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Scientific Planning Worksheet

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Scientific Method

A science project is an investigation using the scientific method to discover the answer to a scientific problem. Before starting your project, you need to understand the scientific method. This section uses examples to illustrate and explain the basic steps of the scientific method. The scientific method is the "tool" that scientists use to find the answers to questions. It is the process of thinking through the possible solutions to a problem and testing each possibility to find the best solution. The scientific method involves the following steps: doing research, identifying the problem, stating a hypothesis, conducting project experimentation, and reaching a conclusion.

Part 1: Find a problem. (Ask a scientific question that you are able to test.)

Scientific Problems

The problem is the scientific question to be solved. It is best expressed as an "open-ended" question, which is a question that is answered with a statement, not just a yes or a no. For example, "How does light affect the reproduction of bread mold on white bread?"

- Do limit your problem. Note that the previous question is about one life process of molds—reproduction; one type of mold—bread mold; one type of bread—white bread; and one factor that affects its growth—light. To find the answer to a question such as "How does light affect molds?" would require that you test different life processes and an extensive variety of molds.
- Do choose a problem that can be solved experimentally. For example, the question "What is a mold?" can be answered by finding the definition of the word *mold* in the dictionary. But, "At room temperature, what is the growth rate of bread mold on white bread?" is a question that can be answered by experimentation.

Our problem:

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Part 2: Do the research.

Researching Your Project

Once you've chosen a topic you can start your research. The purpose of researching is to understand your topic. Once you understand your topic, you will be able to plan out your experiment and state a specific hypothesis. You will also have background knowledge so that you will know what to watch for in your experiment.

Finding general information

The best starting point is to find general information about your topic. An encyclopedia or general science site is usually the first stop. Once you have some basic information you'll know the search terms for understanding more specific information on your project.

As the time this web page is written, the best science encyclopedias are in print or on CD-Rom. Encarta, World Book and Encyclopedia Brittanica are the favorites of many people. You may, however, find some information from an online encyclopedia.

General Science Sites

- BrainPOP Science
- How Stuff Works
- Science Fair Research Department
- Biology4Kids
- CLN Science Theme Pages
- Ventura County Research Site
- NSTA resources
- Access Excellence Resource Page
- Chem4Kids

Search engines that give good science sites for Middle School Students

- KidsClick!
- Itaki for Kids
- Yahooligans
- Google
- Vivisimo
- Ask Jeeves

No matter what kind of project you do, you need to gather as much information about your topic as possible. When doing your research, use a wide variety of resources, including:

- the internet
- government agencies
- local colleges and universities
- museums
- local science laboratories
- libraries, for books, magazines, cassette tapes, videotapes and maps
- historical societies and national parks
- hospitals
- planetariums
- zoo
- encyclopedias

You are required to summarize your research and include it in your introduction to your project.

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Complete the following sheet as note taking for your project.

- As well you must provided a ***works consulted*** once you have completed your project so keep an accurate list of all websites you looked at or used.

Fact Finding Sheet

Topic

In the boxes below, document your research in note taking form.
Don't forget to write down your sources.

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Part 3: Make a hypothesis - that is, a guess.

Hypothesis

A hypothesis is an idea about the solution to a problem, based on knowledge and research. While the hypothesis is a single statement, it is the key to a successful project.

All of your project research is done with the goal of expressing a problem, proposing an answer to it (the hypothesis), and designing project experimentation. Then all of your project experimenting will be performed to test the hypothesis. The hypothesis should make a claim about how two factors relate. For example, in the following sample hypothesis, the two relating factors are light and bread mold growth.

Here is one example of a hypothesis for the earlier problem question:

"I believe that bread mold does not need light for reproduction on white bread. I base my hypothesis on these facts: Organisms with chlorophyll need light to survive. Molds do not have chlorophyll.

In my exploratory experiment, bread mold grew on white bread kept in a dark bread box."

- Do state facts from past experiences or observations on which you base your hypothesis.
- Do write down your hypothesis before beginning the project experimentation.
- Don't change your hypothesis even if experimentation does not support it. If time permits, repeat or redesign the experiment to confirm your results.

Our hypothesis:

- Predict what the answer to the question will be.
- Be confident. Write your hypothesis in the form of a statement. Don't be wishy washy and begin your statement with "I think."

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Part 4: Experiment!

