ST. BASIL ACADEMY

9th GRADE
SCIENCE
RESEARCH PROJECT

STUDENT
HANDBOOK

2007-2008

I. The Scientific Method

Introduction

Scientific research is a process of investigation in which a hypothesis is tested under controlled conditions. This project is not the kind in which you build model of our Solar System or write report on Aquatic Mammals.

This is a project in which you will:

- ∞ Select a topic.
- ∞ Research basic information about your topic.
- ∞ Pose a problem to solve
- ∞ Put forth a hypothesis
- ∞ Write a procedure
- ∞ Collect and analyze data
- ∞ Draw a conclusion

We will spend several hours of class time in the computer lab and the library. This will allow you time to refine your question and to make sure there is enough available information.

A good project will require you to be thoughtful and creative. It would be great if you advanced to the regional fair but the most important thing is what you learn not what you won.

In an experiment, you collect information in order to test your hypothesis and design an experiment to test your question. The goal of the experiment is to determine how a change in one variable affects the outcome of the experiment. For example, you might test 5 brands of foot spray to determine which one effectively inhibits growth bacteria that cause foot odor.

An experimental design should have a control group and as many experimental groups as possible. The control establishes what the results would be if the variables did not change, so the data collected is under normal conditions. For example if you chose to test the most effective foot spray for bacterial growth, the control would be one dish with out being subjected to foot spray. Instead of medicated spray water should be used.
All other variables that effect bacterial growth should be kept the same.
(Temperature, light exposure, culture medium). The control group will then be compared to the experimental groups.

Choosing a Topic

One of the biggest Hurdles you face is choosing a good project idea. Some points to consider are:

- ∞ choose a topic that interests you

- choose a topic that you can understand
- choose a topic that is not too complicated

Narrow your topic into science project ideas by learning as much as you can about the subject. Discuss your ideas with teachers and people that may be able to help you design your project. Check out the library, magazines, and of course, the sciencefaircenter.com links for information you can use.
After studying your selected topic, begin asking questions that you can answer with scientific experimentation. Keep focusing in on a smaller subtopic until you have a specific question. Your question needs to be very specific. It should indicate the subject to be studied and the variables that will produce the data.

Some science fair projects that involve human subjects, vertebrate animals (animals with a backbone) or animal tissue, pathogenic agents, DNA, or controlled or hazardous substances, need SRC (Scientific Review Committee) approval from your science fair BEFORE you start experimentation. Now is the time to start thinking about getting approval if necessary for your science project.

Your Science Fair Research Project Question

The question that you select for your science fair project is the cornerstone of your work. The research and experiment you will be conducting all revolve around finding an answer to the question you are posing. It is important to select a question that is going to be interesting to work on for at least a month or two and a question that is specific enough to allow you to find the answer with a simple experiment. A scientific question usually starts with: How, What, When, Who, Which, Why, or Where. Here are some characteristics of a good science fair project question:

- The question should be interesting enough to read about, and then work on for the next couple months.
- There should be at least 3 sources of written information on the subject. You want to be able to build on the experience of others!
-

It is important to think ahead. This will save you lots of unhappiness later. Imagine the experiment you might perform to answer your question. How does that possible experiment stack up against these issues?

- The experiment should measure changes to the important factors (variables) using a number that represents a quantity such as a count, percentage, length, width, weight, voltage, velocity, energy, time, etc. Or, just as good might be an experiment that measures a factor (variable) that is simply present or not present. For example, lights ON in one trial, then lights OFF in another trial, or USE fertilizer in one trial, then DON'T USE fertilizer in another trial. If you can't measure the results of your experiment, you're not doing science!

- You must be able to control other factors that might influence your experiment, so that you can do a fair test. A "fair test" occurs when you change only one factor (variable) and keep all other conditions the same.

- Is your experiment safe to perform?

- Do you have all the materials and equipment you need for your science fair project, or will you be able to obtain them quickly and at a very low cost?

- Do you have enough time to do your experiment before the science fair? For example, most plants take weeks to grow. If you want to do a project on plants, you need to start very early! For most experiments you will want to allow enough time to do a practice run in order to work out any problems in your procedures.

- Have you avoided the bad science fair projects listed in the table below?

If you don't have good answers for the above issues, then you probably should look for a better science fair project question to answer.

Examples

These are examples of good science fair project questions:

- How does water purity affect surface tension?
- When is the best time to plant soy beans?
- Which material is the best insulator?
- How does arch curvature affect load carrying strength?
- How do different foundations stand up to earthquakes?
- What sugars do yeast use?

