

# Four Tools *for* Science Fair Success

*These teacher-tested ideas will guide your students to true inquiry-based projects.*

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**H**ave you been reluctant to take on running a science fair? Perhaps you fear a fair comprised of slapdash, last-minute projects. You likely feel pressure to teach to the standards. We are a team of veteran teachers who have overcome these same concerns by creating and testing several ways to improve the science fair experience in our classrooms. We have added to our programs by using the resources of Science Buddies, a nonprofit organization dedicated to providing free science fair project ideas, answers, and tools for teachers and students in grades K–12 (see Internet Resources).

We offer four ideas to guide students in creating true inquiry-based projects as they accomplish some steps independently at home. Two of our ideas, the Topic Selection Wizard and Science Project Timeline, are appropriate for all science fair programs, even new ones. For existing programs, the Black Box of Project Improvement and After-School Project Clinic improve project quality and broaden participation.



## Topic Selection Wizard

**Key objective: Help students find topics of their own interest.**

In classrooms across the country, students have used the Science Buddies online Topic Selection Wizard to find their own science project area of interest (see Internet Resources). In our classrooms, when students found project ideas related to their own areas of interest, they became more committed to working on their projects long term. In addition, using knowledge they already had, they were able to come up with predictions and ideas for experimental procedures more quickly and accurately.

The Topic Selection Wizard is a tool that not only helps uncover interests but leads students to science project questions that are inquiry-based and practical. The Wizard covers six major science categories and 25 specific interest areas, a wide range that has something for every child. At Crestmont Elementary in Roseville, California, coauthor Barbara Messmer's fifth-grade students used the Wizard during weekly computer lab time in preparation for a science fair. First, children took the Science Interest Survey, which they each completed in an average of 10 minutes. The survey included 36 fun questions such as, "Are you interested in science fiction stories involving faster-than-light travel and 'beams' that do amazing things?" Then the Wizard presented each student with a custom-tailored list of suitable project ideas, complete with a key illustrating such aspects as difficulty level and safety, which each student reviewed for approximately 30 minutes.

There were two main results. First, 85% of the students found the core idea for their project using the Wizard. They successfully overcame the trickiest part of the science fair journey: starting out with a testable question. The other 15% of students felt committed to other topics that they discovered through interactions with family members or other experiences in their lives. Teachers had to work more diligently with these children to convert their interest areas into testable project idea questions.

Second, the children who used the website were passionate about their projects. Four of five children interviewed were excited to carry on with the same topics in the next fair.

## Science Project Timeline

**Key objective: Require work over the long term and assess project progress at key checkpoints along the way.**

In our schools, teachers guided children's science projects in class by assessing progress at key checkpoints along the way. Figure 1 is a synthesis of the schedules that they used and the one suggested by Science Buddies online.

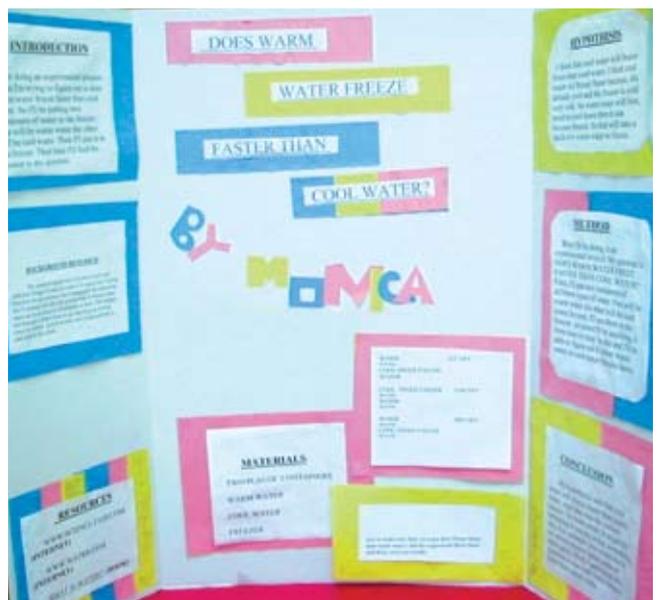
This strategy reduced the two project extremes: parent-generated masterpieces and slapdash night-before trifles. Overall, the timeline broke long-term science projects into manageable pieces. Teachers reviewed work at each step, so that students who were off track could start going in the right direction without wasting effort. For example, the timeline set an early deadline for students to develop a testable question. Teachers signed off on this key task early on, so that students could begin experimentation safely and with confidence that their experiments would relate to their questions.

