Steps in Doing a Science Research Project

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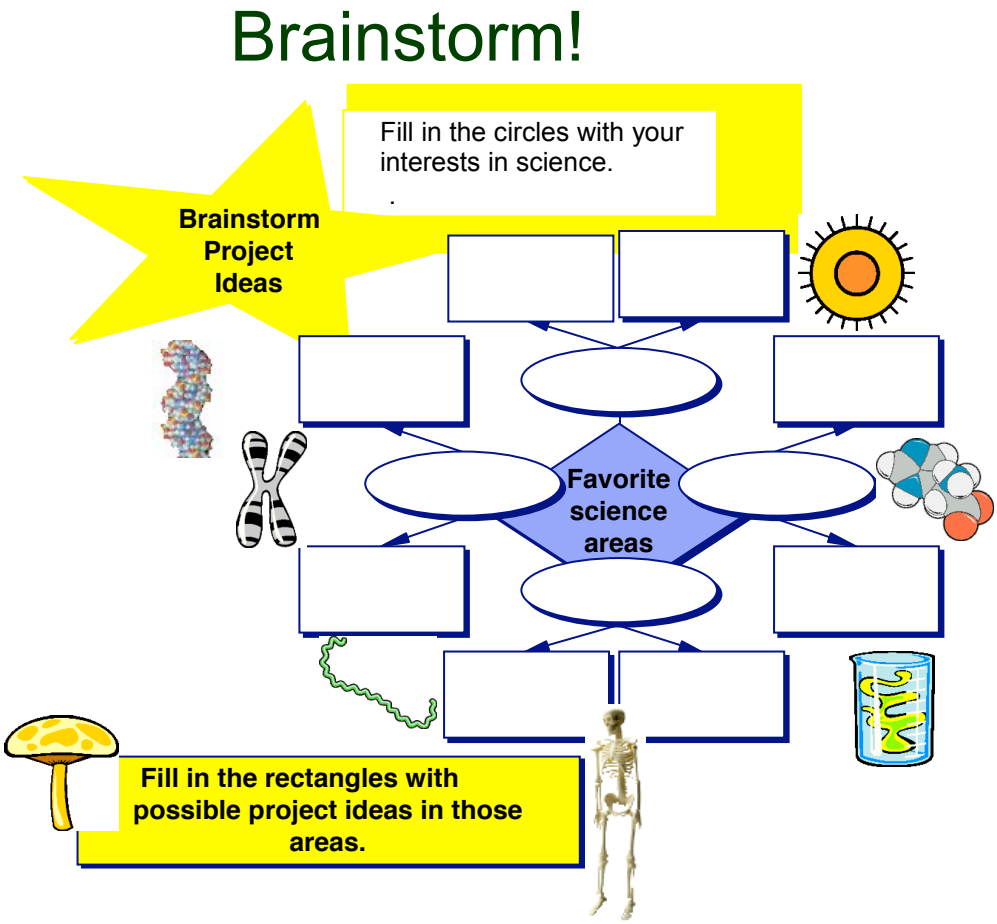
Step 1 - How do I figure out what project to do?



1) Have student fill in the ovals with their favorite science areas of interest.
2) Have student fill in the rectangles with topics in that science or interest area that could be studied or explored.
3) Have students select one or two of the rectangle topics and do some research about the topic.
4) Have student write a question that they have about that topic that is a "testable" question—one that requires them to take data to answer. Explain the difference between a "testable question" and an "informational question" – one that they can find the answer by reading a book or going on the Internet.

---The Four Question Strategy

Have students choose their area of interest then follow the Four Question method to aid them in identifying the problem to be solved. We will use the topic of plants for our example below.

1. **What materials are readily available for conducting experiment on … ("bubbles")?**

   Soap, water, additives, heat, blower types, light conditions, rulers, Containers

2. **How do ("bubbles") act?**
   Expand, shrink, have colors, wiggle, freeze

3. How **can I change the set of ("bubble") materials to affect the action?**
   (The student is identifying the "independent variable.")
   Different types of water
   Different soap types
   Different additives
   Different soap to water concentration
   Different sized bubbles

Similarly, changes in temperature, blower type/ liquid volumes, and light need to be listed. This is a time for brainstorming and the longer the list the better. Answers to this question allow students to see the numerous potential independent variables, even with a simple topic.

4. How can I measure or **describe the response of ("bubbles")** to the change?
   (The student is identifying the "dependent variable.")

