A Parent's Guide to Science Fairs

Science Fair 101 (recommended for all parents)

Science Fair 102 (recommended for parents of children grades 3-4)

Science Fair 103 (recommended for parents of children grades 5-6)

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Science Fair 101: The Basics

Help! My kids want to do a science project! As a parent you are now in a panic and wonder what to do, and how to fit it into your schedule. Not to worry – it can be fun, rather than stressful. Below is a quick parent's guide, followed by a more in-depth look at what the parent's role might be.

To do a science fair project, a student will ask a question, guess at an answer, test their answer by doing an experiment, and then draw a conclusion about whether their guess was right or not. Any question which can be tested by a student will make a good project. So you might want to ask your kids if they have a question they are interested in exploring. Or you might want to have them look at the list of ideas or venture through the links of many websites that provide thousands of prospects.

As students do their experiment, they will take notes so that they can prepare a poster which describes their project so that someone else can understand what they learned. By the way, professional scientists share their work in exactly the same way at scientific conferences!

Where should you start? Well if you and your child have no idea what type of a project to work on, maybe start at a web site called Science Buddies. It is an excellent site to go to for help with your project. Their "topic selection wizard" allows you to answer a series of questions to help you narrow down projects your child would enjoy. This site also rates projects by grade level and provides background scientific information as well as complete instructions for how to do the experiment.

Students should do as much of the work as possible for their age level.

After all of the research has been gathered, it is time to 'present it.' This is where the display board comes in. It will be a lot easier for you to type or write your information and titles for each section (see the information on display boards, also posted on the RH web site) on a separate piece of paper and then paste or tape this paper onto your poster board rather than writing on the board itself. Your poster will be more interesting if you include some pictures you take while doing your experiment or use clip art pictures or pictures you draw. Some students may want to use stickers, colored paper or cut out letters to make their poster more attractive.

The information on the poster can be hand written or typed. It is all right for parents to type up their children's notes or oral explanations of their projects; however, they should be sure that the child tells them what to write. Moreover, it is important to make sure that your child can explain everything they did

1. **Title** (This could be your question—or something to make your audience interested in your topic.)
2. **Question** (State your question clearly and explain how you got interested in this question)
3. **Hypothesis** (This is your guess of the answer to your question. Tell why you think this will be the result.)
4. **Materials and Equipment** (a list of what you will need for your experiment).
5. **Resources** (Who helped you? What books or websites gave you ideas?)

6. **Results and Data** (Your description of what happened when you did your experiment. You should include any graphs or charts which help show your results.)
7. **Procedures** (the plan for testing your question and why you chose this plan.)
8. **Conclusion** (This is where you explain what happened, and tell whether your guess was correct or not. This is also where you can explain why you got the results you did. If you did your experiment again, would you change anything?)
9. **Personal Information**: Your name, grade and teacher.

Your child may bring some of the examples from your experiment to put in front of your poster if it is appropriate.

You might want to help your child practice for talking on the night of the science fair by asking them some of these questions.

1. How did you get interested in this topic?
2. What question did you ask?
3. What experiment did you do to try to answer your question?
4. What did you think was going to happen in your experiment?
5. What happened? Were you surprised by the results?
6. If you were going to do the experiment again, would you change anything?
7. What was most interesting to you about your project?
8. What part did you do? What did you get help with?
9. What did you learn?

So take a deep breath and enjoy the adventure of learning about science with your kids.

Science Fair 102: An in-depth look at the parents role in preparation for a science fair

What is the parent's role?

The parent's role is not exactly hands-on, but not exactly hands-off either. Think of yourself as chief facilitator. Your place is in the back seat, hands folded (make that clasped!) in your lap, with the student at the wheel (except, of course, for those trips to the craft store and transporting delicate 3-D models and tri-fold display boards).

