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About This Book

The National Science Teachers Association (NSTA) has assembled this collection of selected reprints from three of its journals—Science and Children, the journal for elementary teachers; Science Scope, the journal for middle and junior high school teachers; and The Science Teacher, the journal for high school teachers—to help K–8 teachers organize and conduct successful science events with their students. Whether you decide to conduct a traditional science fair or explore a science expo or festival, this book provides you with practical information to ensure success.

NSTA Position Statement on Science Competitions

The National Science Teachers Association recognizes that many kinds of learning experiences, including science competitions, can contribute significantly to the education of students of science. With respect to science competitions such as science fairs, science leagues, symposia, Olympiads, and talent searches, the Association takes the position that participation should be guided by the following principles:

I. Student and staff participation in science competition should be voluntary.
II. Emphasis should be placed on the learning experience rather than on the competition.
III. Science competitions should supplement and enhance other educational experiences.
IV. The emphasis should be on scientific process, content, and/or application.
V. Projects and presentations must be the work of the student with proper credit to others for their contributions.

—The NSTA Board of Directors adopted this position statement in July 1986. In fall 2002, the Board was in the process of revising the statement; go to www.nsta.org/position for the latest version.

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.

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

Volcanoes Are OK
and Other Divine Secrets of Successful K–8 Science Fairs, Expos, and Festivals

Donna Gail Shaw

After twenty years of teaching science at the elementary, middle, and college level, and almost that many years serving as a judge at local and state science fairs, I and other authors published in this book have discovered some secrets that teachers will find helpful when facing the task of organizing a science event or getting students ready for the event. Read on. These secrets are divine.

Secret 1. Organizing a school science fair is not complicated.

Just the thought of organizing a science fair for an elementary or middle school can seem overwhelming. Deborah Fort and Ruth Bombaugh have uncovered numerous ways to ensure the smooth operation of a school science fair. Fort (page 4), in her description of the start-to-finish operation of a science fair at an elementary school, offers advice on everything from deciding what a science project actually is, to picking the judges, to conducting a science fair wrap-up. Bombaugh (page 12), self-described as organizationally challenged, shares a master schedule she developed for organizing a middle school science fair that has passed the test of time.

Secret 2. Picking a topic is the easy part.

Gail Foster (page 20) states that selecting a topic and identifying a problem can be the most difficult parts of the science fair project. However, after making this statement, she lets us in on a secret: she provides expert guidance on how to make the process of selecting the topic easy for the students. Foster explains how to (1) introduce students to the idea of asking questions, (2) create excitement and arouse curiosity, (3) help students who need additional assistance in picking a topic, and (4) narrow broad topics to specific problem statements. Susan Shaffer (page 16), as well as Fort (page 4), also offer suggestions for helping students select topics. In addition, Shaffer lists Internet sites for finding help with science fair...
ideas and preparation. (See also Appendix A, Resource List, of this book for other science fair sites on the Internet.)

**Secret 3. Judging science fair projects can be effective and fair.**

While there is some debate over whether science fair projects should be judged at all (Fort, page 4; Evelyn Streng, page 38), Lawrence Bellipanni, Donald Cotten, and Jan Marion Kirkwood (page 48) share five basic criteria for judging projects. They stress the importance of the judges using the same criteria in the same way to ensure fairness. Bellipanni and James Edward Lilly (page 30) share similar criteria as well as suggestions for the selection and preparation of judges. Norman F. Smith (page 58) highlights some of the pitfalls of judging and proposes a separate judging category for experimental projects. The divine secret is in the way the information is presented to children of varying ages and one’s belief in their ability to learn the process.

**Secret 4. Teaching the scientific method to children of all ages is possible.**

Donna Gail Shaw, Cheryl Cooke, and Tera lyn Ribelin (page 40) share how to teach the scientific method to a diverse group of learners in a K, 1, 2 multi-age, full-inclusion classroom by conducting a whole class project. In accordance with what is known about child development and the brain, it should be noted that primary level students (K–3) may have difficulty manipulating more than one variable at a time (Lowery 1998). Understanding that there is a biological basis for this difficulty will lessen the teacher’s frustration while guiding this age group to use inquiry-based science. Stephen Blume (page 24) simplifies the process for elementary students by suggesting the use of six easy questions. Finally, Charlene Czerniak (page 26) shares a quick way to teach middle school students the scientific method by using either quantitative or qualitative measures. The divine secret is in the way the information is presented to children of varying ages and one’s belief in their ability to learn the process.

