instructions in Chapter 10 ("Dress of the Day," p. 135). Food and food containers should never be anywhere near the spaces intended for science experiments.

Saving Moments

- Save unused plastic cups, old cafeteria trays, and clean trays from prepackaged foods for distributing materials. Once used for labs, don't use these items for any other purpose.
- Keep supplies in a locked area.
- Measure out needed supplies in advance. Keep stock bottles locked up during class.
- Establish a regular system for distributing and collecting materials and supplies; train students to participate.
- If you must move materials and supplies, move only small quantities in locked storage units.
- When equipment is limited, alternate lab days for half the class with desk or computer workstation activities such as investigation planning, data analysis, and data graphing for the other half.
- Post safety instructions on an overhead transparency or in a computer database for review.

The Best-Laid Plans

Middle school students need structure, direction, and clear expectations. Detailed planning is essential and so are communicating expectations and setting limits. Make sure every lesson has a beginning, a middle, and an end. Give directions and goals before anyone begins work. Specify the safety issues and procedures even if you are repeating an instruction. Make sure everyone stops working when it is time to clean up, return equipment, and decontaminate work areas. No one should leave until everyone is checked out.

Whether you are a new teacher or a veteran, if you establish the discipline of preparing complete and detailed plans, you will lower your stress and your liability. As you'll see in Chapter 11 ("The Best Defense," p. 152), these plans not only create peace of mind but also are valuable documentation in case a problem ever occurs.

But remember that detailed lesson plans can look great on paper but fall short in practice. The best format is easy for you to follow and complete in a reasonable amount of time. You might create columns in your plan book to list materials to purchase, time requirements, chemical allocations, and safety reminders.

Providing students with a written version of your instructions and safety directions and repeating them at the beginning of each class is important. If at all possible, avoid students' leaving your class when you give directions. A student who reenters the room in the middle of a science experience can be a hazard to the rest of the group. When students are absent, they may miss safety directions. Keep an explicit record of what safety instruction has been given, when, and to which students. Keep this checklist as evidence that you gave proper and appropriate safety information to each student.

Your planning also must consider the consequences of both teacher and student absences. Every day there is someone absent in almost every classroom.

Remember you are responsible for the program offered by your substitute. Because your substitute is unlikely to have your knowledge of the subject matter or your control of the classroom, it is best to have a substitute conduct nonlaboratory activities or those without potential hazards. If you direct a substitute to do an activity that results in an accident, you could be held liable. (See Chapter 11, "Substitute Teachers, Interns, and Student Teachers," p. 149.) If you will be absent for an extended period, request a science-trained substitute.

Many teachers prepare a special substitute folder for unexpected one-day absences. This folder contains instructions for nonlaboratory science activities that fit almost any part of the year. Take time to speak to your substitutes and ensure they are competent to carry out your plans. Your students can assume a great deal of responsibility when you are away if they are accustomed to sharing the routine of your classroom.

Students who are absent need to make up lab activities. They must have access to supplies and missed instructions and must do these activities under your direct supervision—never in a hall or storeroom. To make the process easier, organize materials in labeled boxes or bins containing the supplies and instructions for a particular activity or unit. Place a laminated card with the relevant safety rules in with the supplies. Although clear or translucent containers are ideal, shoeboxes and the 10-ream copy paper cartons may also serve you well. Create outside labels that not only show the title of the activity but also list the items inside. (See Chapter 4, p. 37, for storage tips.)

Many teachers find assigning students homework buddies or makeup-work buddies a helpful practice. Teach cooperation and responsibility along with science, espe-

cially if you have heterogeneous classes and special needs students. Every student should feel responsible for every other member of his or her science team every day.

For Whom the Bell Tolls

When planning science activities, make sure you account for set-up and clean-up time within the lesson. Distributing materials at the beginning of the class, collecting materials at the end, and cleaning up the work space and used equipment take real time to do properly. Your students should see this as part of their responsibility. Because these housekeeping tasks are an integral part of the entire science activity, make sure you build your schedule with enough time to complete them. If you have set up a specific time to do a science activity, then make sure no one begins before everything is properly distributed and everyone has stopped the activity when it is time to clean up.

