Science a-z

SCIENCE FAIR TEACHER'S GUIDE

GRADES 3–4

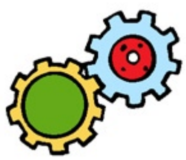
## INTRODUCTION

MORE

**Science Fair Resources on Science A-Z:**

- Science Fair Student Guide
- Science Fair Rubric
- Science Fair Project Ideas (for each unit)

It is never too early for students to become familiar with the steps of the scientific method, and science fair projects give students an opportunity to apply the power of that method to their own questions. Science fair projects provide an ideal opportunity for children to ask questions, and to explore ideas, materials, and outcomes using a formal process. The scientific method introduces cause-and-effect relationships, event sequencing, and logical-reasoning skills, as well as information-retrieval skills that are useful in all areas of the curriculum, including science. Perhaps most importantly, science fair projects allow students to generate authentic questions and investigate them using hands-on experimentation.



Students in grades 3-4 will likely need their teachers to model an investigation using the scientific method. Students should be actively encouraged to participate in this investigation before conducting one on their own. A guide showing the steps of the scientific method can be displayed for students to follow. As instructors model the investigation, they should make sure that each portion of the scientific method is introduced concisely and reviewed thoroughly. During each portion of the model investigation, safety must be emphasized as the number one priority.

## SCIENCE JOURNALS

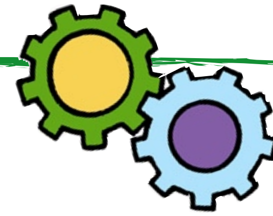
Good research habits can be introduced and encouraged with the use of a science journal. At first, the instructor may wish to use pieces of chart paper, which can later be bound into a "Big Book" to use as a model for future investigations. After the model research project has been completed, teachers can move to premade science journals, which help guide the students through each step and provide a space for writing, illustrations, and photographs. Later, students may use a composition book or spiral notebook and follow a step-by-step guide of the scientific method.

TIP The *Science Fair Student Guide* includes instruction on keeping a science journal.

## THE SCIENTIFIC METHOD

In general, the structure for most science fairs is the scientific method. While there are many variations, the basic organization is as follows:

1) Form a question
2) Conduct background research
3) State a hypothesis
4) Design an experiment to test the hypothesis
5) Conduct testing and gather data
6) Observe and interpret results



7) Draw conclusions
8) Report the findings in a display

The scientific method lays a foundation for scientific thinking and the pursuit of knowledge. It gives a basic structure to investigations and helps students learn to back claims with evidence. By testing theories and pursuing curiosity, students can feel more certain about something than by merely thinking or believing that it is so. As students grow, they may conduct more complex investigations. For first-time science fair participants, the traditional scientific method provides a solid foundation and guide.

The steps of the scientific method can be seen as the *minimum* steps students must follow. There can be variations. For example, students can be encouraged to make more than one hypothesis, perform multiple trials of the experiment, try several ways to investigate the same hypothesis, pursue a second research question once the first has been answered, or interpret and present data in multiple ways. In this guide, we present a suggested format that follows the scientific method to help guide students through a science fair project. Teachers are encouraged to modify it as they see fit.

The main sections of a science project are typically:

- Research Question and Purpose
- Hypothesis
- Materials List
- Procedures
- Results
- Conclusion

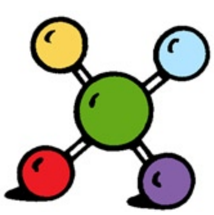
## RESEARCH PAPER

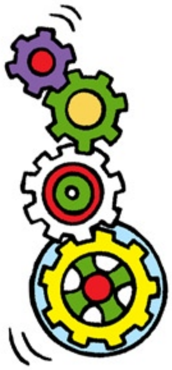
In addition to presenting the project on a display board, a research paper may accompany the project. This paper will often be placed on a table in front of the display.

TIP See the *Science Fair Student Guide* on Science A-Z for detailed information on helping students write a research paper.