**Secret 5. Conducting nonexperimental research can meet the goals for school science.**

The goals for school science (National Research Council 1996) are to educate students who are able to

- experience the richness and excitement of knowing about and understanding the natural world;
- use appropriate scientific processes and principles in making personal decisions;
- engage intelligently in public discourse and debate about matters of scientific and technological concern; and
- increase their economic productivity through the use of the knowledge, understanding, and skills of the scientifically literate person in their careers. (13)

John Stiles (page 64) and Smith (page 58) explore the current plight of elementary and middle school science fairs. Based on their experiences as science fair judges, they believe that the only worthwhile projects are experimental in nature and that models, demonstrations of principles, and report and poster projects do not promote the goals of science teaching. However, Streng (page 38) expands on the type of projects she considers appropriate by includ-
ing any problem-centered projects that focus on the process rather than the product. Even though she postulates that controlled experimentation is the most valuable type of problem from the viewpoint of understanding science, she includes observation of the environment and demonstration of a basic principle as appropriate topics of study for an elementary science fair. Margaret McNay (page 54) also makes a convincing argument for the value of nonexperimental projects, pointing out that much of science is descriptive study rather than experimental.

How does one reconcile the differences of opinion in the literature? By taking a look at the goals of school science above, one can infer that an inquiry-based approach to science is needed; however, inquiry is not limited to experimentation. For example, volcanoes are okay as science fair projects as long as one has taken an inquiry approach to the study of the volcano. If the focus of the project is the making of the model, then a goal of science teaching has not been met. However, if the focus of the project is to understand volcanoes and their structure and to share that knowledge with others, which results in further inquiry and exploration, then the divine secret is understood.

Secret 6. Frustrating experiences can be positive learning experiences.

Linda Sittig and Cecelia Cope show how reflection can turn frustration into something positive. Sittig (page 36) shares her frustrations and reflections about her six-year-old daughters’ science fair experiences from a parent’s perspective. Cope (page 50) shares how she helps her “drained” middle school students reflect on their science fair experiences, resulting in a boost to classroom morale.

Secret 7. Implementing noncompetitive alternatives to the science fair, such as expos, carnivals, and festivals, can increase student, family, and community involvement.

Debbie Silver and others share this secret as they explore alternatives to science fairs. Silver (page 70), while working at a small, rural, elementary school, revitalized the science fair program by involving the community and including cooperative and noncompetitive options. In reading her article, one will note that she uses the scientific method to solve a problem.

- **Problem:** How can I increase the participation in the school’s science fair?
- **Research:** Silver reviews the literature on science fairs and the impact of competition on participation. She also reviews various noncompetitive alternatives to science fairs.
- **Hypothesis:** If the competitive nature of the science fair is removed, then participation by students will increase.
- **Procedure:** Because Silver cannot decide which alternative to try, she implements all of the ideas and calls the event an expo. The events include the traditional, judged science fair, a share fair, class demonstrations, an invention convention, family physics fun festival, family science Olympiad, business exhibits, and special presentations from members of the community. She repeats the event over a multiyear period.
- **Results:** Even though participation in the expo is not required, most of the students in her school now choose to participate.
- **Conclusion:** Removing the competitive nature appears to have increased participation by students.

One may argue that other uncontrolled variables contributed to the success, such as commu-
nity and family involvement; nevertheless, this small school has achieved something remarkable and solved its problem of low participation in a science event.

Daniel Wolfe (page 78), inspired by Silver’s success, implements an expo for 4th through 12th grade students. He decides to keep the competitive component intact for the expo projects; however, he allows students to choose whether they want their projects judged.

Doug Cooper (page 82) shares his ideas for implementing a noncompetitive science event patterned after the traditional school carnival. He provides suggestions for organizing the event, and recommends setting up booths that explore the scientific phenomena associated with the games found at a typical carnival.

Similar in design is the science festival. According to Verilette Parker and Brian Gerber (page 86), the characteristic that distinguishes a science festival from a science fair is the interactive nature of the science exhibits that students share with each other. The authors offer several ideas for some popular interactive exhibits.

If you have experiences with science fairs or science fair alternatives that you would like to share with others, the editors of Science and Children and Science Scope want to hear from you. Please visit the NSTA website at http://nsta.org/ for author guidelines.