Project Experimentation

- Project experimentation is the process of testing a hypothesis.
- Think of a way to test your hypothesis. The test is the experiment.

The things that have an effect on the experiment are called ***variables***. There are three kinds of variables that you need to identify in your experiments: ***independent, dependent,*** and ***controlled.***

The ***independent variable*** is the variable you purposely manipulate (change).

The ***dependent variable*** is the variable that is being observed, which changes in response to the independent variable.

The variables that are not changed are called ***controlled variables***.

Do have only one independent variable during an experiment.
Do repeat the experiment more than once to verify your results.
Do have a control.
Do have more than one control, with each being identical.
Do organize data.

How will we test our hypothesis?

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What materials will we need to test our hypothesis?

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Important Factors: Variables and Controls

Your experiment should be carefully planned (that is, designed) to test one idea only. To do this, you will need a test variable and a control subject. A variable is a part (the one and only part) of the experiment that you change to test your idea. For example, to test whether plants need light, light should be the only variable.

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Say you use four plants in your experiment. You begin by setting plant #1 aside, giving it enough light and water to keep it healthy and lush. Plant #1 is your control.

For the other three plants, the only thing you change is the amount of light each gets (more or less than the standard set for your control plant). The amount of light is your variable. Everything else, such as soil, water, air, type of plant, type of pot and temperature should all be the same for all four test subjects.

Controls

- the subject that will never be tested on; it is used to compare results i.e. plant grown with tap water

Our control(s):

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Variables

- the substances that you will use to perform your experiment i.e. plants grown with coffee, Coca-cola, tea, etc.

Our Variable(s):

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Our Procedure:

- How are we going to perform the experiment and what steps will we take to test our hypothesis?
- How long will you be performing the experiment?

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Part 5: Scientific Journal

- Record the results in your journal.
- Continually collect data from the experiment over the next three weeks.
- Don't forget to take pictures if possible as they be can used on your presentation board.
- As well it is useful to record information in chart form since it is great to include them on your presentation board.

Example Journal Entry

Day 1

Observations: (interesting things, results, note all observations...even the smallest things)

Today is the first day after I planted my alfalfa sprouts and already things have grown! When I got up to water the plants this morning, I was surprised to find that 3 plants had actually popped out of the soil. This was incredible! Of course, none of these plants were photosynthetic yet because they had not turned green and they lacked chlorophyll, the substance that captures the sun's energy.
Today, the tallest plants (4 mm) were the ones fed with tap water. However, the coffee fed plants had the most sprouts (11 plants and 3 mm in height) compared with the tap water fed ones (two plants).

In order of growth (height):
Tap water (4 mm)
Coffee (3 mm)
Soap (2 mm)
The rest of the plants have not germinated.

- **USE THE FOLLOWING SHEET AS A TEMPLATE OR REPRODUCE IT ON YOUR HOME PRINTER.**

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Scientific Observation Journal

Day _____

Observations:

- interesting things, results, charts, etc.

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Part 6: Draw a conclusion.

Project Conclusion

The project conclusion is a summary of the results of the project experimentation and a statement of how the results relate to the hypothesis. Reasons for experimental results that are contrary to the hypothesis are included. If applicable, the conclusion can end by giving ideas for further testing.

If your results support your hypothesis:
You might say, for example, "As stated in my hypothesis, I believe that light is not necessary during the germination of bean seeds. My experimentation supports the idea that bean seeds will germinate without light. After seven days, the seeds tested were seen growing in full light and in no light. It is possible that some light reached the 'no light' containers that were placed in a dark closet. If I were to improve on this experiment, I would place the 'no light' containers in a light-proof box and/or wrap them in light-proof material, such as aluminum foil."

If your results do not support your hypothesis:
- DON'T change your hypothesis.
- DON'T leave out experimental results that do not support your hypothesis.
- DO give possible reasons for the difference between your hypothesis and the experimental results.
- DO give ways that you can experiment further to find a solution.

Figure out what the experimental data tells you by asking yourself the questions below:

- Do the results of your experiment tell you your hypothesis is on the right track or the wrong track? How?
- Is it possible to repeat the experiment? Should you change the experiment in any way?
- Did the experiment make you think of new questions that need answers?
- How can the information you found be useful? How does it relate to the world in which you live?

Our Conclusion:

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