Based on your available time, and type of project your child is completing, you may end up wearing several hats: lab safety supervisor, lab assistant, personal shopper, deadline cop. Be there for moral support, to help gather supplies, keep an eye on the calendar, monitor progress, and to make sure things don't (unintentionally) explode, catch on fire, or slip through the cracks.

Towards the end of the process, build in time to listen to your child rehearse how they could answer questions people may ask them about their project. Be a kind audience member, give gentle reminders and a bit of constructive criticism, and ask helpful questions. Do some role playing and add some humor if your child doesn't respond well to the exercise.

How do I help my student come up with a project idea?

Choosing a topic is a difficult task, as the possibilities can seem endless. Parents can help with subtle suggestions and reality checks, but students should ultimately come up with their own idea based on their own personal interests - one they'll be motivated to stick with over several weeks as they work through the project to completion.

You can set your children up for an interest in science by providing opportunities to learn about exciting technological advances as well as practical, everyday applications of science all around them. Watch a television science program together. Propose a trip to a science museum or go to the museum's on-line web site. Discuss a science news article from the newspaper or a magazine. A trip to the science section of your local library can help to spark ideas or to fine-tune existing ones.

For those who are scientifically inclined, try to resist the urge to propose ideas of your own. Instead, use your knowledge of how scientists come up with their own questions to get your child to think about what they would like to learn and what kind of investigation they'd like to conduct. Remember that children don't have the same background and experiences as adults. Something that seems to be common knowledge to you will be new to them and worth exploring and learning on their own. Science projects should be about experiencing the process of science.

If your child is interested in inventions and problem solving, that angle of science and engineering, discuss things around them that may be frustrating and that could be improved by changing them. Watch some of the television programs on engineering and inventing. Look at inventions in museums. Even social engineering is fair game – could they, for example, think of how to get people to throw away less and recycle more? What change would they make and how would they measure that change?

Project Ideas 101

Educate yourself as they begin brainstorming. In order to advise on the feasibility of a project idea, you need to understand the basic framework and requirements of the entire process. It's one thing to come with an enthusiastic idea, quite another to come up with an workable, testable project.

Types of Science Fair Projects

There are basically three types.

The Information Project

The science report: students have an interest in learning something that is already known. What are galaxies? How are coral reefs endangered? How does a laser work? These projects are interesting, but it must be noted that they do not actually allow students to practice science. Students do learn a lot about what other scientists have done, but the student doesn't actually conduct an investigation or create anything (other than a great display). Students may make models and they may even repeat some data they have found. This may be the best way to go for the younger scientists.

The Experimental Investigation

The experimental investigation: this is where students ask “testable” questions and roll up their sleeves and practice science. This type of science project is a unique opportunity for them to experience the whole science process. Students ask a testable question, identify simple variables, research the background on the question, propose a hypothesis, conduct the investigation, collect data, and draw a conclusion. Even when the project is simple and an adult might know the answer, the student benefits from practicing the science process and finding out for him or herself.

The Invention

The invention: some students like to see their results put to practical use. They see a local problem, such as a backpack that is too heavy and propose a solution. What makes it scientific is that the change they propose is measured and recorded in some way. The student comes away with proof that the solution worked or it didn't work.

How much time will we need?

Now this is an area where students can definitely use a parent's help. Together you should build a realistic timeline for completing the project. It's okay to tweak it slightly here and there along the way, as long as a solid framework is in place and the final deadlines are in full view. Most investigations and inventions take time to prepare, complete, analyze, and document. Anticipate errors, spillages, roadblocks, revisions, and occasional student meltdowns about their decision to create a science fair project.

A critical point is the decision about the investigation or invention. How much time will it take to set up and collect all the data? Make sure the topic, question, or idea fits within the time frame. Don't forget to subtract the time it will take to put the display together and prepare a “script” about their project.

Timeframe

Remember this: These things always take more time than you think. Work with your young scientist to make a realistic schedule. Science is never completely predictable, which is what makes it so much fun! Build in enough time for mishaps and revisions in the design, for careful observation and recording of data, and for the professional-looking presentation of scientific findings.

