Science Fair Guide

RESOURCES FOR TEACHERS

Hands-on Science

The most obvious goal of a science project is to extend a student's understanding of science. Science is hands-on by nature, and there is no doubt that hands-on experiences facilitate the learning process. The scientific method allows scientists to collect and analyze data in a strategic and unified manner. When students use the scientific method to design and execute a project, they use the same steps professional researchers use to gather new information.

Building Scientific Confidence More importantly, science projects make science more fun and relevant to the student. Every student, regardless of aptitude, can benefit from planning and executing an inquiry-based science project. A science project can be a great way to spark a student's interest in science or to help a student develop a broader interest in research.

Philosophy of Science Fairs

Science fairs range in scale from a single class of students sharing their projects to an international event offering scholarship money as prizes. From the largest science fair to the smallest, science fairs generally share a common philosophy and similar values:

- emphasis on using the scientific method
- investigation by experimentation (inquiry-based learning)
- development of critical thinking skills
- opportunity for a positive learning experience
- extension of formal science education

How to Use This Guide

While a science project is entirely the product of a student's ingenuity and work, motivation from teachers and parents is invaluable. The *Science Fair Guide* leads teachers, parents, and students through the process of developing a science project.

What's in This Guide Using the scientific method, this guide divides the science project into five phases:

- Phase 1: Generating an Idea
- Phase 2: Research and Planning
- Phase 3: Data Collection and Analysis
- Phase 4: Writing a Report
- Phase 5: Creating and Exhibiting a Display

For each phase, you will find a set of management tips for teachers, an instruction worksheet for students, and a handout encouraging parental involvement. This guide also provides three progress reports, allowing each participant—the teacher, the student, and the

parents—to monitor the student's work. Also included are sample timelines, rubrics, and safety guidelines. For additional resources on ideas and equipment, see pp. 28–29.

Rules, Rules, Rules Often a school will conduct its own science fair. The winners of the school science fair may enter a citywide science fair, and the winners of a citywide science fair may enter a regional science fair. Before assigning the project, consider whether your students should prepare their science project to meet the requirements of subsequent science fairs.

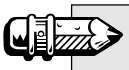
Regulations vary from science fair to science fair and even from year to year, so it is essential to contact the science fair sponsors for current listing of rules and regulations. Some science fairs have registration fees and cutoff dates, lists of materials that students are not permitted to use, and requirements for reports and displays. It is extremely important to be prepared with the necessary information before assigning a science project.

Getting Started

Before you begin Phase 1, complete these steps using the strategies that follow.

1. create a timeline
2. send home a parent letter with a safety guide, a safety contract, and a copy of the timeline
3. hand out Resources for Students and get students excited about the science fair
4. send home Resources for Parents and explain how parents should use the progress reports

1. **Timelines** Your first step is to create a timeline that will allow plenty of time for students to develop a project that is suitable for entering the chosen science fair. If students are participating in a national science fair, their projects will be more involved, requiring more teacher and parental guidance. On the next few pages, you will find sample timelines for a 4-week schedule (page 5), an 8-week schedule (pp. 6–7), and a blank timeline (page 8) that allows you to create a schedule tailored to your students' needs. Distribute this timeline to both parents and students, letting them know in advance what their responsibilities will be.



SCHEDULING TIP

On the timeline, having Monday as a completion date for each assignment will allow parents to help their child over the weekend with library trips, data collection, and other parts of the project.

2. **Prepping Parents** After you have notified the students of the upcoming activity, you are ready to prepare the parents. You may choose to send them a notice 1 or 2 weeks before you make the first assignment. Include the timeline, which identifies the date

of the science fair and describes when assignments are due. Also include the Safety Guide (page 33) and Safety Contract (page 34) for parents to read with their child in preparation for the experiment. Below is a sample letter.

 You can find this letter on the *One-Stop Planner CD-ROM*.

Dear Parent or Guardian,

In the next few weeks, your son or daughter will begin a science project in our science class. The science project's objective is to give every child hands-on experience using the scientific method. In addition, each student will have the opportunity to independently research a topic of his or her interest. You can help motivate your son or daughter by taking an interest in the project.

Your child will have an opportunity to enter his or her science project in the science fair, which takes place on _____. The emphasis of our project is not on winning, but on having positive learning experiences and having fun.

I am including with this letter a copy of a timeline for our class projects, a safety guide, and a safety contract. Please go over the safety guide with your child, and have him or her return the signed contract. An information packet for parents will be arriving shortly to keep you informed about how you can best assist your child with his or her project. Thank you for your help.