## SELECTING A TOPIC

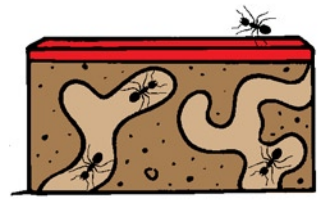
There are many available lists of possible science fair topics, including the *Science Fair Project Ideas* provided with each Science A-Z unit. While these lists serve a purpose as a starting point, they are not exhaustive lists of all possible areas of inquiry for students. A science fair is a chance to build on children's natural curiosity and to allow them to be self-motivated. What are their interests? What makes them curious? Students will generally be most motivated when they get to choose their own idea for a science fair project. And if the project will be entered in a competition, originality will be attractive to judges.





One effective way to help students pick a topic is to encourage them to list things they enjoy—foods, sports, games, and so on—and then ask questions about them. Instructors might write some common question starters on the board, such as:

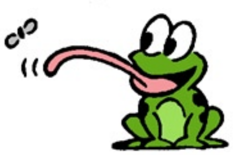
"What would happen if …"
"I wonder why …"
"How does …"
"Which …"



Students may need help in narrowing their choices to those topics that are testable and practical, given time constraints, availability of materials, and safety and ethical considerations (see below). Each student should get the teacher's approval before finally deciding on a topic.

## SAFETY AND ETHICS

A crucial point of emphasis should be made concerning safety and ethics with regard to science fair projects, particularly when involving human or animal subjects. During topic selection, students should keep in mind that they and any other live participants must remain safe and unharmed throughout the experiment. Many states have strict safety and ethics guidelines and require students to gain approval from review boards before engaging in certain types of research.



## MODELING SCIENTIFIC INVESTIGATIONS FOR STUDENTS

Before expecting students to conduct their own science fair projects, it may be useful for instructors to let the whole class participate in a group investigation. Some competitions even allow entries by large groups, which can lend extra motivation to doing a classwide model experiment.

### Research Question and Purpose

Teachers should begin by modeling how a research question and purpose are formed. "What works fastest at cooling off my mouth after eating spicy food?" "Which paper airplane will fly farther than the rest?" "What kind of juice will make my pennies the shiniest?" These are all examples of research questions that allow a student to collect information using hands-on experimentation. Projects that allow students to answer their questions through firsthand experimentation (versus research) are engaging and, as an added bonus, tend to be favored by judges in science fairs. Once a teacher has a small pool of questions to choose from, he or she should model how to decide on one question to research. For example, a teacher might say to the class, "I eat a lot of spicy food, and I think that it would be interesting to find out what cools off my mouth fastest. So I decided on the first question."

## Hypothesis and Background Research

Hypotheses for this age group should include reasoning based on prior knowledge and research. For grades 3–4, this background research may be simple and include one to three sources. The teacher may model research collection using books or encyclopedias from the library, or Web-based sources. For this age group, collecting between ten and fifteen facts relevant to the research question is appropriate. Each fact may be written on an index card with the source written on the back (if using multiple sources). These facts can then be easily arranged and written up as background research. Such facts may include the results of previous studies as well as background information about the topic. For example, many studies have been done to answer the research question, "What works fastest at cooling off my mouth after eating spicy food?" Results from one or two of these studies, plus a few facts on what makes foods spicy, would provide enough background research to create a hypothesis.

Having collected background research, the teacher should model how to write a hypothesis. For grades 3–4, the standard definition of a hypothesis as an "educated guess" is appropriate. Even after conducting background research, it is suggested that teachers have the materials gathered and displayed, as it will help make generating a hypothesis easier and more real for students in grades 3–4 if they can see and touch the materials. Suggested formats include "If … then … because …" or "I expect … because …."

The teacher should ask students to help generate hypotheses for the model lesson. An example of a thorough hypothesis that a fourth grader might write is, "If I bite a pepperoncini, whole milk will work the fastest at cooling off my mouth, because the fat and protein in the milk will wash away the oils from the spice."

TIP For more resources on hypotheses, visit the Process Science page on the Science A-Z website.

## Materials List

Students can help list the items that will be needed during every part of the model investigation. The list may grow once testing begins and other materials are needed. Teachers should model how to write this list, including checking the material labels or dictionary for correct spelling.