Parent Tips: Steps for a Science Fair Project:

Below is a table of steps that may need to be completed!

Project Steps
Decide on topic and develop question or solution
Background research on topic
Determine materials and purchase them
Set up project and begin to collect data
Shop for project display supplies
Prepare project display
Prepare supporting oral “material”

Deliver presentation display to school	
Science Fair Day	
Bring project home	

How do I help with the project?

Once your child has chosen a topic, narrowed it down to a testable question, it's time to begin planning and designing the procedure (often referred to as the experiment). Some students are able to do this entirely on their own, but many benefit from a parent's help. Here's how you can assist with the procedure stage:

Designing a procedure takes time. Suggest that you jump-start the process together by brainstorming and taking notes. You can get the brainstorming rolling by throwing out questions, but it should quickly turn into a back-and-forth process, with the student doing the note-taking and sketching.

Once the plan for the procedure is finalized, you can make a shopping list together.

Schedule a day when you both have time to devote to the experiment itself. This part requires focus and precision, but it should also be fun, not stressful. Set aside enough time to repeat the procedure several times. This is the time to get excited about science—to get messy, make mistakes, try new things, take off on tangents if it sparks new ideas.

Remind your child to take careful notes and record all data and observations along the way. You can help by taking photographs of every step, so that your child's hands can be free for hands-on science.

What are they major sticking points for students?

From experience, we know that students get tripped up on certain areas more than others. Remember that students like to try to work things out on their own before they ask you for help. Unfortunately, they often let too much time pass before they ask. So you, as the adult, have the unenviable task of making sure they stay on track while allowing them the freedom of choice and the opportunity to make honest mistakes.

The following points in the process are good ones to monitor and help out if and when you are needed:

Narrowing the topic and developing a question or problem statement

Most students can tell you their favorite topics. But they have trouble coming up with an idea for an investigation or a solution to a problem that has a measureable outcome. They may not think of some of their favorite things to do as science. You can help them see that there is a science investigation in just about everything.

Like sports? There is a lot of science involved making a good basketball, or the best bat, or streamlining a body or a car for racing. Experiment to find out! Invent something better!

Like cooking? Cooking is all about chemistry and good cooks know that just changing one thing in a recipe can affect the food's texture or flavor. Experiment to find out! Come up with your own recipe!

Like the outdoors? One change in the environment can affect hundreds of species. You can conduct small investigations to find out how big things change.

Science really is all around us.

In the end, students need to end up with an idea that is specific, testable, measurable, and doable. Shoot for a reasonable level of difficulty. This doesn't have to be rocket science, but it should be challenging enough to keep them intrigued and teach them things they didn't know before.

Setting up a controlled experiment OR designing and building an invention

Whether the student opts to conduct an experimental investigation or solve a problem scientifically, this part usually takes more time than anyone thought it would. Often, experiments should be repeated to ensure accuracy. And some time is needed at the start to tinker and try different things with the materials. But in the end the task is to test the hypothesis or prove that the solution works. To do this accurately students need to keep track of the thing that they change, the things that stay the same, and what happens as a result of the one change. It is critical for students to understand how to set up a fair test and to identify the variables before the experiment begins.

Materials

Two different sets of materials are needed: The first is what is needed to do the investigation or invention. The second is what is needed for the project presentation.

Have your child make a list of everything they could possibly need for both the procedure and the presentation. If you think they MIGHT need it, it should be put on the list. If they think they might not need it, but aren't sure, put it on the list anyway. The point is to anticipate needs up front, so what is needed for the science project is there precisely when needed. A research scientist doesn't want to run out to the store to in frantic search of test tubes; a graphic designer (hopefully) does not run out of materials in the middle of a project.

Safety

Check the rules and regulations of the science fair. Advice: take lots of pictures if you cannot bring your subject matter to school with you!