As you are considering these checkpoints to teach the students, always keep your primary objective project safety. Assess safety when children decide on questions, when they write their experimental procedures, and when they bring display boards to the fair.



Science Buddies recommends that teachers evaluate a student's project against three tests of safety:

- Is it safe for other people or animals that are involved?
- If the student is going to another science fair after your own, does it meet the rules for that fair?
- Finally, has the student addressed all other safety concerns to your satisfaction? Make students themselves address safety issues in their project proposal, then you should evaluate:
  1. Where will the experiment be performed?
  2. What safety gear will be used?
  3. Who will be supervising the experiment? Do they have common sense and/or training in the procedures being used?



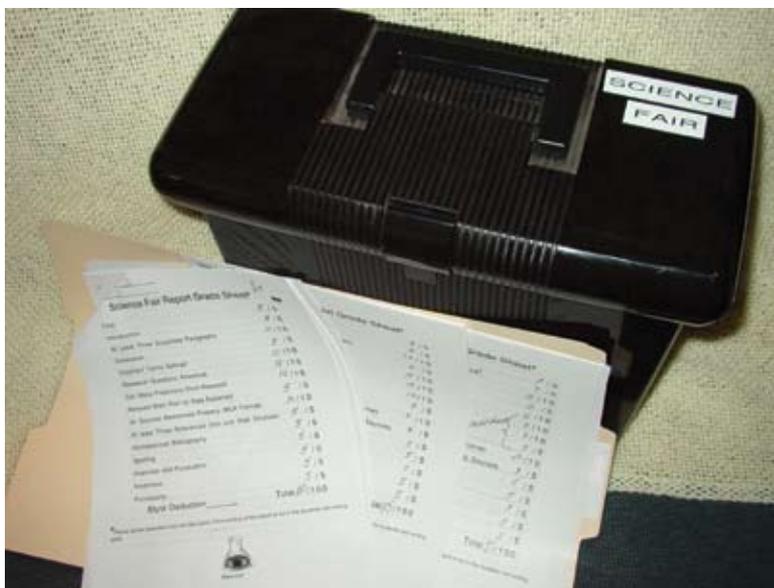
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Timelines and key checkpoints help ensure that students do project work themselves.

**Figure 1.**Science fair project timeline, from [www.sciencebuddies.org](http://www.sciencebuddies.org).

<b>Assignment</b>	<b>To Do or Read (Readings are in the Project Guide at <a href="http://www.sciencebuddies.org">www.sciencebuddies.org</a>)</b>	<b>Hand In (Worksheets are on the Teachers Resources page at <a href="http://www.sciencebuddies.org">www.sciencebuddies.org</a>)</b>	<b>Duration</b>	<b>Due Date</b>
Ask a question	Complete the Topic Selection Wizard ( <a href="http://www.sciencebuddies.org">www.sciencebuddies.org</a> ). Read "The Scientific Method." Read "Your Question."	Print the Topic Selection Wizard results for your teacher, or write down your project question. Fill in your Project Proposal Form.	2 weeks	
Do background research Part I: Collect information	Read "Background Research Plan." Read "Finding Information." Read "Bibliography."	Complete the Background Research Plan Worksheet. Complete the Bibliography Worksheet.	1 week	
Do background research Part II: Write your research paper	Read "Research Paper."	Write your research paper. Complete the Research Paper Checklist.	1 week	
Construct a hypothesis	Read "Variables for Beginners." Read "Hypothesis."	Complete the Variables & Hypothesis Worksheet.	1 week	
Test your hypothesis by doing an experiment Part I: Design an experimental procedure	Read "Experimental Procedure." Read "Materials List."	Write a materials list, including measurements. Write experimental procedure steps.	1 week	
Test your hypothesis by doing an experiment Part II: Do an experiment	Read "Conducting an Experiment." Repeat your experiment at least three times.	Write one paragraph describing your observations. Bring in the data that you collected in a data table.	2 weeks	
Analyze your data and draw a conclusion	Read "Data Analysis & Graphs." Read "Conclusions."	Make at least one graph. Write your conclusion.	1 week	
Communicate your results	Read "Display Board." Make the pieces of your display board: title, question, hypothesis, materials list, experimental procedure, data analysis, conclusions, and acknowledgements.	Display Board pieces, not yet attached to the board.	1 week	
Congratulations! It's time for the Science Fair			Total: 10 weeks	

Do you need to customize this timeline? Download it on the Teacher Resources Page at [www.sciencebuddies.com](http://www.sciencebuddies.com).