Sincerely,

3. **Motivating Students** Next, you will want to discuss with students what a science fair is and get them excited about the event. When you introduce the science fair, give the students their instruction worksheets (Part 2: Resources for Students). You can either hand out Resources for Students in its entirety or as individual worksheets as the class begins each phase. Either way, make sure students are aware of the due dates for their assignments. Also, be certain that they clearly understand the safety guidelines they are expected to uphold. Distribute the Student's Progress Reports (pp. 35–36), and explain how they will be used.
4. **Request Back-up** Finally, send home the parent information packet (Part 3 of this guide) so that the parents are prepared to help with each phase of the student's work. Be sure to explain how they can use the Parent's Progress Report (pp. 65–66) to guide their children. You will find more about how to use the progress reports in the Evaluation section of this guide (page 11).

Timeline for a 4-Week Science Project

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Week project is assigned						**Phase 1** Brainstorm ideas in school and at home over weekend	
Week 1		Library research day	Develop investigative question Student-teacher meetings to confirm topic Develop hypothesis		Check progress report—end of Phase 1	**Phase 2** Library research day Reconfirm hypothesis with teacher	
Week 2			Check progress report—end of Phase 2	**Phase 3** Brief safety reminder	In-class data collection		
Week 3		In-class data collection and analysis	Check progress report—end of Phase 3 **Phase 4** Begin outline	Outline due Begin written report		In-class draft check	
Week 4		Written report due	Check progress report—end of Phase 4	**Phase 5** Reminder of display requirements	Display due Oral presentation, practice for interview Check progress report—end of Phase 5	**Science Fair!**	

Timeline for an 8-Week Science Project

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Week project is assigned						**Phase 1** Brainstorm ideas in school and at home over weekend	
Week 1		Library research day			Develop investigative question Student-teacher meetings to confirm topic Develop hypothesis		
Week 2		Check progress report—end of Phase 1	**Phase 2** Library research day	Reconfirm hypothesis with teacher			
Week 3				Library research day			
Week 4			Check progress report—end of Phase 2	**Phase 3** Brief safety reminder		In-class data collection	

Timeline for an 8-Week Science Project, continued

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Week 5			In-class data collection			In-class data collection and analysis	
Week 6			Check progress report—end of Phase 3	**Phase 4** Begin outline		Outline due Begin written report	
Week 7			In-class draft check			Writen report due	
Week 8		Check progress report—end of Phase 4	**Phase 5** Reminder of display requirements		Display due Oral presentation, practice for interview Check progress report—end of Phase 5	**Science Fair!**	

Create Your Own Timeline

	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Week							
Week							
Week							
Week							
Week							
Week							
Week							
Week							

Evaluation

The science projects will likely be evaluated twice: first by you for a grade and second by the judges at the science fair. Setting your evaluative criteria to reflect the criteria the judges hold for a competitive project will be helpful for students who are entering the science fair. Students can then use your evaluation to improve the project before presenting it to the judges.

What the Judges Are Looking For

Because science fairs vary widely, it is of the utmost importance that you familiarize yourself with the specific judging criteria of a particular science fair. Many science fairs judge entries using the following criteria:

use of scientific thought	30%
creativity of approach	30%
thoroughness of investigation and research	15%
skill of experimental technique	15%
clarity of expression in presentation and report	10%

Other Considerations

The following are suggestions for evaluating a student project or predicting how a judge will evaluate a project:

- Besides assessing the five categories that appear above, some science fairs reward memorable presentations or displays.
- A science project should have a clear hypothesis, research plan, and conclusion.
- Many science fairs will not accept models or demonstrations, only experiments that follow the scientific method.
- Simple library research or an unplanned experiment is not acceptable.
- The student should design a controlled experiment.
- Judges typically evaluate projects using a rubric.
- Projects should be assessed against the other projects in the science fair or competition, as opposed to being judged against an ideal.
- Judges at most science fairs will be asking themselves how they would approach the investigative question and whether they would draw the same conclusions the student did.
- Creative use of materials should be considered.

Student Understanding The student's work should be evident in the project. The scientific process and the manner in which the research was conducted tend to outweigh the actual display of information. The judges will be looking carefully to see that the student

has an understanding of his or her project and is responsible for the final product. In a group project, the judges will be looking for evidence that each group member completed specified tasks that furthered the progress of the group.

Tailoring Evaluation to Criteria of a Particular Fair Each science fair differs in the types of science projects that qualify for entry. Some strictly require that students perform experiments that follow the scientific method rather than perform demonstrations of scientific principles. Other science fairs accept inventions, scientific models, engineering projects, and informative exhibits. For instance, Invent America, a nonprofit K–8 educational program, holds a national contest in which students can enter inventions that solve everyday problems. The resources in this guide are tailored for experimental science projects. If you choose to broaden the scope of the projects that you accept, be sure to inform your students and their parents.