Displays

The visual display is the first thing people see before they even know what the project is about. Try to make lines straight (use a ruler or T-square). The display should tell the story of your project in a very clear, yet compelling way. It should pique the interest of passers-by, draw them in, and quickly convey the most important information in a logical way.

What should the final project look like?

The final project is the culmination of the entire process and comprises several parts. The main feature is a large display board that tells the whole life story of the student's project, detailing exactly how scientific methodology was used at each stage. This is propped up on a table, where students display accompanying material. These might include: a journal of detailed notes and sketches, a photo album documenting procedures and materials, and a sample of background research material. Some young scientists also include hand-made models pertaining to their topic. If your child opted to do an invention rather than an investigation, and the invention is transportable, the invention itself will be center stage in front of the display. Pictures of a non-transportable invention are good, too.

Displays

Although there's a bit of room for creativity, the display board format is fairly formulaic. On one hand, this makes things easy because there's no need to reinvent the wheel. On the other hand, those with an artistic spirit may find it limiting. Together you can look at sample layouts to see standard grid formats and sequence of categories. Stress that effective communication is the key, and that accomplishing this within tight parameters is actually a highly creative skill. If your child is itchy for something more edgy, suggest they splash out and make the project title as eye-catching and exciting as possible.

Science Fair Shopping List

Although you may have a child who's super responsible and proactive at every step, it's a smart idea to check out the shopping checklist yourself. You may already have many of the supplies around the house. Do this sooner rather than later, and you may save gas money as well as your sanity! If you are unable to afford items for the procedure or display, don't hesitate to talk to the fair coordinators. Classmates may be able to share supplies at the after school work help session.

Where do I get supplies?

Supplies for your child's experiment really depend on the particular project. Some rely on everyday items easily found around the house and others require scientific tools, supplies and bits from prepackaged science kits. Product selection will vary from retailer to retailer.

What else can I do to help?

Being there for unconditional support is the most important thing you can do by far. Consider volunteering at the science fair.

Science Fair 103: The Details Behind the Science

Process of Investigation

The terms "investigation" and "experiment" are sometimes used interchangeably. We define investigation as a science fair project that uses scientific methods (which includes an experiment) to carry out an investigation.

Here's an explanation with more detail:

During an investigation, the student starts out with a question based on a scientific problem; develops a hypothesis (or educated guess) as to the answer; designs and performs an experiment to test the hypothesis; documents and analyzes the results; and draws a conclusion.

The key to a good investigation is what is called a "testable question." Often, students may want to ask broad questions, such as "How is a galaxy formed?" This is an excellent science question, but it's not an investigation question. To find out about galaxy formation, the student reads about research that others have done and reports on it. In a science investigation, the student asks a question that can be answered by doing the science, collecting data, and making sense of the data.

The table below shows how testable questions could be addressed in an investigation. Any of the variables could be chosen as the changed or "independent" variable.

Easier level (recommended for elementary)

Testable Question	What is changed?	What stays the same?	Data collected
What amount of water is best to grow tomatoes?	Amount of water (.5L, 1L, 2L)	Soil, amount of light, type of plant, temperature, location	Height of each plant over time
What type of paper makes the best paper airplane?	Type of paper	Design of plane, size of paper, thrust, air currents	Distance plane travels using the same amount of thrust
Does the sun heat salt water and fresh water at the same rate?	Salinity of the water (grams of salt per liter)	Container, starting temperature	Temperature over time (1 hour)
What is the best insulator to keep ice from melting?	Type of insulation in a container	Amount of ice, starting temperature	Time for ice to completely melt

Process of Invention (solving a real world problem)

Some students may opt to do an invention rather than an investigation for their project. What does this mean, exactly? The word "invention" connotes everything from mad scientists with wacky contraptions to such revolutionary advances as the invention of the airplane, telephone and Internet. For the purposes of school science fairs, inventions can be fairly simple.