**Figure 2.**

**Black Box science project grading rubric.**

Name \_\_\_\_\_

Date \_\_\_\_\_

Science Fair Background Research Paper Grade Sheet

Title	/5
Introduction	/5
At Least Three Supported Paragraphs	/10
Conclusion	/5
Important Terms Defined	/10
Research Questions Answered	/10
Can Make Predictions from Research	/10
Relevant Math Plan for Data Explained	/5
All Sources Referenced Properly (MLA Format)	/10
At Least Three References (Not Just Web Sources)	/5
Alphabetized Bibliography	/5
Spelling	/5
Grammar and Punctuation	/5
Neatness	/5
Punctuality	/5
Style Deduction _____	/100

Points will be deducted from the total score if the wording of this report is not in the student’s own writing style.

Source: Crestmont Elementary, Roseville, California, Barbara Messmer

The Science Buddies website has additional information about safety, including more detail on the suggestions above, as well as guidelines for some special areas such as chemistry, microbiology, and rocketry.

**The Black Box of Project Improvement**

**Key objective: Develop a system that encourages students to continually improve and revise their projects according to provided rubrics.**

Crestmont Elementary fifth-grade students followed a timeline with a twist. They turned in assignments according to a timeline, but they also had the chance to redo key steps to improve their projects and grades at several points along the way. Their teacher encouraged them to keep improving their background research papers and final reports, and she kept a record of all of the drafts in a file box called the “Black Box.” The chance for improvement modeled the scientific process in the real world, where projects are never fully done and graded—and there are opportunities to loop back and improve.

The Black Box approach took place at two key phases during the projects: when students were researching and writing the background research paper (review of literature), and when students were compiling their final science fair project reports. The background research paper phase began in the second week of the two-month project, after students created a testable question, and it ended in the fourth week. All students turned in their first draft on a set due date. Then the teacher conducted the first round of project improvement by reviewing each draft using a score sheet (Figure 2) over a one- or two-day period. The teacher photocopied each draft and score sheet to document improvements in the student’s file folder.

Students then decided whether to improve their scores. Guided by teacher comments and where they were missing points, students did revisions in one or two days, and then the teacher repeated the steps above for each student submitting corrections. Students chose how many times they wanted to submit improvements and the target points that they wanted to earn. Students were accountable for their own results.

The next phase of project improvement occurred one week before the fair. Students brought in all of the sections of their final report. In this phase, the teacher completed a checklist of all of the different report sections, such as materials list and conclusion. Students provided missing items or fixed deficient items quickly, over one or two days, as most had their documents on computers. Although most students completed revisions in the one-week timeframe between turning in their final reports and attending the science fair, some students even had the chance to make further improvements after the fair.

A case study of how students improved their background research papers early in the process illustrates the effectiveness of the Black Box. Students fell into three groups. One group of students primarily made mechanical errors in grammar and spelling. Also, these students often failed to create the single most overlooked item of first drafts: a “math plan” for data analysis. For example, a math plan should indicate:

- What the student will measure
- How he or she will measure it
- That he or she will record measurements in a data table
- The number of trials planned
- What he or she will calculate, such as the mean of all of the measurements

In the second, most typical group, students persevered through up to three attempts at their reports over a one-month period. In a first draft, one student within this group had conducted detailed research on his topic, the effect of temperature on the bouncing of tennis balls. He had not made the leap to connect his research to an actionable experiment. The teacher determined that, although the student had done research on what makes balls bounce, he did not have an understanding of how to design an experimental procedure to test this.

Through the process, in second and third drafts, this student grounded his experimental procedure in research. After discovering that temperature would probably have an effect on bouncing, he wrote a paragraph about how he would heat and cool the tennis balls and how he would drop them from a consistent, controlled height. When planning data analysis, he decided to measure bounce height in a reliable way by creating a measuring board with lines. He set a goal to compare the data from three trials and calculate a mean. In a third draft, he perfected his writing and source citations. In the end, he improved his score by two letter grades, but more important, he learned to persevere to understand a topic.

In the third group, a small number of students had to revise their work significantly. These students had trouble picking questions that they could answer through investigation. They could not conceptualize how the data they were gathering would lead them to conclusions. After Black Box checkpoints, all were able to start with new topics and succeed in their second tries.