References

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Preparation
The first task of volunteers and staff alike was to help students struggle with the thorny problem of what, exactly, a science project is. Young children need some clear guidelines on scientific method, because the difference between a science and an art project can be something of a mystery to a kindergartner. Children in the lower grades can be taught to see science projects as opportunities for problem solving, for critical and analytical thinking, and for understanding cause and effect. Upper elementary students can sharpen research skills and discover new ways of conducting experiments.

Many educators believe that science fair projects should be part of the regular curriculum. Whether or not this is possible in your school, some fall preparation and continued work over the year before the big push in the spring will help you avoid some of the pitfalls that can diminish the value of science fairs or even make them harmful.

If a science fair project is an overall requirement, as it was for the Murch sixth graders, the science teacher—ideally in tandem with classroom instructors, volunteers, and the principal—should meet in the fall with all the children to give them an outline of scientific method, to
define the categories in which they might work, and to try to get them thinking about their special interests.

If the science fair is a voluntary affair, as it was for the younger Murch students, divide interested children by age (say, first through third graders and fourth through fifth), and begin small group discussions, like those offered by the enrichment teacher at Murch, as early in the year as possible. Because you will be approaching each child’s project as a unique expression of his needs or her experiences, expect this procedure to take several meetings. Once the school staff has a sense of which children are interested in entering, provide volunteers with a list of their names. An early call to the parents of participants is likely to produce more help later, better sustained efforts on the parts of their own sons and daughters, and perhaps even some assistance for entrants who don’t have strong support at home.

“I Can’t Think of Anything”
The Murch science teacher finds that requiring her students each month to read part of any science magazine such as *Science News*, *Science Digest*, *Smithsonian*, *Ranger Rick*, *National Geographic World*, *Discover*, or *Scientific American* can help to focus students who think they have no ideas for projects. She couples weekly encouragement for all students with trips to the library as a counter to this kind of vagueness.

If a child expresses no specific interest but is tending toward something unfocused like “animals,” encourage him to be more concrete. Does he want to know more about dogs, or does he want to learn about other animals? Does he have a dog? What kind? What exactly would he like to know about his uncle’s Hungarian sheepdog that he doesn’t know now?

**If a child expresses no specific interest but is tending toward something unfocused like “animals,” encourage him to be more concrete.**

**Know Thyself**
The best science fair projects grow out of something important in the child’s life. For example, one Murch eight year old, the owner of a mixed breed collie and German shepherd, studied the responses of various neighborhood dogs to recorded wolf howls. A second grader who had suffered a stroke as an infant studied his own ability to exert self-control through biofeedback.

Science fair projects should be in progress certainly by October, ideally by summer or even earlier. They should stimulate children to more ambitious future projects. In addition, most projects should involve mathematical skills; they should encourage organizational ability; and they should show children how to demonstrate method and results. However, not all science fair projects need be experiments calling for hypotheses and conclusions. Children can also learn a great deal from nonexperimental projects like those suggested by Margaret McNay on pages 54–56 of this book.

According to the Murch principal, what begins as a part-time effort should eventually be refined or expanded so that a project started one year can
Ideally, judges talk with each child and respond to oral input individually, allowing presenters to be proud and informative.

carry over into another year—and beyond. Teachers can encourage the choice of and commitment to longitudinal studies in topics like human growth and development (children can study themselves), methods of energy saving, changing purification systems, and conservation projects (what begins as an experiment involving plants can become part of a school garden).

“The Matthew Effect”

Like a strong science program, a science fair must serve all students—not just those lucky enough to come from homes where science is valued and practiced. Otherwise, we run the risk of further hurting children who already suffer from disadvantaged home environments—of intensifying what R.K. Merton has called, “The Matthew Effect.” The words of the parable—“whosoever hath, to him shall be given, and he shall have more abundance, but whosoever hath not, from him shall be taken away even that he hath” (Matthew 13:12)—whatever their meaning in Christian theology, should not be an apt description for our children, particularly those who are not lucky enough to have parents who support them academically. Such children, more than the offspring of the privileged, need superior teachers as well as contact with peer academic achievers.

The Biggest Show in Town

In the best of all possible worlds, each elementary school student would do a year-long project. The Murch science teacher believes that she should help all children who want to enter rather than helping only a few intensively. Although the latter method does seem to produce winners, it is often hard to tell where the child stopped and the professional started. In addition, this approach focuses too much on winning and can deprive the majority of children of the chance to participate (or at least to do so without expert help). Parents and other volunteers can offer valuable help, but understanding the appropriate limits of that assistance is very important. Written explanations of who did what, like that offered by the grandfather of one young solar engineer, offer a possible solution to an old dilemma.