The invention must serve a purpose and solve a real problem. The change or solution must be measureable – in other words, we have to be able to prove that the change made a difference. It can also be something that improves an object previously invented by someone else or takes it in a completely different direction. An invention can also be a model of something that would work better in real life.

Thinking up invention ideas can be a fun exercise for the whole family. Look in the kitchen or the garage. Visit a hardware or home improvement store. Look for simple devices that solve a problem (like "chip clips," designed to prevent potato chips from going stale) or poorly designed products that drive you crazy. Keep the problem that the invention solves within the student's reach. Or suggest using a model. Improving the local bridge may not be possible, but using a model to show how it could be improved is.

Just as with an investigation, the student must outline and document every step along the way. Remind your child that the process is just as important as the final product—which means mistakes and problems should be treated as valuable steps (rather than sources of frustration) and documented along with other notes and sketches in a record-keeping journal.

Gathering Background Research

- Helps students gain in depth knowledge about the topic and processes they will be observing during the investigation.
- Sparks ideas about different variables to test when setting up the investigation.
- Provides the basis for predicting what will happen in the investigation when making a hypothesis.
- Provides the understanding needed to interpret and explain the results to others

Investigation: Conduct Background Research

Once students have a testable question, it is important to do some background research. What do scientists think they already know about the topic? What are the processes involved and how do they work? Background research can be gathered first hand from primary sources such as interviews with a teacher, scientist at a local university, or other persons with specialized knowledge. Students can use secondary sources such as books, magazines, journals, newspapers, online documents, or literature from non-profit organizations. Don't forget to make a record of any resource used so that credit can be given.

Investigation: Compose Hypothesis

After gathering background research, students will be better prepared to formulate a hypothesis. More than a random guess, a hypothesis is a testable statement based on background knowledge, research, or scientific reason. A hypothesis states the anticipated cause and effect that may be observed during the investigation. Consider the following hypothesis:

If ice is placed in a styrofoam container, it will take longer to melt than if placed in a plastic or glass container. I think this is true because my research shows that a lot of people purchase styrofoam coolers to keep drinks cool.

The time it takes for ice to melt (dependent variable) depends on the type of container used (independent variable.). A hypothesis shows the relationship among variables in the investigation and often (but not always) uses the words *if* and *then*.

Take a look at these additional examples:

- If a mixture of vinegar and baking soda are used, then more stains may be removed. I think this because vinegar and baking soda are used in many different cleaning products.

- Tomato plants will grow best if they get at least 12 hours of light each day. This is based on research that says that tomatoes need lots of light.
- When an object has a volume greater than 30 cubic centimeters, then it will sink in water. In the past, I have seen big objects sink.

"The important thing about a hypothesis is not its initial accuracy. For instance, looking at the last example, students are likely to determine that the materials used or the shape of those materials will also impact an object's ability to sink or float. For students who worry that their hypothesis does not match their experimental results, parents and teachers should emphasize the idea that all hypotheses are valuable regardless of their truth if they lead to fruitful investigations." (Benchmarks for Science Literacy, 2003)

Investigation: Design Experiment

Once students formulate a hypothesis for their investigation, they must design a procedure to test it. A well-designed investigation contains procedures that take into account all of the factors that could impact the results of the investigation. These factors are called variables.

NOTE: at our elementary level, you may wish to begin by using the phrases "What is changed," "What stays the same," and "What is measured." Once students are comfortable with these ideas and that of controlling the experiment, the term variable can be introduced. Young students can often get hung up on the differences among the terms, which can hamper the investigation.

There are three types of variables to consider when designing the investigation procedure.

- The independent variable is the one variable the investigator chooses to change.
- Controlled variables are variables that are kept the same each time.
- The dependent variable is the variable that changes as a result of /or in response to the independent variable.

Having students talk through the investigation will help them to clarify the different variables involved in the experimental design. What factors will change? What factors will stay the same? The challenge is for students to create what is called a "fair test." In a fair test, only one factor or variable is changed at one time so that the investigator can determine if the changed factor has an impact on the end results.