Apart from giving the students a structure to improve, Black Box records established to outside judges that the students really did their own work. As an additional assessment, all five fifth graders who went on to the district fair received medals. Two of the five fourth graders received medals. Going forward, teachers plan to refine the Black Box process by putting more emphasis on children’s initial experimental procedures so that they ensure early on that their experiments are practical and doable.

## After-School Project Clinic

**Key objective: Level the playing field for children who do not have access to knowledgeable mentors.**

At Valley Oak Elementary in Davis, California, children had a chance to reach their investigative potential by attending an after-school science project clinic. Science specialists Bill Storm and Sarita Cooper provided a diverse group of fourth- through sixth-grade students, most with socioeconomic disadvantages, with the extra support and mentoring needed to create and present successful inquiry projects at the mandatory science fair in their district.

In the first step, teachers approached the local university, University of California, Davis, to find student volunteers, including education students seeking internships as well as independent students seeking community service. Approximately 20 volunteers signed up to help these students. Before any volunteer recruitment and management effort, familiarize yourself with the safety rules, such as the need for background checks or supervision, of your school and district.



The second step was to find students requiring additional support. The science teachers polled all staff to gain insight as to students who needed academic or language support; required sponsorship for materials, including a display board; lacked support at home; or resided in group homes.

Counselors, English language teachers, classroom staff, resource teachers, psychologists, and speech therapists all worked to identify students in these categories. Science teachers also informed students that extra support was available, and a few additional students beyond those identified by staff came forward to participate. The

science teachers then asked for parental permission for the students to participate. In the end, around 30 students needed extra support out of a population of 360 students in the upper-elementary grades.

In the third step, science teachers provided structure for the enthusiastic university volunteers and students to work on their projects. For six weeks they worked one-on-one with elementary school students on Wednesday afternoons at the school. The mere presence of special people from the university encouraged students to participate in the after-school time. Volunteers used a six-week timeline of assignments and expectations to guide the students.

After students picked a question, the volunteers accompanied the students into the library to do research and to the computer lab to type elements of the project. Students and volunteers together especially enjoyed “shopping” for project materials in the school’s two science labs.

Throughout the process, volunteers and students benefited from school resources, such as a Spanish translation on the school website of all informational materials available, which included a letter to parents introducing the science fair, an assignment timeline, topic selection homework, a permission/sponsor form, a grading checklist, and project ideas.

The culmination came when the volunteers helped the students create their display boards, a task for which the program provided appropriate latitude. For example, some students presented display boards in their native language.

The main result of the program was that the volunteers helped students meet a key objective to gain public acknowledgement of personal work. At the fair, students had the chance to show their projects to the volunteers and their families. They saw for themselves that their work mattered to a larger community. These successes were the results of an entire school team getting involved in the science fair process, including resource teachers, paraeducator aides, English language teachers, after-school homework teachers, and volunteers.

## Pick One, and Get Going!

The ideas you choose to implement at your science fair depend upon the issues that are most salient at your school. For example, if your key issue is students needing basic resources to participate, then the After-School Project Clinic may be the most appropriate idea for you. If you are just starting a program, however, you might want to start with the Topic Selection Wizard and Science Project Timeline. Add the Black Box, the idea of improving continually when you have a year or two

## Connecting to the Standards

This article relates to the following *National Science Education Standards* (NRC 1996).

### Science Teaching Standards

**Standard A:** Teachers of science plan an inquiry-based science program for their students.

**Standard B:** Teachers of science guide and facilitate learning.

**Standard C:** Teachers of science engage in ongoing assessment of their teaching and of student learning.

**Standard D:** Teachers of science design and manage learning environments that provide students with the time, space, and resources needed for learning science.

**Standard E:** Teachers of science develop communities of science learners that reflect the intellectual rigor of scientific inquiry and the attitudes and social values conducive to science learning.

### Content Standards

#### Grades K–8

#### Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understanding about scientific inquiry

of experience. However and whatever you implement, there are resources available every step of the way to help you make the science fair at your school the valuable inquiry experience it can be.

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### Resources

- Fredericks, A.D., and I. Asimov. 2001. *Science fair handbook: The complete guide for teachers and parents*. Tucson, AZ: Good Year Books.
- National Research Council (NRC). 1996. *National science education standards*. Washington, DC: National Academy Press.

### Internet

- Science Buddies  
[www.sciencebuddies.org](http://www.sciencebuddies.org)