If you agree that the biggest science fair is the best, you should think about logistics now. Line up parent volunteers this month, for example, unless you were so well organized as to have asked for them on the first volunteer sign-up sheets sent out last month. And, if you’re in a school with many students and not much display space, maybe you’ll want two science fairs—one for the lower grades and another for the upper ones. Careful planning now can lead to a fine show in the spring science fair.

Labors of Love

The parent organizers of the Murch fair included a child psychiatrist, an artist, and a U.S. government administrator, whose hours of help...
Wilbur and Orville Started Out on the Ground

A judge at the Murch Fair commented on her search for creativity, imagination, and scientific method, which she defined as “a question leading to an answer (though not necessarily the one expected).”

One fifth grader’s winning study of “Heart Music” fitted her definition. He attempted to measure the impact on the heart of different types of music as measured by an electrocardiogram (EKG), loaned by an obliging uncle who worked as a doctor at a local hospital. His subjects were his 34-year-old uncle (76.5 kg), his 30-year-old aunt (51.5 kg), and his 8-year-old brother (22.5 kg). After learning how to use the EKG machine from his uncle (who also assisted by hooking up the participants), the investigator first tested his subjects’ hearts without music, then as they listened to “Footloose” (“a fast rock and roll song”), a Mozart concerto (a “slow, calm, classical piece”), Frank Sinatra’s rendition of “New York, New York” (a “medium-paced song with a strong beat”), and the Beatles’ “I Want to Hold Your Hand” (a “calm rock and roll song”).

The young scientist’s hypothesis, the faster the music, the faster the heart will beat (and vice versa), was not supported by his data.

He concluded that he had ignored many variables. For instance, he realized that the readings could have been affected by what the subjects had eaten, by their physical condition, by the volume of the music, and by their emotions. “For example, my brother laughed the whole time he was tested,” a fact that perhaps contributed to his wild EKG.

Science Triumphant

Some of the hypotheses at the Murch Fair were proved.

One third grader studied hydrilla, which he described as “a noxious weed taking over the Potomac” [river] and which his display asserted was “wanted dead or alive.” Early in October, he and his family went down to a dock in the Potomac to collect hydrilla samples. He put 0.070 g of hydrilla in each of 26 large Mason jars also containing various concentrations of river water, salt, and mud. The experiment stank so foully that his mother removed it to the attic at Thanksgiving where it eventually cleared and stopped stinking. Over the Christmas holidays, the hydrilla seemed to die and decompose; however, when the experimenter brought it back downstairs in January, almost all of it came greenly and slimily back to life.
The hydrilla died permanently only in very salty concentrations; mostly its decomposition was followed by a total regeneration accompanied by tiny snails whose eggs must have been in the samples the student collected in the fall.

Washingtonians, especially ones who enjoy boating on the Potomac, are deeply concerned about the spread of hydrilla. They wonder how far upriver it will spread—this Murch scientist thinks he knows the answer. Look for the snails, and you’ll later find the weed.

Last But Not Least
Inspired by Laura Ingalls Wilder’s Farmer Boy, a second grader experimented with the best ways to preserve ice. According to Wilder’s title character, ice blocks 20 inches square cut from frozen lakes and buried in sawdust “would not melt in the hottest summer weather. One at a time they would be dug out, and Mother would make ice-cream and lemonade and cold egg-nog.”

The investigator measured the room temperature, gathered his materials, surrounded ice with various substances, and recorded the time when the ice first began to melt. He studied the insulating ability of aluminum, water, paper, dirt, sand, and sawdust. Like Wilder’s farmers, he found that sawdust works best.