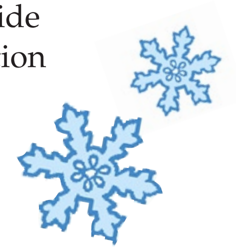
Materials are often listed in the order they will be used.
Here is an example of a materials list:

- 4 glasses
- Measuring cup
- Tap water
- Lemonade
- Skim milk
- Whole milk
- Large pepperoncini
- Plate
- Knife
- Camera

## Procedures

At this point, the teacher should give the class some background in creating and following procedures. Procedures may be defined very simply as steps to follow during an experiment. A classic lesson for teaching students procedures is "How to Build a Peanut Butter Sandwich," during which time the teacher follows student directions exactly, until they understand the importance of giving and following step-by-step procedures.

Next, teachers should model how to create the Procedures section of the science project. It would be helpful to have "Step 1, Step 2, Step 3 …" already bulleted on chart paper or on the board as a visual guide for students to follow. Here is an example of a procedures section for the sample experiment:



Step 1: Gather all materials.

Step 2: Label each glass.

Step 3: Measure 1 cup of tap water, lemonade, skim milk, and whole milk into each of the glasses.

Step 4: Carefully cut the pepperoncini. Remove the seeds. Cut the skin into 12 equal portions and place on plate.

Step 5: Take the first piece of pepperoncini and chew it three times.

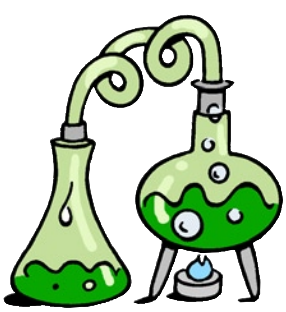
Step 6: Drink the entire cup of water. Wait for ten seconds. Rate the spiciness left in mouth on a "hotness scale."

Step 7: Wait for ten minutes.

Step 8: Repeat steps 5–7 using the lemonade, skim milk, and whole milk.

Step 9: Wait for ten minutes.

Step 10: Conduct two more trials. Repeat steps 5–7 using water, lemonade, skim milk, and whole milk.



Teachers should explain the importance of making everything in an experiment the same (constant) except for one thing—the variable. Students may need the words *constant* and *variable* explained. One might ask the students, "Would it be a fair experiment if one bite of pepperoncini had ten seeds, but the next had none?" Also, students may not intuitively know how or why to use tools such as a measuring cup, scale, or ruler; this must be modeled and explained.

TIP For a variety of instructional materials on science tools, visit the Process Science page on the Science A-Z website.

## Results

Once the research question and purpose have been written, a hypothesis made, materials gathered, and the procedures written and reviewed, the instructor is ready to model the investigation. Before beginning to follow the procedures, however, the instructor should model how results will be measured. For example, will centimeters be used if the investigation measures plant growth? If so, the proper use of a ruler must be taught and practiced. Or if investigating the question, "What works fastest at cooling off my mouth after eating spicy food?" a scale could be created to assess "hotness."

It is also important for the instructor to model following the procedures step-by-step to encourage consistency. Some investigations will call for incremental data collection while others need only final results. Following the above procedures, the class can collect the results for the spicy food investigation in one day, using ten-minute intervals until three trials have been completed. Data might also be displayed visually, such as on a bar graph. In addition to the bar graph, the student who bit the pepperoncini might share the differences that he or she observed between each of the beverages; these differences could be recorded in the class's science journal.