One of the easiest ways to help students understand the concept of a fair test is to give them an example that is NOT a fair test. For instance, suppose the problem is to determine which stain remover is best at removing stains. It would not be fair to test one stain remover on a well set grass stain while testing the other stain remover on fabric only lightly soiled with dirt—a much easier stain to remove. A well designed procedure avoids such unfair comparisons.

Another hands-on way to introduce a fair test is to ask students, "Who can make the best paper airplane?" Once two students are selected to compete, hand one a large piece of construction paper and the other a piece of regular copy paper. Students will immediately note that this is "unfair." If we want the test to be fair, only the paper airplane design can be different. Everything else, including how hard the airplane is tossed, must be the same.

Following the steps listed below will help students as they develop an investigative procedure.

Step A – Clarify Variable (example)

Clarify the variables involved in the investigation by developing a table such as the one below.

Testable Question	What is changed? (independent variable)	What stays the same? (controlled variables)	Data Collected (dependent variable)
What detergent removes stains the best?	Type of detergent, type of stain	Type of cloth, physical process of stain removal	Stain fading over time for combinations of detergents and stains

Step B – List Materials (example)

Make a list of materials that will be used in the investigation.

Stain Removal Investigation Materials

- 100% cotton cloth samples
- Ketchup
- Coffee
- Ink
- Grass
- Soil
- Commercial detergent #1
- Commercial detergent #2
- Vinegar
- Vinegar and baking soda mixture
- Water
- Soap
- Wash basin
- Timer/stopwatch
- Rubber gloves

Step C – List Steps (example)

List the steps needed to carry out the investigation.

Stain Remover Investigation Procedure

1. Place a ketchup stain approximately 4 inches in diameter on 100% cotton fabric. Prepare 4 identical stain samples in addition to the first sample. Label the samples (vinegar, vinegar and baking soda mixture, commercial detergent #1, commercial detergent #2)
2. Place 10mL of stain remover on the ketchup stain sample. Wait 3 minutes. Scrub for 1 minute. Repeat with each of 4 stain removers. (vinegar, vinegar and baking soda mixture, commercial detergent #1, commercial detergent #2)
3. On the fifth sample, do not put on any stain remover. Leave the ketchup stain as is. Scrub for 1 minute. Use permanent marker to write the word ketchup on each sample.
4. Wash each sample using soap and water in a basin.
5. Compare the samples to see which stain remover worked the best.
6. Repeat the experiment using different stains (coffee, ink, grass, and soil)

Step D – Estimate Time (example)

Estimate the time it will take to complete the investigation. Will the data be gathered in one sitting or over the course of several weeks?

Step E – Check Work (example)

Check the work. Ask someone else to read the procedure to make sure the steps are clear. Are there any steps missing? Double check the materials list to be sure all to the necessary materials are included.

Investigation: Set Up and Collect Data

After designing the procedure and gathering the materials, it is time to set up and to carry out the investigation.

When setting up the investigation, students will need to consider…

The location Choose a low traffic area to reduce the risk of someone accidentally tampering with the investigation results—especially if the investigation lasts for several weeks.

Safety Avoid harmful accidents by using safe practices.

- The use of construction tools or potentially harmful chemicals will require adult supervision.
- Locate the nearest sink or fire extinguisher as a safety precaution.
- Determine how to dispose of materials. For example, some chemicals should not be mixed together or put down a sink drain.
- Wear protective clothing such as goggles and gloves. Tie back loose hair so that it does not get caught on any of the equipment.

Documentation Making a rough sketch or recording notes of the investigation set up is helpful if the experiment is to be repeated in the future.

Carrying out the investigation involves data collection. There are two types of data that may be collected—quantitative data and qualitative data.