See that work surfaces are washed and dried completely after any science activity before going on to the next. This is a great habit to instill even if it sometimes doesn't seem necessary. Make cleanup a responsibility for students, but have them use only mild dish detergent. You will need a material safety data sheet (MSDS) for the cleaners. (See Chapter 4, p. 41, for more information.) Do not allow students to leave the room for appointments or pullout programs unless they first clean up their work areas.

Building in "think time" is also important. When students do a lab or other hands-on activity and then run out the door before they analyze what happened and why, they may not get much benefit. That sometimes means preplanning to break lab experiences into smaller lessons, with discussion, journal, and cleanup time built in rather than trying to squeeze everything into a single period. If your lesson feels rushed, it probably is. Redesign the activity, expand it to multiple periods, use self-reflections as homework, or find an alternative that permits you and your class enough time to think about the activity, not just complete it.

Making Every Minute Count

A Typical Lesson

- Overview and safety tips (5 minutes)
- Distribution of supplies (5 minutes)
- Activity period (10 minutes)
- Assessment break (5 minutes)
- Activity continues (10 minutes)
- Cleanup and equipment check (10 minutes)
- Brief review and prep for followup and/or homework (5 minutes)

Total_____ (50 minutes)

Homework Happens

You are responsible and can be held liable for assignments you give as homework. Therefore, consider assignments carefully. Do not ask students to explore chemicals

in their home cabinets without adult supervision or test soils from unknown grounds. On the other hand, don't hesitate to develop safer home assignments for students to share with parents. Many teachers have created portable science kits—backpacks or boxes—that students can check out. They contain such things as measuring tools, binoculars and star charts, or leaf presses. Parents, facing the growing independence of their preteens, appreciate structured opportunities for interaction. Once families have explored together, they are more likely to continue to do so.

Many of the safety practices you promote in science activities can be extended easily to students' homes. Reading labels carefully, the proper handling of sharp instruments and glassware, hand washing and cleanup—all have practical applications in the typical kitchen or bathroom. When you give instructions to keep students safer during field studies, these same rules may help keep them safer when traveling with their parents. So take the opportunity, and invite your students to think of how a rule you have just taught them would apply equally well to a situation at home. Help students to think safety wherever they are and whatever they are doing. Because middle schoolers gradually become more reluctant to discuss school at home, you may want to create an assignment that requires this sort of communication. Parents will welcome the chance for interaction.

If you have a newsletter, voice mail on your school phone, a website, or send out e-mail to parents, you might create a changing message: "This week's lesson encourages hand washing …" or "Parents, check your students' journals for safety rules concerning the handling of …" Encourage students to work with parents to create a child-safe home, especially if younger siblings are present.

Say It Again, Sam

Making Connections

- phone calls
- newsletters
- homework assignments and hotlines
- progress reports
- e-mail
- websites

Repetition is the key to success with middle school students, who may be highly logical in some ways but quite concrete in others. Middle school students are often willing to tutor elementary students on safety, showing off their new maturity to their former schoolmates. Every new application of the ideas you present will help reinforce safety and make it a habit.

If your school has an Internet connection or a homework hotline, make sure safety concepts are included. Many teachers develop safety rules agreements with their students and have parents review them at home early in the year. It's a good idea to update and repeat the contract process each quarter.

Midden Heap or Laboratory?

The physical environment can enhance or detract from your lessons. In middle school, keeping the learning space neat, attractive, and safe can be quite a challenge, because classrooms are no longer self-contained and there is lots of movement in and out. Sometimes it feels like no one owns the space. But when maintaining the learning space is the shared responsibility of everyone who uses it—teachers and students alike—the problem becomes more manageable. As teacher, you are the model; your students will keep their work space clean and neat only if you keep the rest of the classroom that way.

Clutter creates tripping hazards and blocks fire exits. Easily distracted students become more so in messy environments. Most important, a messy, junk-filled room detracts from the impression of a classroom/laboratory as a place for serious business.

Reduce the amount of materials you accumulate. Paper is combustible. Check local fire regulations to ensure that the amount of paper on walls and ceilings conforms to the fire code. Mobiles and hanging paper can be fire hazards.

Be rigorous about throwing things out. Avoid the pack rat syndrome. Anything you have not used in two years, you are not likely to use ever again. You need only one good copy of that favorite lesson, and you might consider saving documents and plans on a CD-ROM. (See Chapter 3 for more tips about facilities and Chapter 4 for more on storage.)