Display Regulations

Although the display may not be an important part of your evaluation, the judges will evaluate it. Rules regarding acceptable display materials vary. Most science fairs have a long list of items that are unacceptable for display. Restricted items can include everything from living organisms to any chemical, including water. It is also important to verify the parameters for displays. For example, some science fairs limit the size of displays to 76 cm deep, 122 cm wide, and 274 cm high, including the height of the table supporting the display. Be sure students have the list of unacceptable display items and the required display parameters at the time the projects are assigned.

The Poster Session Preliminary judging sometimes includes a "poster session" in which no electrical power is provided for the displays. The purpose of this session is to maintain the focus on the creative and scientific aspects of the project and to decrease the impact of a fancy display.

What to Look For

Positive Learning Many students do not feel like they can win and therefore become discouraged about participating. Emphasize healthy competition and a positive learning experience over simply winning. Participating in a science fair allows a student the opportunity to take charge of his or her own learning experience and to explore something that interests him or her. To emphasize positive learning, your evaluation can focus on the student's use of the scientific method and the amount of effort he or she put into the project rather than the student's ability to win a science fair.

Rubrics You may find that some students excel at developing a scientifically sound experiment yet are not as talented at expressing what they have learned. Others have good oral and written skills but do not have a firm grasp of the scientific method. Since both the development process and the clear expression of ideas are important aspects of a competitive science project, it may be best to focus on

these skills in separate evaluations. For this reason, you will find included in this guide one rubric that emphasizes the development process and another that emphasizes the final report and display. You can use these together, or you may choose to develop your own rubric using the Create Your Own Rubric found on page 14.

Additional checklists and rubrics can be found on the *One-Stop Planner CD-ROM*.

Progress Reports

Many students find it difficult to keep track of all of the tasks required in a project that lasts several weeks. To help you monitor student progress, you will find a Teacher's Progress Report on pp. 15–16. You may choose to use this as a checklist to determine whether or not a student performed each assigned task on time.

Student's Progress Report Maintaining the Student's Progress Report (pp. 35–36) may help your students better understand their responsibilities. The Student's Progress Report lists the tasks required in each phase of the science project, giving students a better understanding of what the judges may be looking for as well as what you expect of them. The Student's Progress Report also can serve as a handy checklist to remind students what to do next.

Parent's Progress Report A Parent's Progress Report is also included in Resources for Parents on pp. 65–66. Parents may find the progress reports useful if their child requires help with long-term organization and keeping track of responsibilities.

Progress Reports and Evaluation You may wish to include the results of all three progress reports in the final evaluation. This approach will reward students who carefully planned their science project and spent time developing each phase. Including the progress reports in your evaluation will discourage students from waiting until the weekend before the science fair to prepare the entire science project. However you choose to incorporate the progress reports into your evaluation, be sure to make both students and parents aware of the intended use of the progress reports.

Group Projects

You may choose to let your students work in groups. If this is the case, assign the groups before beginning Phase 1. For progress reports, you may still want to evaluate students on an individual basis. Making this clear at the beginning of the project may encourage participation from students who tend to let the others do the work. Consult *Holt Science & Technology Assessment Checklists & Rubrics* for a sample teacher evaluation of a cooperative group activity.

Science Project Development Rubric

This rubric focuses on the development process (planning, research, and data collection) of a science project.

Possible points	Use of Scientific Method (40 points possible)
40–31	Student designed an experiment with clear control and experimental groups that effectively tested a hypothesis.
30–21	Student designed an experiment with control and experimental groups that adequately tested a hypothesis.
20–11	Student designed an experiment with control and experimental groups that were related indirectly to the hypothesis.
10–1	Student designed an experiment that did not effectively test a hypothesis and had inadequate control and experimental groups.
	Thoroughness of Research and Data Collection (40 points possible)
40–31	Student thoroughly researched topic, collected data with care and precision, recorded all observations and sources in a science project journal, and achieved a high level of detail.
30–21	Student researched topic well, collected data with care but lack of precision, recorded most observations and sources in a science project journal, and achieved moderate detail.
20–11	Student adequately researched topic, collected data imprecisely, made a fair attempt to record observations and sources in a science project journal, and achieved average detail.
10–1	Student poorly researched topic, collected data inappropriately, and made a poor attempt to record observations and sources in a science project journal; research lacked detail.
	Originality of Approach and Use of Equipment (20 points possible)
20–16	Student adopted an original, resourceful, and novel approach and had creative design and use of equipment.
15–11	Student extended standard approach and use of equipment and exercised moderate creativity.
10–6	Student employed standard approach and use of equipment and exercised little creativity.
5–1	Student used equipment and topic in an ineffective and unimaginative way.