Finally, an artistic as well as scientific upperclassman studied “Breakin.” His full-color exhibit featured a large illustration—a brown man twirling on one hand (gloved in fingerless mitts), blue pants and red sneakers reaching for the ceiling. The scientist was trying to discover whether boys would react to break-dancing more than girls, and his hypothesis was that males would be more responsive. He observed, music box in hand, on the playground for several days, finding “Few girls stopped playing, but most boys stopped playing and began to do [move] to the rhythm of the music. … There were 11 boys who did a complete routine.”
provided far more than elbow grease, scissors, paste, and lunch from a fast food restaurant on judgment day (though their contribution included these items). Concerned that the children not become confused that science fairs “are” science and that the fairs offer genuine opportunities for learning, not just ones for last minute competitiveness, the parents combined their offers to carry and to set up heavy and complex projects with an equally important willingness to discuss and, at times, explain concepts to the children. Parental helpers stressed the need for good lines of communication among faculty, administrators, and volunteers regarding practical matters like time tables, resources for assisting students with project assembly, and availability of materials. They planned a November letter to parents signed by the principal and science teacher as well as by them to explain the philosophy of the fair and to encourage participation. They backed this overture with approaches to the students in the once-a-week science classes and in follow-up calls to parents of interested children.

After working on projects at home over the winter holidays and into January, students were encouraged in mid-February to submit written summaries of their work to the science teacher for her input. The principal made the science teacher available to participants in each class one hour a week; the sixth graders, whose participation was required, got more specialized attention. Then, during the week before the fair, parental volunteers were available after school to help with lettering, pasting, and assembling, as well as encouraging and explaining.

Set-up day was the Saturday morning before the fair (the weekend hours guaranteed a good deal of volunteer help from working parents). After the projects were judged on Monday, every class had a chance to walk through the exhibit hall and inspect the projects. The principal also arranged for early morning and late afternoon hours, so that parents and other interested spectators who worked would be able to see the science fair exhibits.

But the most important contributors to the success of the fair were the children—their commitment, their time, their imagination. About a third of the students offered projects in the following categories: behavioral science (23 projects), biology (25), botany (7), chemistry (6), mathematics and computers (2), physics (28). As they set up their exhibits and stood beside their completed projects, the children were glad to offer comments to the classmates and parents who came to ask questions and admire.

Here Come the Judges
Picking the judges—how many and with what qualifications—is a decision that is important to the success of your school’s fair. If the judges are part of your school’s community, their anonymity should be closely guarded. This precaution
Preparation is, of course, unnecessary if the judges are chosen from outside.

When picking judges—and you should get as many as possible, preferably enough that each project can receive several evaluations before the results are averaged—try to find flexible scientists and educators who will be willing to respond to the projects as wholes and who will not lose sight of the creativity that may fuel an imperfectly presented project. Before the judging begins, present each judge with a set of the criteria students have followed in creating their projects.

Whatever your particular criteria, the judges should note the display and, as relevant, the hypothesis, method, data collection, and conclusion, as well as the level of understanding the student demonstrates through the display and in response to questions. Ideally, the judges should be able to talk with each child and respond to his or her oral input individually, offering each presenter time to be proud as well as informative.

Murch’s judges, recruited by the science teacher and the parent volunteers, included a chemist from a local hospital, an educator from a neighboring state’s public school system, a military scientist, and a junior high science teacher.

There Go the Judges

Another judging possibility—albeit a heretical one—is to give all participants A’s. At one recent fair, the only acceptable judgments were Superior, Outstanding, and Noteworthy. In any case, make sure that all contestants win something—a ribbon, a certificate, or a medal.

Or, even more of a violation of the American spirit of competition, dispense with judgment altogether. Making each child’s science fair project part of the regular science curriculum would render public ratings unnecessary, and everyone—from the most advantaged student to the least—would have a chance to participate. Such a procedure would also help to separate the parental contributions from the children’s.

Fair Enough?

Once the projects have gone back to homes and (unfortunately) sometimes to trash cans, try to keep the memory alive to fuel enthusiasm for next year’s fair and for this year’s achievements.

For instance, do a follow-up unit on a particularly impressive project. The Murch enrichment teacher had her third graders create a book called *Hydrilla Monster* based on one child’s project.

In addition, she asked some significant questions:

- Did you like your project? (yes or no)
- Did you find out everything you wanted to know about it? (yes or no)
- Would you like to continue learning about it? (yes or no)

Although the results were mixed on the first two questions, a resounding 90 percent responded affirmatively to the third question.

So, if your students react similarly, note that fact and encourage them to get started early next year on science fair projects that are logical extensions of the experiments they seem unwilling to abandon.

A science fair wrap-up is also a good occasion for catching the attention of those students who didn’t participate this year and who may wish now they had. Encourage them to start thinking now about areas that could become a project for the future. Help them to picture themselves as part of the fair next year even though they missed out this time.