Quantitative Data

1. Uses numbers to describe the amount of something.
2. Involves tools such as rulers, timers, graduated cylinders, etc.
3. Uses standard metric units (For instance, meters and centimeters for length, grams for mass, and degrees Celsius for volume.
4. May involve the use of a scale such as in the example below.

Qualitative Data

- Uses words to describe the data
- Describes physical properties such as how something looks, feels, smells, tastes, or sounds.

Stain Removal Results

4 no change

3 Faded

2 slightly faded

1 Gone

As data is collected it can be organized into lists and tables. Organizing data will be helpful for identifying relationships later when making an analysis. Encourage students to make use of technology such as spreadsheets to organize their data.

Investigation: Analyze Data and Draw Conclusions

After students have collected their data the next step is to analyze it. The goal of data analysis is to determine if there is a relationship between the independent and dependent variables. In student terms, this is called “looking for patterns in the data.” Did the change I made have an effect that can be measured?

Recording data on a table or chart makes it much easier to observe relationships and trends. For example, look at the following data table.

Tomato Plant Response to Light

Time	A Plants (12 hours light)		B Plants (8 hours light)		C Plants: (4 hours light)	
Day	Height (cm)	Leaves	Height (cm)	Leaves	Height (cm)	Leaves
11	1.0	1	1.0	1	1.0	1
12	1.5	2	1.3	1	1.1	1
13	1.9	2	1.4	1	1.2	2
14	2.1	2	1.6	2	1.3	2
15	2.3	2	1.7	2	1.4	2
16	2.5	3	1.9	2	1.6	2
17	2.7	3	2.1	2	1.7	3
18	3.0	3	2.3	2	1.8	3
19	3.3	4	2.5	2	2.0	3
20	3.7	4	2.8	3	2.2	3
21	4.0	4	3.1	3	2.4	3
22	4.4	5	3.4	3	2.6	3
23	4.9	5	3.7	3	2.8	4
24	5.3	6	4.1	4	3.1	4
25	5.9	7	4.5	4	3.4	4
26	6.5	7	4.9	4	3.7	4
27	7.1	8	5.4	5	4.0	5
28	7.8	9	6.0	5	4.4	5
29	8.6	10	6.6	6	4.8	5