Measure bubble size
Measure bubble lifetime
Measure bubble colors

Adapted from: Cothron, Julia H., Giese, Ronald N. and Rezbaa, Richard J., (2006). *Students and Research Practical Strategies for Science Classrooms and Competitions.* Dubuque, Iowa: Kendall/Hunt Publishing Company.

---Using Resource Books, Magazines and Websites for Topic Ideas, Questions and Complete Project Designs

1) Go to your school and/or public libraries and have the librarian have a session for your students on the location of science books, particularly books and magazines that would give ideas to students that could develop into testable questions.

2) Use programs and other resources from past science competitions that could give ideas for students to think about and develop.

3) Go on line to www.dvsf.org Click "Student Link" and you will find a list of websites that will give excellent ideas or places to start the search for ideas.

4) Another excellent online site is: www.sciencebuddies.org At this website students will find complete project questions, procedures and expansions for beginning their research project.

5) Goggle "Science Projects" or if you are interested in a biology project, goggle "Biology Science Projects."

6) Borrow old lab manuals and have the students review them for ideas. You can change a variable in many of the experiments listed to make a brand new project for them.

7) Go to library use www.webfeetguides.org for literature searches for ideas. (Your school must purchase this program)

8) Interviewing or speaking with adults and other students can often raise good ideas to be tested. Some students contact a mentor who is an adult with an expertise in a given area and together they are able to develop some new ideas and questions to be studied.

9) Go to Society for Science and the Public's (formerly Science Service) web site at www.societyforscience.org. You will find many resources that will guide you toward project ideas.

How To Record the Student Researcher's Progress and Findings

As the student begins their work, they should start a "Science Project Journal" or "Log Book" to detail their work on the project. They should record the date and then a brief statement of what they did on the project for that date. They should list the resources they used in the project selection part.

Once they begin researching for the written report, they should divide the book into sections – 1) Literature Review, 2) Bibliography, 3) Experimental Design, 4) Data and Analysis,5) Conclusions, 6) Expansion/Applications and 7)Photos .

Scientists keep a log book and it is one of their most precious possessions!

Log Book or Journal Entries

The logbook (sometimes called a "data book") is a very critical part to the science research project. This is a daily record of what the student is doing with their project. It is a log of how many hours they have worked on the project. It is an important part for the judges or teacher reading prior to the students arriving at the fairs during the day of judging. It helps the judges formulate questions about the project.

As stated above, students should record background information, bibliography, raw data collected, any information obtained via phone calls, e-mail, or postal mail and any expenses incurred in this book. Dividing it into sections will help the judges and teachers see the progress of the project. It is good to have a title page and a table of contents and to number the pages. Make sure to date each entry. Cross out mistakes with a single line, but allow errors or transitions of thoughts to be included in this book.

This daily logbook will also help the student reference information when being questioned by the judges. They may refer to their data book to cite findings not recorded on the display board to clarify information for the judges. Remember to keep this data book up to date.

Step 2 – Research background information for topic selected
Literature Review

All projects need to have a research paper. This includes the background information obtained about the topic they are investigating. They are to collect as much current information about the topic as they can. Be sure to use a variety of resource types, not just Internet Information. Use books, magazines, journals, encyclopedias, interviews and websites. Contact universities and companies that may have information applicable to the topic. Make sure to record all bibliographic information (The student should have at least 5 credible sources). Once the research is completed, a research paper is to be written.

The research paper should cite the referenced information not commonly known about the topic, as well as new information. The purpose of writing the research report is to summarize the student's understanding of the topic and to convey to both teachers and judges that they have a thorough understanding of the topic.

Once the student has completed their background research, they are now able to make their "Hypothesis." A "hypothesis" is an "educated guess." That means that the researcher has some understanding of the topic and may have some idea about the answer to the testable question. The student should, at this point, record their hypothesis in their log book. They must understand that whether the hypothesis is correct or incorrect at the end of the experiment does not matter! It is merely a guide or guess to give them some direction as they put together their experimental design or "Procedure."