These are examples of bad science fair project topics that you should avoid:

Science Project Topics to Avoid	Why
Any topic that boils down to a simple preference or taste comparison. For example, "Which tastes better: Coke or Pepsi?"	Such experiments don't involve the kinds of numerical measurements we want in a science fair project. They are more of a survey than an experiment.
Most consumer product testing of the "Which is best?" type. This includes comparisons of popcorn, bubblegum, make-up, detergents, cleaning products,	These projects only have scientific validity if the Investigator fully understands the science behind why the product works and applies that

and paper towels.	understanding to the experiment. While many consumer products are easy to use, the science behind them is often at the level of a graduate student in college.
Any topic that requires people to recall things they did in the past.	The data tends to be unreliable.
Effect of colored light on plants	Several people do this project at almost every science fair. You can be more creative!
Effect of music or talking on plants	Difficult to measure.
Effect of running, music, video games, or almost anything on blood pressure	The result is either obvious (the heart beats faster when you run) or difficult to measure with proper controls (the effect of music).
Effect of color on memory, emotion, mood, taste, strength, etc.	Highly subjective and difficult to measure.
Any topic that requires measurements that will be extremely difficult to make or repeat, given your equipment.	Without measurement, you can't do science.
Graphology or handwriting analysis	Questionable scientific validity.
Astrology or ESP	No scientific validity.
Any topic that requires dangerous, hard to find, expensive, or illegal materials.	Violates the rules of virtually any science fair.
Any topic that requires drugging, pain, or injury to a live vertebrate animal.	Violates the rules of virtually any science fair.
Any topic that creates unacceptable risk (physical or psychological) to a human subject.	Violates the rules of virtually any science fair.
Any topic that involves collection of tissue samples from living humans or vertebrate animals.	Violates the rules of virtually any science fair.

Logbook
You will need a logbook (marble composition book) to record your question, take notes, and write your procedure, and bibliography, and record data. This book will be collected and reviewed through your experiment. All entries should be hand written.

Organize your logbook as indicated below: (page numbers can be changed depending on the amount of sub-questions you have.)

Page 1: Name
Page 2: Top- Title
Middle- Topic
Bottom – Purpose (keep it short and simple, begin with the word -"To"
Example. *Purpose – To determine if plants magnetic fields inhibit the growth of aquatic plants*)
Page 3 &4 Bibliography
Page 5 List of 5-10 sub-questions. (These are questions that you have about your topic)
Page 6-15 following your sub questions, each individual question should be written at the top of its own page. The remaining part of the part will be used to record notes that answer the question.
Page 16 Hypothesis
Page 17 Materials
Page 18 Procedure
Page 19+- Data and observations

RESEARCH
As you conduct your research, make a list of questions that occur to you. Record these questions on page 5 of your log book. Then as you discover answers to these questions, take notes in your logbook on the pages following this list.
When it is time to write the research for this report, the answers to these questions will be used to main content for this section.

Bibliography – See attached paper MLA format

Hypothesis

A hypothesis is a tentative statement that proposes a possible explanation to some phenomenon or event. A useful hypothesis is a testable statement which may include a prediction.

State you hypothesis as an If……then….. Statement.

If acetone inhibits growth in a bean plant, than those plants exposed to a 10 percent solution will not grow as tall as those exposed to a 5 percent solution. Those not exposed to acetone will grow the tallest.

Materials
In this section, list all of the equipment needed to carry out your experiment. Number each item. Use metric measurements

Example:
1. 1.5 liters of orange juice
2. hammer
3. 10 cm long electrical tape
4. 100 ml water

Procedure
In this section describe how to carry out your experiment. List your steps in numerical order. Each step needs to be written so that another person could carry out your exact experiment.
If this step is giving you trouble it may be due to not knowing enough about your topic, to may variables or a lack of control. See me for help.

Data
In your log book, your data can be recorded as observations, measurements or survey results.

Observations- before you begin your experiment describe what you see, take photos. As the experiment progresses, record changes, take more photos.

Measurements- when possible arrange data into a titled and labeled data chart.

The key to starting to interpret or analyze your data is a good Data Table. A good table should have the following parts:

- Title
- Column (Variable) Titles
- Units listed for each variable

Note: Use a computer spreadsheet to make a table. It is already arranged in columns and rows. You can then graph from the spreadsheet, and you can cut and paste the table into a word processing document.

Basic Format:

SAMPLE TABLE

Effect of Temperature on Plant Growth

TEMPERATURE (^{c}o)	PLANT GROWTH (cm)
10	14.2
15	15.7
20	17.1
25	18.9

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GRAPHING

In your final report your data must be presented by a graph. The independent variable should be on the x axis and the dependent on the y axis.

When organizing data into tables and graphs, always be sure to label columns/axes correctly and include units of measurement.

See Sample graphs at the end of this hand book.

Results

In this section you will discuss what your data shows; it is not the conclusion. Things you will need to discuss include:

- Does your data show a relationship or reveal some pattern?

- Is there a significant difference between your 2 groups?

- What possible sources of error are there?

Conclusion

In this section you will discuss what your project is proving. If your data does not show a pattern or if the difference between groups is small, you should say that there was no relationship or difference. This does not mean your project is a failure. Finding that there is **no** relationship is just as important to science as finding that there is. Also include:

- Acceptance or rejection of your hypothesis.

- Summary of what the project shows us, relating background reading and data.

- Explanation of whether you think your results are significant or possible affected by error or caused by coincidence.

- Significance or possible application of your findings.

- Recommendation for further investigation of the topic.

Rough Draft

The rough draft of the paper includes the following

- ∞ Title
- ∞ Purpose
- ∞ Research
- ∞ Works consulted
- ∞ Hypothesis
- ∞ Materials
- ∞ Procedure
- ∞ Data
- ∞ Results
- ∞ Conclusion

Refer to the information about all of the above in this handbook before turning in your draft. Due date will be announced.

Abstract

The abstract is the summary of your entire project. In its basic form, it should do 3 things:

1. Summarize what your project was about, why you chose it, and what you were attempting to learn.
2. Explain how you did it - describe briefly your procedure, groups, and variables.
3. What did you learn? - List data highlights, summarize what the data shows, and extend your project by indicating how you would do it again or apply the results to other situations.

Sample Abstract

This project concerns activity happening millions of miles away, on the sun. Sunspots are cooler, dark regions of the sun where the magnetic fields are disturbed. They are signs to an active sun. They can disrupt commutations on Earth when there is a solar maximum, or many sunspots and activity on the sun. A solar maximum is apart of the 11 year sunspot cycle. At the beginning of the cycle there are few sunspots, solar minimum, then gradually more appear, solar maximum, then it returns back to a solar minimum.

I have an interest in the sun, so I chose to perform this project. The problem is to discover the rotation rate of the sun and if there is a daily change in the number of sunspots. The other problems were to find the duration of sunspots, and if there are changes in the sizes of spots. It was hypothesized that there would be a smaller amount of large sunspots when compared to lesser ones and that they will last up until 30 days. It was also predicted that the rotation period of the sun determined by sunspots would be about 27 days. I believe that all sunspots will gradually increase in number and appear more frequently near the equator of the sun.

To answer the problems, accurate maps of the sun were received by logging on the Internet and visiting NASA's web site. The angle in which a sunspot had moved over a period of time was found next. To find the total number of sunspots, the sunspots were grouped into sizes by comparing a mark on an index card to the spot on the maps. The groups were >3mm, 2-3mm, 1mm, and <1mm. The sunspots in each group were totaled to find the variation in the number of spots. I also mapped the sun on my own using a reflecting telescope and a piece of white paper.

It was found that it takes the sun about 26 days to make a complete rotation, which is close to the actual rotation period, and my prediction of 27 days. It was also found that there are more less than 1mm marks than any other size. Next came 1mm, 2-3mm and, the least most occurring size of a sunspot is greater than 3mm. The number of sunspots varied from 18 spots to 52 spots. The predictions that were made were correct! Scientists can use my data to more thoroughly understand the sun and sunspots. I now look at the sun in a different 'light'.

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Displaying your work

Things to Remember:

1. Do not try to crowd too much information on your poster
2. Focus on only a few main points
3. Create simplified charts, graphs, and diagrams
4. Make key points clear by using a figure, table, or photograph
5. Vary the shape and size of visual elements
6. Use text simply and sparingly in a readable font

How To Layout Your Display Board

ABSTRACT	**Title** **Procedure** **Materials** **(number steps)** **(metric)**	**Results**
Purpose Hypothesis	**Graphs** **Pictures** **Data Table(s)**	**Conclusion**

Display Board "Do's and Don'ts

Do's

1. Keep your title short, snappy, and to the point.
2. Make sure all text can be read from a reasonable, comfortable distance
3. Lay out your information in a logical order
4. Stay close by, but stand off to the side in case visitors have any questions.

Don'ts

1. Use an overlong title
2. Use text that is too small
3. Separate complimentary ideas, pictures, charts, or graphs
4. Stand in front of your display