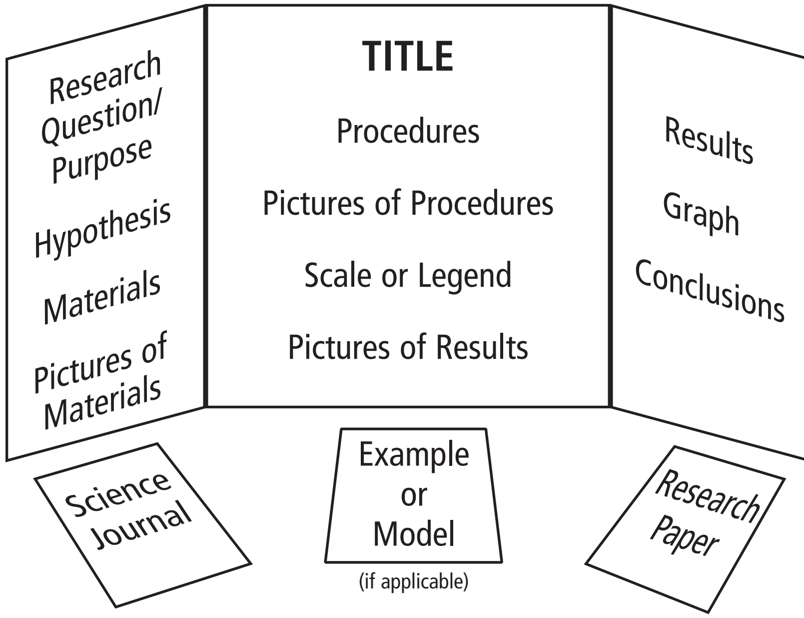
## Conclusions

Conclusions typically consist of whether the hypothesis was proven or disproven, what was learned, and what would be done differently if the study were to be repeated. Students should be encouraged to include new and unanswered questions, and to pursue these questions in later investigations. The instructor may need to help students with the terms "proven" and "disproven," and model how to write phrases such as, "My hypothesis was disproven. Skim milk and whole milk worked equally well at cooling off my mouth after biting a pepperoncini." Students might be asked to help the instructor brainstorm a list of things that were learned during the study, as well as how to change or add to future studies.

## Creating the Display

After the class completes the investigation, the instructor should model how to create a display board.

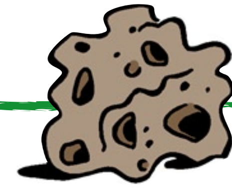
Most science fairs have rules for displays. Size of the display board is often regulated. Photographs of people's faces are usually not allowed. To discourage judge bias, student names are also generally not allowed on the front of display boards. Presentation styles may vary from one project to another. One format is illustrated on the following page.




When creating a model display board, the instructor should be careful to point out tips for making the display eye-catching. Bright colors; consistent, large, and easy-to-read fonts; clear graphs/charts/tables; and interesting photographs, pictures, or illustrations all draw a judge's attention. Having a neat, proofread, and orderly science journal available in front of the display board is also important. Making sure that the display board, science journal, and research paper are easy to read and enjoyable to look at helps the teacher or a judge maintain interest as he or she examines the content of the investigation.

## SMALL GROUP PRACTICE

Once the instructor has modeled the elements of a successful science fair project enough to know that students are comfortable with the process, it may be helpful to allow students to complete an investigation in a small-group setting. Each group may be assigned a simple research question or may choose one from a short list supplied by the instructor. Although students will be working in small groups, it is advisable that the entire class work on only one or two different questions at this time. Working in small groups will allow students to use one another's knowledge as a resource as well as provide the instructor time to troubleshoot and answer questions as he or she rotates to each small group. Working in a group will also provide students with a support system when it is time to present their projects to the class.



## INDEPENDENT PRACTICE

Once students have completed a project in a small group, it is time for them to begin an independent science fair project. If the project is to be completed at home, the instructor should send home a packet for students and parents to use as a reference. Science A-Z offers a cover letter to families, step-by-step instructions, a project timeline, and rough draft worksheets in the *Science Fair Student Guide*. Science A-Z also provides a *Science Fair Rubric*, which lists criteria and includes a scoring form.

If creating a customized packet to send home with students, it should include:

- A rubric or list of judging criteria
- A list of due dates, including class presentation dates
- A list of sample science fair research questions appropriate for the grade level
- An explanation of the science journal and what must be included
- A step-by-step guide for the research paper that explains the scientific method. It should clearly state each step that students must complete, and the due date for each step. It is recommended that the packet require a parent signature after each step is completed. This guide may be used as a rough draft. Once the teacher reviews and returns each page, it may be transcribed into the science journal.
- A list of science fair rules and deadlines
- A clear picture of a sample completed display board, as well as tips on where to buy a science fair display board

## REFLECTION

After the completion of the science fair project, it is important for students to reflect on their experience. Instructors may want to hold discussions—with the whole class, small groups, or individuals—to review the process of completing a science fair project. What was learned? What challenges had to be overcome? What new questions arose? How will this experience affect the next science fair project in which students participate? These questions and more can serve as valuable writing prompts as well.

## SUMMARY

Providing opportunities for students to create science fair projects encourages children to explore their own questions through structured investigation. It can be useful to guide students in grades 3–4 through a whole-class model investigation and to provide the chance to work through a project in a small-group setting, before expecting students to be able to complete a successful science fair project on their own.