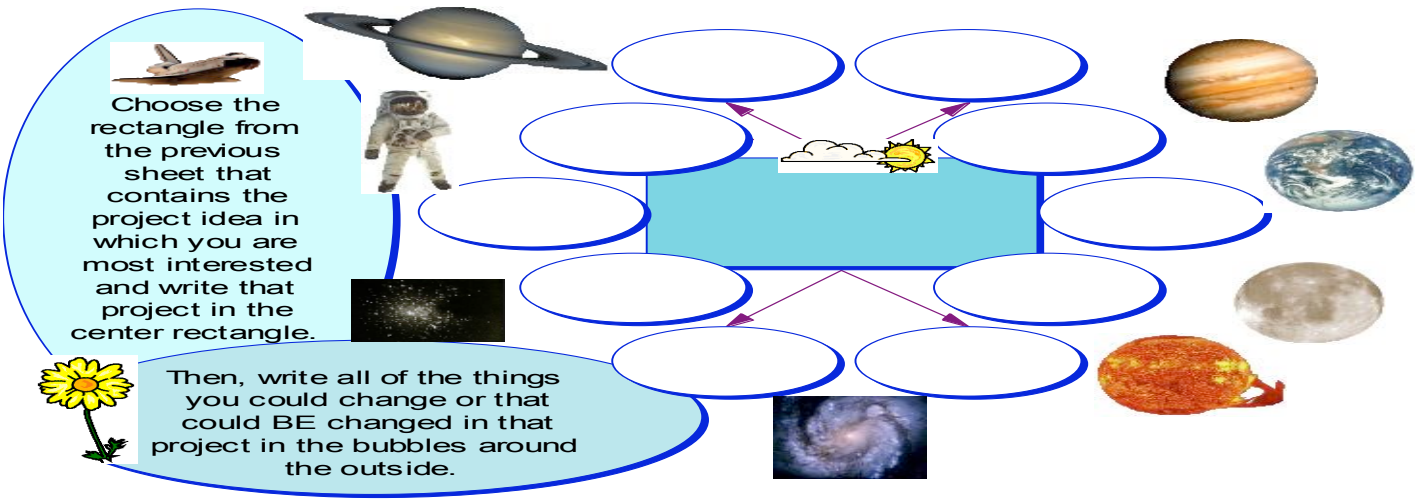
Step – 3 --Develop a Testable Question or Problem to Solve

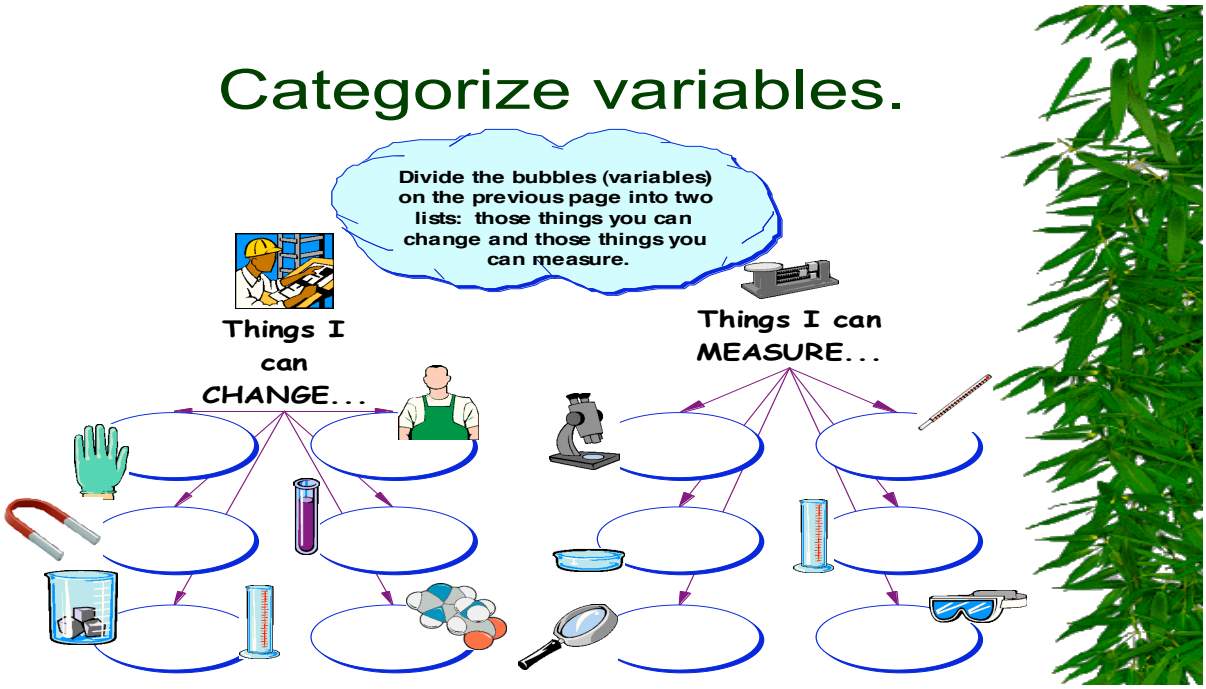
Once the student has their idea, they must now formulate the "testable question." This is a question that requires data to be taken and analyzed to answer that question. For example, "How does the amount of microwave radiation affect the germination rate of radish seeds?" (Be careful that the students do not develop an "informational question". For example, "Where are the most radishes produced in the United States?")