Science Project Presentation Rubric

This rubric focuses on the final written report and display of a science project.

Possible points	Understanding and Scientific Thought (40 points possible)
40–31	Student completely understands the topic and uses scientific terminology properly and effectively.
30–21	Student demonstrates solid understanding of the topic and adequate use of scientific terminology.
20–11	Student displays insufficient understanding of the topic and uses very little scientific terminology.
10–1	Student lacks understanding of the topic and incorrectly uses scientific terminology.
	Quality of Oral/Written Presentation (32 points possible)
32–25	Student exhibits an original, resourceful, and novel approach to presentation of topic; paper is creatively and clearly written.
24–17	Student presents topic with standard approach; writing is unimaginative but effectively gets point across.
16–9	Student's presentation of topic is incomplete and unimaginative; writing lacks clarity.
8–1	Student's presentation of topic is ineffective and lacks cohesion; paper lacks clarity and is poorly written.
	Effectiveness of Exhibit or Display (28 points possible)
28–22	Layout is logical and imaginative and can be followed easily; student displays creative use of materials.
21–15	Layout of exhibit is acceptable; student demonstrates proper use of materials.
14–8	Layout lacks organization; student exhibits poor but effective use of materials.
7–1	Layout is difficult to understand; student uses materials poorly and ineffectively.

Create Your Own Rubric

Possible points	Criteria

Name _____ Date _____ Class _____

Teacher's Progress Report

❑ individual project ❑ team member

For each step of each phase of the science project, record the task due date and the date the student accomplished the task.

Phase 1—Generating an Idea	Date due	Date accomplished
Student brainstormed five possible subjects.		
Student came up with two investigative questions for each topic.		
Student consulted with teacher and parents about project possibilities.		
Student chose a suitable topic.		
Student formed a hypothesis.		
Student discussed topic and hypothesis with teacher and gained approval.		
Student recorded ideas in science project journal.		

Phase 2—Research and Planning	Date due	Date accomplished
Student researched the hypothesis.		
Student reconfirmed or changed the hypothesis based on further research and then gained teacher approval.		
Student contacted all appropriate people before beginning data collection.		
Student recorded all details of research so far in a bibliography in the science project journal.		
Student filled out the Procedural Plan for Action and obtained necessary signatures.		
Student developed the initial plan for display materials.		

Teacher comments:

_____

_____

_____

_____

Name _____ Date _____ Class _____

Teacher's Progress Report, continued

Phase 3—Data Collection and Analysis	Date due	Date accomplished
Student conducted the experiment safely.		
Student chose an appropriate sample size.		
Student performed several trials of his or her experiment.		
Student collected data accurately.		
Student recorded all data and observations in the science project journal.		
Student graphed or charted data and looked for trends.		
Student prepared a written conclusion supported by the data.		

Phase 4—Writing a Report	Date due	Date accomplished
Student answered the questions on page 55.		
Student prepared an outline and discussed it with the teacher.		
Student prepared a draft and discussed it with the teacher.		
Student revised the draft according to the teacher's feedback.		
Student turned in the final draft of the written report.		

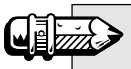
Phase 5—Creating and Exhibiting a Display	Date due	Date accomplished
Student sketched possible designs for display.		
Student created a display board within the appropriate parameters.		
Student displayed the results in a clear and interesting manner.		
Student gave an oral presentation as practice for the science fair interview.		

Phase 1—Generating an Idea: Management Tips

DURING THIS PHASE, STUDENTS WILL

1. brainstorm five possible subjects
2. come up with two investigative questions per topic
3. consult with teacher and parents about project possibilities
4. choose a suitable topic and investigative question
5. form a hypothesis
6. discuss topic and hypothesis with the teacher and gain approval
7. record ideas in their science project journal

Begin by distributing the Phase 1 packet to students and parents. Check the timeline and schedule library visits and individual meetings with students.



TIP

Throughout the course of the project, and especially during the beginning stages, emphasize that one of the main goals of the project is to have fun. Healthy competition can be exciting, but the purpose of a science project is to learn about science through inquiry in a hands-on experiment.

The Journal: An Important Tool Resources for Students periodically reminds students to enter information in their science project journals. Students will need their science project journals as soon as they begin Phase 1. They may use a spiral bound notebook, or they may choose to make a journal by stapling together ruled paper or graph paper.

Explain to students that this journal is an important tool that they will use in every phase of the science project. For instance, they will write in their journal all of the notes that they take while brainstorming and researching. They will also record all data, observations, and calculations in their journals. This way all of the information needed for writing a report and preparing a display will be in one place. For group projects, every team member must keep a science project journal containing their notes and data.