You do not have to be an artist or spend precious dollars on elaborate posters for bulletin and trim boards. Student work and data from lab activities make the best displays of all. Students who stare at the walls can learn from what surrounds them in their classrooms. Use your board space to display student work that emphasizes continuing themes and ongoing safety rules. Put a safety theme on a bulletin board and encourage students to bring in photos to illustrate it. Make a feature out of the classroom fire escape route and emergency instructions. Encourage students to develop posters reminding one another of hand washing, proper disposal, and recycling.

A Reputation for Excellence

Science is highly motivating. For that reason, a good science teacher can become something of a local hero in the middle school. But it is critical for you to understand that excellence does not mean doing high school science at the middle school level. Students in grades 5 through 8 have content and process needs and developmental maturity different than high schoolers'. Trying to transpose that great lab from high school to middle school, even if it generates excitement or enthusiasm, is not a good idea. Such a practice may make good press but is usually not good education and may create serious safety hazards.

Because middle school students move around the school more than they did in elementary grades, corridor and other common-area displays can call attention to the work going on in your science program and attract students to your science place—a classroom with mini-museums, displays, and interactive bulletin boards. But becoming the local gathering place has its complications. The rules for safety must be clear enough that even the casual visitor will learn them quickly. Be especially careful if you maintain live organisms in your classroom or mini-museum. You are responsible for the safety of visitors and organisms and must ensure against mischief. Make sure your room is supervised or locked during change of class.

Make all your students docents in your classroom. Give them a sense of ownership, and encourage them to explain the rules—and why they are necessary—to visitors. You may want to set up a few test runs with some invited guests so you can test the students for both hospitality and safety consciousness.

Students can share the excitement of their lessons via the computer. Middle school students can produce PowerPoint slides of their experiments that can be scrolled at a workstation in the media center or in your room during parent night. Middle schoolers have created great Web pages for their school sites. An inexpensive digital camera can be used to prepare displays allowing you and your students to share their science experiences without having constant traffic in the room.

Remember, it is far better to have a reputation for inquiry than for chaos. If people who enter your room find they are challenged to think, you'll become that local hero.

Set High Expectations

As any veteran teacher knows, high achievement is the reward for setting high expectations for our students. This is as true for safety as for any other expectation. The more you make students responsible for using and enforcing safe laboratory and fieldwork procedures, the more easily safe practice can become habit. Once you have established a classroom climate based on the expectation that students should be as vigilant as you in spotting safety hazards and eliminating them, you may find that fewer rules can work better than rules for every step and procedure. Middle school students respond well to greater responsibilities. "Now that you are older" almost guarantees cooperation. Your students are your best tools for a safe science environment. The ultimate safety rule should be: "Don't do anything you know or think might be unsafe for yourself or others."

With an inquiry-based science program, you are likely to encourage students to experiment, observe, and explore on their own in addition to following your step-by-step instructions. But there can be no experimentation with safety rules. When it comes to safety instructions and safe procedures, you must be explicit and exacting—especially with your middle school students who are so often distracted by their other

interests. Although safe practices support inquiry-based science, do not let students learn by trial and error when it comes to matters of safety. If you catch your students quoting you, you've succeeded.

THE SAVVY SCIENCE TEACHER

Ms. B's classroom was becoming quite a zoo. Newly born animals were generating so much interest and excitement that the room was constantly filled with visiting students running in to check on the broods. During one change of class, a young animal was almost crushed between a wheel and the wall of the cage by an overly enthusiastic visitor. Something had to be done.

Ms. B went to the school's technology teacher for help and found a solution. Now, each day, her students take a 25-second MPEG video of the latest developments in the gerbil habitat and narrate it for the school's closed circuit television broadcast. The report has become a highlight of the daily program. Next month, other classes plan to join Ms. B's team in reporting on their study of a local stream.

Connections

- American Chemical Society. 2001. *Safety in the Elementary (K–6) Science Classroom* (2nd ed.). Washington, D.C. American Chemical Society.
- NSTA Press. 2003. *Safety in the Elementary Classroom.* Arlington, VA: NSTA Press.