It is important to have the student understand the terms: "variable" (a condition that may change the results of an experiment), an "Independent variable" (the variable you choose to change), a "Dependent variable" (the variable you measure during the experiment to see if there was any change) and a "Controlled experiment"(an experiment where only one variable is changed at a time—all other variables remain the same or are held constant).

For example if a student is interested in rockets, he or she may want to test the type of fins to see how it affects the height a rocket reaches. Their testable question might be: "How does Fin Type Affect the Maximum Altitude that a Rocket Reaches." To answer that question, the student would have to do testing and measure the altitudes obtained when different fin types are used on the same rocket, using the same amount of fuel, with the same wind conditions.
You can use the diagrams below to help in identifying the variables that could be tested and which ones could be the independent variable ("Things I Could Change") and which could be the dependent variable ("Things I Could Measure").

Selecting Your Project Idea and ideas to change within the project





Now choose one from each group and write your "testable question" or "Problem".

Step – 4-- Develop the Experimental Design or Procedure and Data Table

As stated before to develop the experimental design for a project, the student must understand the concepts of "variables," "independent variable", "dependent variable," "controlled experiment," "control group," and "sample size." Some projects may be found where the experimental design or "procedure" is already written for the student. This has some good and bad points. The good—1) quick and easy for both the student and teacher and 2) the experiment is designed correctly; The bad—1) students do not get the experience of learning how to design experiments themselves and 2) some previously written procedures are poorly done, but taken as acceptable.

Setting Up A Controlled Experiment

To conduct a scientific investigation care must be taken to follow experimental procedures. You must design an experiment that answers a testable question not an informational question. When planning your experiment remember to keep everything the same except for the single variable being tested. A variable is something that can be changed in the experiment. It is what you are testing. Everything else must be the same and only one variable or condition is altered or changed. A dependent variable is when the experimenter changes something to observe what happens, the things that are changed may "cause" something else to happen. The "something else" is the dependent variable. An independent variable is when the person doing the experiment changes something to

observe what happens. The "something" that is changed is the independent variable. A control group should be used when conducting an experiment. This group receives the same attention as the test groups; however it will not be influenced by the variable used with the other groups in testing.

It is important that an adequate number of subjects/tests be done. This is called the **"Sample Size." An important principle for this is; "The more trials or subjects tested, the more sure you can be or your results."** In testing plants, the minimum number of plants in each group should be ten. In testing people, the minimum number of subjects should be 20, but closer to 50 would give more confidence in the results. In doing testing of objects, a minimum of 3 trials should be completed with 5-10 a better number.

Example of an Experimental Design or "Procedure" for a testable question:

Purpose: How will the amount of soap detergent used affect bubble size?

Hypothesis: If more soap is used then the greater growth the maximum bubble size.

Procedures: The test variable will be the amount of soap used. All other variables and conditions will remain the same.

1. The same soap detergent is used in all trials.
2. All bubbles blown will be blown by the same straw with the same amount of soap juice.
3. All bubbles will blown on the same surface
4. The temperature should be the same for all bubbles. (Tell temperature).
5. At least 10 bubbles should be used in each test group.
6. Set one group (at least 10 bubbles) as the Control Group. This group will be blown with the 5 gm/ liter concentration.
7. Set up at least two other test groups (at least 10 bubbles). Each receives a different concentration of soap to water—10g/ liter and 20 g./ml .
8. Take measurements of each popped bubble using the residue mark left by the bubble, using millimeters and average results.
9. Repeat procedures 5-8 for each soap solution for 5 days.
10. Graph data using a line graph.
11. Analyze data using statistical analysis or appropriate statistics.
12. Make conclusions and applications.
13. Identify sources of error and future project extensions of this project.

Once the experimental design is determined and written up, it should be reviewed by a teacher or mentor to be sure all parts of the procedure are appropriate and complete.

Next, data tables should be designed and drawn in the Log Book so that data can be easily recorded. Data tables will have rows and columns. The data table should have: 1) a title, 2) each column and row labeled and 3) units listed.

For example: The Effect of Soap Solution Concentration(g of soap/liter of water) on the Maximum Size of a Bubble

Trial	5 g/ 1 l	10g / 1 l	20 g/ 1 l
1			
2			
3			
AVG.			