Brainstorming for Topics

Students often find that coming up with a suitable idea is the most challenging part of a project. Encourage students to brainstorm and to be creative. Trying to come up with new ideas can be difficult and sometimes embarrassing for sensitive students. Make sure they feel free to record any idea, no matter how odd it seems at first. Familiarize yourself with the students' packets to help them. If you know of a subject that a student is particularly interested in, offer ideas related to that topic.

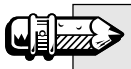
Caution: *Be careful not to take over the brainstorming process for students.* Avoid assigning topics. Unless a student finds something that interests him or her, he or she may have a difficult time putting forth the effort necessary to completing a project.

Suggesting Ideas For students who have trouble coming up with science project topics, try the following:

- Provide your students with a list of projects that previous students have successfully completed.
- You may also decide to list some projects that did not work out as planned. Explain why the projects were unsuccessful (too involved, too expensive, not enough time, etc.).
- *Holt Science & Technology Long-Term Projects & Research Ideas* contains several ideas that may be developed into science projects.
- Resources for Students mentions several topics for science projects.
- The Additional Resources section of this booklet also provides a list of books with ideas for science projects (see pp. 28–29).

Forming Investigative Questions

Require that all students generate at least two investigative questions for each of five topics. If they have 10 investigative questions to choose from, chances are good that they will be able to settle on a viable investigative question.



TIP

The timelines and Resources for Students suggest a library trip early in Phase 1, after a student has brainstormed for topics. Before or during the scheduled library trips, brief students on how to use library resources.

Strengthening Research Skills For students who require additional help with researching topics, use the following worksheets from *Holt Science & Technology Science Skills Worksheets:*

- Worksheet 17: Organizing Your Research
- Worksheet 18: Finding Useful Sources
- Worksheet 19: Researching on the Web

The Teacher-Student Meetings

This is the best time to meet with students individually to ensure that they are on the right track. Discuss their project options, and help them decide which investigative question they will choose. Steer them away from projects that would exceed a reasonable budget or projects that may risk disqualification. During the meetings, it would be helpful for you to have a copy of the science fair rules handy to point out problems that may make a particular project difficult. For example, many science fairs prohibit the display of chemicals. A student may be allowed to perform a supervised procedure with chemicals during the data collection phase of the project, but the rules prohibiting chemicals would limit the display.

Forming a Hypothesis

When students have chosen their topics, it is time for them to form a hypothesis. Having researched their topic thoroughly, students are now able to make an educated guess that answers their investigative question. Make sure students understand the scientific method. Emphasize that they will not design an experiment in order to yield results that *support* the hypothesis they have formed. Instead, they will design an experiment to *test* the hypothesis. There is often great pressure to be right about the hypothesis, but that is not the point of a science project. The purpose is to discover whether the hypothesis is supported or disproved by the experimental results. The quality of the project is independent of the accuracy of the hypothesis.

✓ At the end of Phase 1, make sure you are still following the timeline. Check students' progress on their Student's Progress Report and Parent's Progress Report.

Phase 2—Research and Planning: Management Tips

DURING THIS PHASE, STUDENTS WILL

1. research the hypothesis

2. change or reconfirm the hypothesis with the teacher

3. contact all appropriate people

4. record all research sources in their science project journal

5. fill out the Procedural Plan for Action and obtain signatures

6. develop the initial plan for display materials

Research

You may feel it is necessary to give students a further lesson on Internet research or library research. The library may have a list of useful sources that students can refer to while planning their experiments. You may wish to meet with the librarian to discuss what the students will be researching so that he or she can prepare for the class visit. Also, Additional Resources (page 29) provides a list that includes books about developing science projects. Remind students to record all research in their science project journals.

Students may wish to obtain information using other methods, such as seeking an interview with a scientist or writing a letter to a company. Encourage students to contact all sources early in Phase 2 in order to allow plenty of time for a response. The student packet includes a sample letter for students who wish to contact someone about information needed for their science project.

Bibliography Make sure students are familiar with the style of bibliography that you require. Resources for Students encourages students to record all sources used, including interviews, in their science project journals. Recording all sources during the research phase will give students a head start on the bibliographies that they will need for the written report and the display.

Procedural Plan

Students will plan how they are going to test their investigative questions. Their packets include a brief discussion of control groups versus experimental groups and dependent variables versus independent variables. You may want to discuss these terms further in class. Once each student has an idea of how to scientifically test his or her hypothesis, you may require students to fill out the Procedural Plan for Action (page 47) and the Task List (page 48).

Caution: *Watch for projects that will require too much time, money, or effort.* Now is the time for the student to determine whether the procedural plan for an experiment exceeds budget or time limits. At this point, it would not be too late for a student to choose a different topic. However, changing a project any later than this stage may pose a problem in meeting the deadlines on the timeline.

Obtaining Equipment and Materials

Cutting Costs Remind students to keep cost and availability of materials in mind when planning a project. Some ideas require more resources than are available within a limited budget. Not all expensive ideas need to be discarded. Encourage students to come up with less expensive ways to conduct their experiment or ways to perform a similar yet less costly experiment within the chosen topic. For prices and availability of materials, provide students with a list of local businesses that carry scientific and laboratory supplies (see page 28).

After students have chosen a hypothesis and planned their project, it is important to anticipate costs. When preparing a budget, a student should consider the following expenses:

- Science fair entry fee
- Science fair travel expenses
- Library trips
- Book purchases
- Journal purchase
- Materials necessary for experimentation
- Materials necessary for display

Creativity Counts Judges often take creative use of materials into account when judging a science fair; a student who has built a barometer will likely be recognized as more motivated than a student who purchased one. In other words, high-dollar projects will not be recognized as better just because they employ fancier equipment. The library and Internet may provide resources with suggestions on how to make equipment using inexpensive materials.

Outside Sponsors Also, many businesses and institutions will lend equipment to young scientists. Encourage your students to write to such businesses for help in obtaining expensive equipment or materials for their science projects. Be sure that the schedule allows enough time for students to receive a response. (This approach to procuring equipment works best with an 8-week timeline.)

MONEY-RAISING IDEAS

The following are a few ideas for raising funds to help defray science project expenses:

- A local business may be willing to act as a monetary sponsor in exchange for an advertisement at the event or in the event program.
- Schools participating in science fairs may hold raffles to raise money for projects.
- Parents may be willing to donate materials (or time) to support the science fair.

✓ At the end of Phase 2, make sure you are still following the timeline. Check students' progress on their Student's Progress Report and Parent's Progress Report.

Phase 3—Data Collection and Analysis: Management Tips

DURING THIS PHASE, STUDENTS WILL

1. conduct experiments safely
2. choose an appropriate sample size
3. perform several trials of the experiment
4. collect data accurately
5. record all data and observations in their science project journal
6. graph or chart the data and look for trends
7. prepare a written conclusion supported by the data

Safety First! Safety is of particular concern during the data collection phase. The timelines allow one class period for a brief review of safety before students begin collecting data. The in-class data collection days give you a chance to supervise safety. Remind students to have an adult supervise all data collection at home.

In-Class Data Collection

The following tips may be helpful during in-class data collection:

- Take a moment in class to review the difference between qualitative data and quantitative data. Go over with your students the kinds of projects that call for each type of data.
- Make sure that students understand the importance of using an adequate sample size, as discussed in Resources for Students on page 50.
- Explain that in order for data to be valid, a researcher must perform several trials of an experiment.
- Watch to see that students measure accurately. (You may choose to distribute the SI Unit Conversion Chart on page 30.)
- Check students' science project journals to make sure that they keep a neat record of all aspects of the project.
- If a student's project does not lend itself to collecting data in class, ask the student to bring in a book he or she is reading for continued research so that class time will be used effectively.
- Students who have collected all the data they need can use the in-class data collection days to work on analyzing the data.

Strengthening Data Collection Skills For students who require additional help with data collection, use the following worksheets from *Holt Science & Technology Science Skills Worksheets:*

- Worksheet 14: Using the International System of Units (SI)
- Worksheet 15: Measuring
- Worksheet 23: Science Drawing

Analysis and Conclusions

Analysis When students have finished collecting data and making observations, they can begin the analysis. As part of the analysis, students will make charts and graphs in their science project journals. Page 54 includes a sheet of graph paper that can be used for graphing purposes. Resources for Students discusses graphing, which you may want to review in class, along with a brief lesson on useful mathematical terms, such as *median* and *mean*. Instruct students to examine the charts and graphs for trends and record these trends and all calculations in their journal.

Strengthening Graphing and Analysis Skills For students who require additional help with graphing and analysis, use the following worksheets from *Holt Science & Technology Science Skills Worksheets:*

- Worksheet 25: Introduction to Graphs
- Worksheet 26: Grasping Graphing
- Worksheet 27: Interpreting Your Data
- Worksheet 28: Recognizing Bias in Graphs
- Worksheet 29: Making Data *Mean*ingful

Conclusions In the conclusion, students will determine whether the results support or disprove the hypothesis. Discourage students from simply writing opinions in the conclusion. Instead have students discuss factors that contributed to the results and explain how they would control these factors if the experiment were performed again.

✓ At the end of Phase 3, make sure you are still following the timeline. Check students' progress on their Student's Progress Report and Parent's Progress Report.

Phase 4—Writing a Report: Management Tips

DURING THIS PHASE, STUDENTS WILL

1. answer the questions on page 55

2. prepare an outline and discuss it with the teacher

3. prepare a draft and discuss it with the teacher

4. revise the draft according to the teacher's feedback

5. turn in a completed draft

Assigning a Written Report If the science fair you are entering requires a written report, you will need to share the particulars (how long it should be, whether it must be typed, etc.) with your students and their parents. Not all science fairs require a written report, but a paper gives students the chance to express what about the project meant the most to them and to organize their thoughts for an oral presentation. It is also a very important part of any scientific endeavor.

Having Fun Have your students use the italicized questions on page 55 of Resources for Students as a guideline for writing their reports. By asking students to answer questions about their personal experiences with the emphasis on what they enjoyed about doing a science project, you can reinforce that the science fair can be fun. The more fun they have writing the report, the easier it will be to complete and the more interesting it will be to read.

Writing Tips

Use the following tips to help students with writing:

- Require students to first write an outline for the written report. You may need to review the outlining process in class.
- Explain how index cards that are grouped together by subject can be helpful in writing a paper.
- Written reports can greatly improve when students write more than one draft. You may wish to add more drafts to the timeline.

Strengthening Writing Skills For students who require additional help with science writing, use Worksheet 22: Science Writing from *Holt Science & Technology Science Skills Worksheets*.

Feedback and Assessment

Giving feedback to a student need not be difficult. The following tips may help:

- Try to mention both the strong and weak points of a draft.
- Encourage students to do several drafts, if needed, and to ask an adult to read each one.
- Peer editing may be helpful and will give students a chance to see how their friends are handling similar problems.
- When assessing a written report, be aware that students' different writing abilities can affect the overall quality of presentation. Try not to let that overshadow the quality of the scientific content.

✓ At the end of Phase 4, make sure you are still following the timeline. Check students' progress on their Student's Progress Report and Parent's Progress Report.

Phase 5—Creating and Exhibiting a Display: Management Tips

DURING THIS PHASE, STUDENTS WILL

1. sketch possible designs for the display
2. create a display board within the appropriate parameters
3. display results in a clear and interesting manner
4. give an oral presentation as practice for the science fair interview

The Display Board

A typical display is a trifold board made from corrugated cardboard, foam core, or corkboard. Impress upon students the importance of measuring the display board more than once to ensure that it fits the size constraints of the science fair. Many science fairs require that the display be no more than 274 cm tall, 122 cm wide, and 76 cm deep. Having an oversized display can disqualify the entire project, no matter the quality of the work. Be aware that certain materials are often prohibited in the display area.

A Sample Display You may want to set up a successful sample display in your classroom. Students can study the sample display up close, noticing the neatness of the lettering, the layout of the display, and the type of information contained in each section. Show students how a display board can have a large middle section and two smaller "wings" on the left and right that can fold up, making a display more portable.

Is the Data Clearly Presented and Relevant?

You may decide to have conferences with students about the data that they plan to present. Check charts and graphs for accuracy and readability. Make sure that the information shown in the figures is relevant to the purpose, hypothesis, and conclusion. The purpose of a display is to present the information in the clearest manner possible so that the judges will be able to recognize quickly that the student performed a successful science project.

Display Design Although the display introduces the project, the design should not distract from the content. Encourage students to be creative with borders, font, and layout but not to the point that a judge would find it difficult to read the information contained in the display. Illustrations should be informative, not just decorative. A sleek, mature, and professional style can impress the judges, but they prefer presentations which are unique and are clearly a product of the student who created it.

Preparing for the Interview

Many science fairs require that a student give a presentation about his or her project to the judges. The presentation summarizes each step of the science project: why the student chose his or her subject, a statement of the hypothesis, what kind of data was collected, a brief summary of the data, and the conclusions that the student came to when he or she analyzed the data. Students can also discuss how they would do the experiment differently if they were to start over again or what other questions arose during their research.

A Captive Audience If the science fair your students are entering requires an interview, it is in your students' best interest to practice the presentations at least once before the science fair. Requiring an oral presentation in front of the class can be beneficial to all students. It will give them an opportunity to practice speaking in front of a group and to determine the most effective presentation styles by watching each other. An oral presentation will give you an opportunity to evaluate what students have done, as well as give personal feedback that will be very helpful during the interview with the judges.

During the interview, the judges will likely ask students a few questions. To prepare your students for this, ask questions during their oral presentation to the class. Encourage other students to ask questions as well. Also, suggest that they make a list of possible questions the judges could ask and possible answers to those questions.

Practice, and Practice Again Some students dread the interview part of the science fair. The more practice a student gets for the interview, the more comfortable he or she will be speaking to the judges. Encourage students to practice as often as possible and in front of as many people as possible. For instance, students may want to practice by giving their presentation to family members at home. Remind them to relax and have fun.

✓ At the end of Phase 5, make sure you are still following the timeline. Check students' progress on their Student's Progress Report and Parent's Progress Report.

Additional Resources

On the next few pages, you will find resources that may be helpful in the science fair process. Included are:

- a list of suppliers of scientific laboratory equipment
- the address and phone number of Science Service, a company that supports and regulates science fair administration
- a bibliography of books that can help students choose, design, and complete a science project
- a standard SI unit conversion chart to help students learn to work in the SI system

Additional Resources

The following list is a compilation of resources for students and teachers.

Equipment Suppliers

The following is a list of a few scientific supply companies that specialize in laboratory equipment:

Carolina Biological Supply Co.
2600 York Road
Burlington, NC 27215
(800) 334-5551

Custom Lab Supply
801 98th Avenue
Oakland, CA 94603
(510) 633-1329

Science Kit and Boreal Labs
777 East Park Drive
Tonawanda, NY 14150
(800) 828-7777

WARD's Natural Science Establishment, Inc.
5100 W. Henrietta Rd.
Rochester, NY 14585
(800) 962-2660

Science Fair Administration

Science Service, Inc.
1719 North Street, NW
Washington, DC 20026
(202) 785-2255

Books

Beller, Joel. *So You Want to Do a Science Project!* Paramus, N.J.: Prentice Hall, 1984.

Bochinski, Julianne. *The Complete Handbook of Science Fair Projects.* New York: John Wiley & Sons, 1996.

Bombaugh, Ruth. *Science Fair Success.* Berkeley Heights, N.J.: Enslow Publishers, 1990.

Bonnet, Robert and Daniel Keen. *Botany: 49 Science Fair Projects.* New York: McGraw-Hill, 1989.

Bonnet, Robert and Daniel Keen. *Earth Science: 49 Science Fair Projects.* New York: McGraw-Hill, 1990.

Brisk, Marion. *1001 Ideas for Science Projects.* New York: Macmillan, 1992.

Cook, James. *The Thomas Edison Book of Easy and Incredible Experiments.* New York: John Wiley & Sons, 1988.

Iritz, Maxine. *Science Fair: Developing a Successful and Fun Project.* New York: McGraw-Hill, 1987.

Mandell, Muriel. *Simple Science Experiments with Everyday Materials.* New York: Sterling Publishing, 1989.

Tant, Carl. Projects: *Making Hands-On Science Easy.* Angleton, Texas: Biotech Publishing, 1992.

Tocci, Salvatore. *How to Do a Science Fair Project.* Danbury, Conn.: Franklin Watts, 1989.

Wolfe, Connie. *Search: A Research Guide for Science Fairs and Independent Study.* Tucson, Ariz.: Zephyr Press, 1988.

Wood, Robert. *Physics for Kids: 49 Easy Experiments with Heat.* Blue Ridge Summit, Penn.: TAB Books, 1990.

SI Unit Conversion Chart

Length	1 inch	=	2.54 centimeters	1 centimeter	=	0.39 inch
	1 foot	=	30.48 centimeters	1 centimeter	=	0.03 foot
	1 foot	=	0.30 meter	1 meter	=	3.28 feet
	1 yard	=	0.91 meter	1 meter	=	1.09 yards
	1 mile	=	1.61 kilometers	1 kilometer	=	0.62 mile
Mass	1 ounce	=	28.35 grams	1 gram	=	0.35 ounce
	1 pound	=	0.45 kilogram	1 kilogram	=	2.20 pounds
Volume	1 teaspoon	=	4.93 milliliters	1 milliliter	=	0.20 teaspoon
	1 tablespoon	=	14.79 millilters	1 milliliter	=	0.07 tablespoon
	1 fluid ounce	=	29.57 milliliters	1 milliliter	=	0.03 fluid ounce
	1 cup	=	0.24 liter	1 liter	=	4.23 cups
	1 pint	=	0.47 liter	1 liter	=	2.11 pints
	1 quart	=	0.95 liter	1 liter	=	1.06 quarts
	1 gallon	=	3.79 liters	1 liter	=	0.26 gallon
Freezing point of water	32°F	=	0°C			
Boiling point of water	212°F	=	100°C			
To convert °F to °C	$(°F - 32) \times \frac{5}{9}$					
To convert °C to °F	$°C \times \frac{9}{5} + 32$					