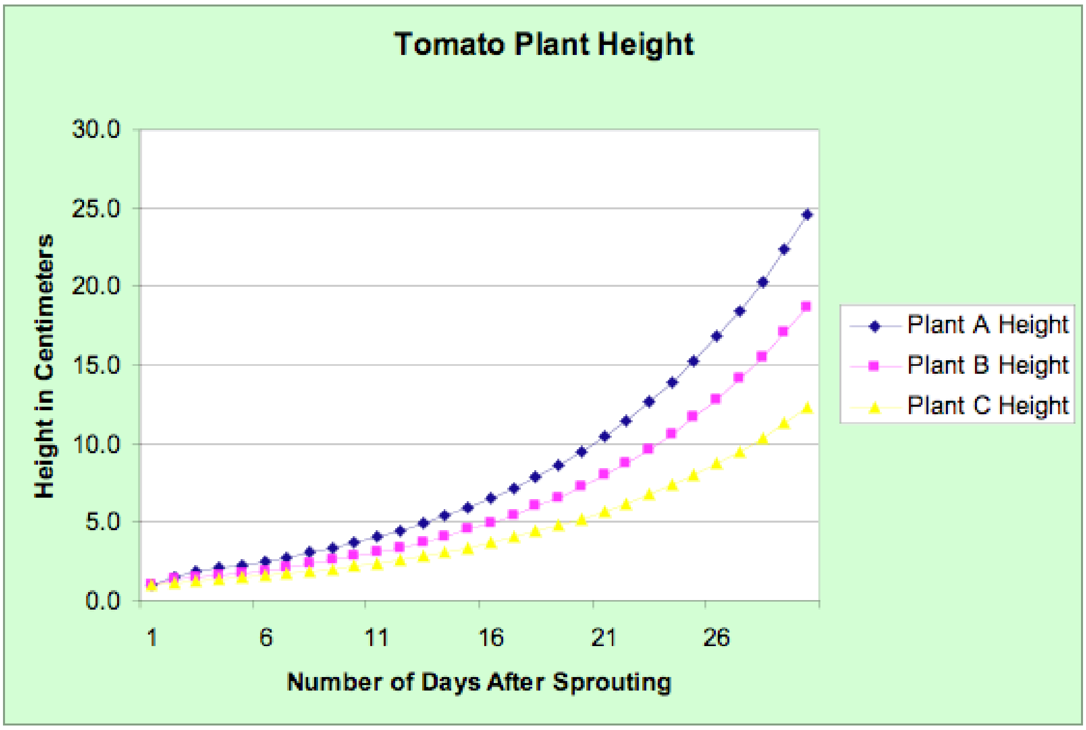
Tomato Plant Response to Light

Time	A Plants (12 hours light)		B Plants (8 hours light)		C Plants: (4 hours light)	
Day	**Height (cm)**	**Leaves**	**Height (cm)**	**Leaves**	**Height (cm)**	**Leaves**
30	9.5	11	7.2	6	5.2	5
31	10.4	12	8.0	7	5.7	6
32	11.5	14	8.7	7	6.2	6
33	12.6	15	9.6	8	6.7	6
34	13.9	17	10.6	9	7.3	7
35	15.3	19	11.6	9	8.0	7
36	16.8	21	12.8	10	8.7	8
37	18.5	23	14.1	11	9.5	8
38	20.3	25	15.5	12	10.3	9
39	22.3	28	17.0	13	11.3	9
40	24.6	31	18.7	15	12.3	10

Students may notice how in all of the plant samples, as the plant height increases, more leaves are produced. Students may also observe how the plants receiving only four hours of light (C Plants) produced less than half the amount of leaves at the end of 40 days than the plants receiving 12 hours of light (A Plants). There are so many observations that students might make when looking at their data tables! Comparing mean average or median numbers of objects, observing trends of increasing or decreasing numbers, comparing modes or numbers of items that occur most frequently are just a few examples of quantitative analysis.

Besides analyzing data on tables or charts, graphs can be used to make a picture of the data. Graphing the data can often help make those relationships and trends easier to see. Graphs are called "pictures of data." The important thing is that appropriate graphs are selected for the type of data. For example, bar graphs, pictographs, or circle graphs should be used to represent categorical data (sometimes called "side by side" data). Line plots are used to show numerical data. Line graphs should be used to show how data changes over time. Graphs can be drawn by hand using graph paper or generated on the computer from spreadsheets for students who are technically able.

Here is what a graph of some of the data from the tomato table looks like. Notice how much easier it is to see the trends in the data here than in the data table.



You can use these questions to help guide students in analyzing their data:

- What can be learned from looking at the data?
- How does the data relate to the student's original hypothesis?
- Did what you changed (independent variable) cause changes in the results (dependent variable)?

After analyzing the data, students will be able to answer these questions as they draw some conclusions. Encourage students not to change their hypothesis if it does not match their findings. The accuracy of a hypothesis is NOT what constitutes a successful science fair investigation. Rather, Science Fair judges will want to see that the conclusions stated match the data that was collected.

Application of the Results: Students may want to include an application as part of their conclusion. For example, after investigating the effectiveness of different stain removers, a student might conclude that vinegar is just as effective at removing stains as are some commercial stain removers. As a result, the student might recommend that people use vinegar as a stain remover since it may be the more eco-friendly product.

In short, conclusions are written to answer the original testable question proposed at the beginning of the investigation. They also explain how the student used science process to develop an accurate answer.

The most important rule regarding the science fair . . . everyone should have fun while learning!

Most information for this document was derived from http://school.discoveryeducation.com/ and http://virginialynne.hubpages.com/hub/How-to-do-a-Great-Science-Fair-Project-and-Board