Recording Observations and Data

Use your data book for recording all measurements and observations. Record information on a daily basis and consider the following things:

- Include dates information was recorded.
- Include accurate measurements. Use metric measurement.
- It is better to have too much data than not enough so keep many notes.
- When making an observation write down the date and time.
- Keep track of the materials used, their quantities and cost and record.
- Take photographs to be used for research report and project board.
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Step – 5 --Take Data

Step – 6 --Design and set up a Graph

The key to good graph analysis is to select the graph type that is most appropriate for the data that has been taken.

- If the student is dealing with one variable that is a number and one that is a word or phrase, a BAR graph is most appropriate.
- If the student is dealing with data that has both variables that are numbers, then a LINE graph is most appropriate.

- If the student has data that is dealing with percents, then a PIE graph is most appropriate.

When setting up a bar or line graph, the independent variable is always plotted on the horizontal or X axis. The dependent variable (the one recorded during the experiment) is plotted on the vertical or Y axis.

A graph must have:
1) A Title
2) Both axes labeled with the name of the variable and the units used to measure each
3) Equal increments on the axis (i.e., each line equals 5 cm.).

Step – 7 --Graph analysis and Drawing Conclusions

For middle school students :
1) look for patterns in the data and write them as your conclusion
2) Use median, mean and/or mode in your conclusion
3) Be sure to answer initial question of the project.

Step – 8 --Write Abstract

The Abstract

It is important to be able to share the project with others. One way to share information is in written form. The abstract is an important part of the research document. The abstract is a one page summary of the work. It should be a maximum of 250 words and include the a) purpose of the experiment, b) procedures used, c) data gathered and conclusions based on data gathered. (An official abstract form as stated in the rule book, is not necessary unless students are chosen to participate at the INTEL International Science and Engineering Fair.)

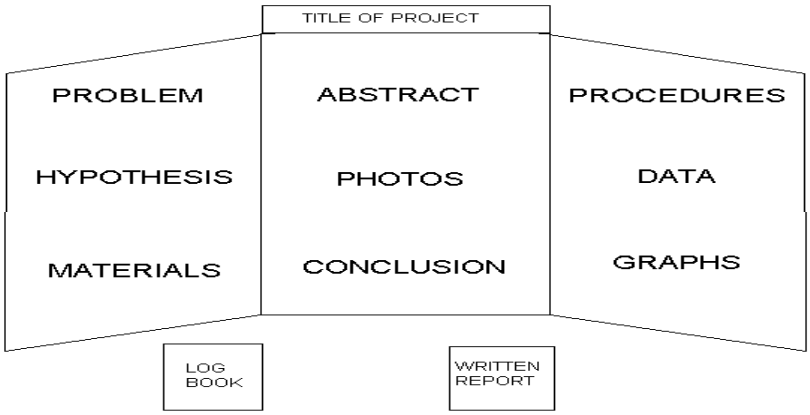
*The Abstract should be the first page of your research report and should be displayed horizontally with the board.

Step – 9 --How To Display The Results of The Experiment and Project

The Display Board

The display or exhibit is a way to communicate to others information about the project in a unique and creative way. Remember however, it's the science not the display that the teacher or judges will be most interested in. For MCSRC Division E, the display can be no more than 30 in. (76cm) deep, 36 in.(122 cm) wide and 108 in. (274 cm) high from floor to top of project. Tables will not exceed 36 inches (91 cm) in height for display of project board. All displays must be free standing. Make sure all materials conform to display and safety rules (See ISEF rule booklet), and are properly attached.
Your school name and teacher's name should not appear on the board, or written report.
See the next page for example.

Step - 10 --Students would present an oral presentation of project.



STEPS TO SUCCESS

The 1st Step to a sure – win project is that someone must ask a question.

The 2nd Step is that having asked the question one must set forth a hypothesis.

The 3rd Step is that having set forth a hypothesis to answer the question one must design a plan to test the hypothesis.

The 4th Step is that having designed a plan one must carry out the plan by experimentation and collection of data.

The 5th Step is that having completed the experimentation one must analyze the data, determine the mean and standard deviation and test for significance or correlation coefficient.

The 6th Step is that one must present the analyzed data meaningfully in graphs and /or tables.

The 7th Step is that one must interpret the data intelligently and clearly in the light of the hypothesis.

The 8th Step is that one must discuss the results in the light of a pertinent literature review.

The 9th Step is that one must form a complete conclusion

The 10th Step is that one must have answered "The Question" to his or her satisfaction and to that of the Science Fair Judges.

Science Research Topic Approval Form

Name _____

Question or Problem to be solved in research:

Purpose of Project

Bibliography (at least 5 credible sources)

Hypothesis:

Materials (List)

Procedures: What is your control and what is the variable in the project? Number each step.

Practical Applications: