**Glossary**

**Control Group:** A control group is identical to all other items or subjects being examined with the exception that it does not receive treatment or experimental manipulation.

**Dependent Variable:** A variable that depends or is affected by the independent variable.

**Experimental Group:** The group manipulated during an experiment.

**Hypothesis:** A hypothesis is an educated guess.

**Independent Variable:** Independent Variable is the values being manipulated or controlled by the experimenter.

**Inquiry:** The act of asking questions and seeking answers.

**Qualitative Data:** Observational changes in an experiment.

**Quantitative Data:** Numerical changes in an experiment.

**References:** The references section is a bibliography consisting of a list of the sources used during the research process.

**Variable:** A variable is what is measured or manipulated in an experiment. Variables provide the means by which scientists structure their observations.

**Websites**

http://research.berkeley.edu/ucday/abstract.html


http://www.ece.cmu.edu/~koopman/essays/abstract.html

http://writing.colostate.edu/guides/documents/abstract/

http://www.experiment-resources.com/drawing-conclusions.html


Now that you have the tools for a rocking research experience, go on and begin your own cool adventure!
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GET READY TO SHOW OFF YOUR WORK!

Now that all the pieces of the puzzle are in tact its time to sell the bigger picture! The way to heritage show your interest and hard work is by writing an abstract and creating a poster that includes all the components of your research in a way that is insightful and interesting to the audience.

An abstract is a complete but brief description of your work to gain the readers interest so that they may want to look more into your work. Abstracts are usually 150-250 words long written in a specific format.

**Purposes for Abstracts**

Abstracts typically serve five main goals:

- Help readers decide if they should read an entire article
- Help readers and researchers remember key findings on a topic
- Help readers understand a text by acting as a pre-reading outline of key points
- Index articles for quick recovery and cross-referencing
- Allow supervisors to review technical work without becoming bogged down in details

**Five key questions an abstract should answer**

1. Why do we care about the problem and results?
   - This section should include the importance of your work, the difficulty of the area, and the impact it might have if successful.
2. What problem are you trying to solve?
   - Inform others about the problem.
3. How did you go about solving or making progress on the problem?
   - Did you use simulation, analytic models, prototype construction, or analysis of field data for an actual product? What was the extent of your work.
4. What is the answer?
   - Briefly explain the outcome of your research.
5. What are the implications of your answers?
   - How significant was this research and how important are the impacts?

The purpose of the brochure is to assist researchers in the process of conducting and presenting their research.

What exactly is research? Research is the creation of new knowledge. There are several forms of research: artistic, business, economic, social, scientific, and many more. The main focus of this booklet is the scientific form of research. Scientific research relies on the application of the scientific method. The following pages will break down the step-by-step process of the scientific method, from choosing a topic, to analyzing and concluding the experiment.
The scientific method is defined as a method of research in which a problem is identified, relevant data are gathered, a hypothesis is formulated from these data, and the hypothesis is empirically tested.

**Completed Research Worksheet**

**Pose a Question / Describe a Problem**

Can selling on-line photos pay back construction costs for the Yangon Sea Turtle Center at the Phu Quoc Green Adventure within five years?

**Formulate the Hypothesis**

No. I believe it would take longer than five years to pay back the construction costs of the Yangon Sea Turtle Center.

**Design the Experiment**

Data to be collected: 1. Can we build a coral reef in a coral reef photo on the side of the road? How many days does it take for the rock to be open?

Procedure for collecting data:
(Provide enough detail so that someone else could repeat your experiment)

1. Build the reef and locate the exact location of the rock.
2. Take a photograph to see how long it takes to get open (side length) the rock. Do this at least 6 or 7 times.
3. When has many people buy an on-line photo of the rock? Do the at least 6 or 7 times.
4. Talk about how many rocks the rock is sold. Check more advanced online book of how much the construction costs of the rock well.

**Analyze the Results**

<table>
<thead>
<tr>
<th>Rock Type</th>
<th>Cost per Rock</th>
<th>Rock Size</th>
<th>Rock Shape</th>
<th>Rock Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$1000</td>
<td>100 kg</td>
<td>Square</td>
<td>Red</td>
</tr>
<tr>
<td>B</td>
<td>$500</td>
<td>50 kg</td>
<td>Round</td>
<td>Blue</td>
</tr>
<tr>
<td>C</td>
<td>$1500</td>
<td>150 kg</td>
<td>Triangle</td>
<td>Green</td>
</tr>
</tbody>
</table>

*State Conclusions*

It will take approximately 15 years to pay $25,000,000 from the construction of Yangon Co. This is much longer than the five years posed in the original question was confirming the hypothesis.
Research Worksheet

Along with the brochure this worksheet will guide you through the research process. You may take notes here or on a separate sheet of paper to be reviewed.

Pose a Question / Describe a Problem

Formulate the Hypothesis

Design the Experiment

Data to be Collected:

Procedure for collecting data:

Conduct the Experiment and Collect the Data

(attach details separately)

Analyze the Results

(attach details separately)

State Conclusions

Choose a topic

The most important step in research is choosing a topic of interest. If the topic is not interesting it is less likely that the research will be enjoyable. It's often helpful to create a list of at least 5 topics and go through the process of elimination.

Formulate the Hypothesis

A scientific question usually begins with: How, What, When, Who, Which, Why, or Where. For example, if the topic of interest is plant growth efficiency, the question could be “Which fertilizer would be most efficient in growing plants?”

Can this question be tested?

The question being asked should involve factors or traits that are easily measured numerically (size, amount) or visually (color).

THINGS TO AVOID

- Opinionated questions that lack scientific validity such as “Which taste better Coke or Pepsi?”
- Any topic or experiment that will be extremely difficult to make or repeat.
- Topics that are highly subjective and difficult to measure such as “Effect of sound on emotion, taste, mood, memory, etc.”
- Any topic that creates unacceptable risk or harm to participant or researcher.
Now that a topic and question is formed it is now necessary to do research. Luckily you can build a plan or series of steps to follow.

- Identify and look up the keywords in your question.
- Generate research questions based on your keywords.
- Look for research or experiments similar to your topic.
- Network and ask for help (Peers, Teachers, Mentors)

### Question Words Table

<table>
<thead>
<tr>
<th>Why</th>
<th>Why does ______ happen?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Why does ______ happen?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>How</th>
<th>How does ______ happen?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>How does ______ happen?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Who</th>
<th>Who needs ______?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Who discovered ______?</td>
</tr>
<tr>
<td></td>
<td>Who invented ______?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>What</th>
<th>What causes ______ to increase (or decrease)?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>What is the composition of ______?</td>
</tr>
<tr>
<td></td>
<td>What are the properties and characteristics of ______?</td>
</tr>
<tr>
<td></td>
<td>What is the relationship between ______ and ______?</td>
</tr>
<tr>
<td></td>
<td>What do we use ______ for?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>When</th>
<th>When does ______ cause ______?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>When was ______ discovered or invented?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Where</th>
<th>Where does ______ occur?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Where do we use ______?</td>
</tr>
</tbody>
</table>

The purpose of a conclusion to sum up the process in which your hypothesis was either **confirmed** or **falsified** based on the results from your experiment.

- Summarize the experimental results.
- If the hypothesis is falsified do not change original hypothesis to match up with the final.
- Explain possible sources or error or what could have been different.

**Conclusion Checklist**

<table>
<thead>
<tr>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you summarize your results and use it to support the findings?</td>
<td>Yes / No</td>
</tr>
<tr>
<td>Do your conclusions state that you proved or disproved your hypothesis?</td>
<td>Yes / No</td>
</tr>
<tr>
<td>(Engineering &amp; programming projects should state whether they met their design criteria.)</td>
<td>Yes / No</td>
</tr>
<tr>
<td>If appropriate, do you state the relationship between the independent and dependent variable?</td>
<td>Yes / No</td>
</tr>
<tr>
<td>Do you summarize and evaluate your experimental procedure, making comments about its success and effectiveness?</td>
<td>Yes / No</td>
</tr>
<tr>
<td>Do you suggest changes in the experimental procedure and/or possibilities for further study?</td>
<td>Yes / No</td>
</tr>
</tbody>
</table>

**REMEMBER!**

- You cannot prove your hypothesis with a single run of an experiment because there is a high change of human error occurring.
- Success or failure is not dependent on whether or not a hypothesis is accepted or rejected, because both results still contribute to scientific knowledge.
Analysis

The analysis is a written description of the data and what happened throughout the procedure.

- Carefully review all the data that has been collected from the experiment.
- Use charts, graphs, and/or tables to analyze data and patterns.
- Were the results expected?
- Is there enough data to determine whether or not hypothesis is correct?
- Are all calculations verified?

Analysis Checklist

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes / No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Is there sufficient data to know whether your hypothesis is correct?</td>
<td></td>
</tr>
<tr>
<td>Is your data accurate?</td>
<td></td>
</tr>
<tr>
<td>Have you summarized your data with an average, if appropriate?</td>
<td></td>
</tr>
<tr>
<td>Does your chart specify units of measurement for all data?</td>
<td></td>
</tr>
<tr>
<td>Have you verified that all calculations (if any) are correct?</td>
<td></td>
</tr>
</tbody>
</table>

Hypothesis

After thoroughly researching your question, the next task is to formulate a hypothesis. A hypothesis is an educated guess often written in the “if-then” format.

- A hypothesis must be testable and later confirmed or falsified in the conclusion of the experiment.
- Contains independent and dependent variable.
  - "If a plant receives fertilizer [having fertilizer is the independent variable], then it will grow to be bigger than a plant that does not receive fertilizer [plant size is the dependent variable]." note *When writing your own leave out part in brackets*
- Variables are easy to measure.
  “Not every question can be answered by the scientific method. The hypothesis is the key. If you can state your question as a testable hypothesis, then you can use the scientific method to obtain an answer.”

Hypothesis Checklist

<table>
<thead>
<tr>
<th>Question</th>
<th>Yes / No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Does the hypothesis include the independent and dependent variables?</td>
<td></td>
</tr>
<tr>
<td>Have you worded the hypothesis so that it can be tested in the experiment?</td>
<td></td>
</tr>
<tr>
<td>If you are doing an engineering or programming project, have you established your design criteria?</td>
<td>Yes / No</td>
</tr>
</tbody>
</table>

If you can answer “yes” for all four questions then you’ll have a solid hypothesis!
The procedure is a step-by-step set of instructions to conducting the experiment that will test the hypothesis. The purpose for having a procedure is to allow duplication of the experiment.

- Plan how the independent variable will be changed and what impact it will have on the dependent variable.
- Make sure ONLY the independent variable is being changed.
- All controlled variables must remain constant.
- Description, amount and size of all materials being used should be listed.
- Procedure should entail how many trials will be run.
  - A typical experiment should be repeated AT LEAST three times for accuracy.
    - Example: If growing plants grow 3 or more in separate pots. (allows for more than one trial to be conducted at the same time.)
  - If experiment involves testing or surveying repeating is not necessary but having a sufficient number of participants is.

**Procedure Checklist**

- Have you included a description and size for all experimental and control groups?  
  Yes / No
- Have you included a step-by-step list of all procedures?  
  Yes / No
- Have you described how to the change independent variable and how to measure that change?  
  Yes / No
- Have you explained how to measure the resulting change in the dependent variable or variables?  
  Yes / No
- Have you explained how the controlled variables will be maintained at a constant value?  
  Yes / No
- Have you specified how many times you intend to repeat the experiment (should be at least three times), and is that number of repetitions sufficient to give you reliable data?  
  Yes / No
- The ultimate test: Can another individual duplicate the experiment based on the experimental procedure you have written?  
  Yes / No
- If you are doing an engineering or programming project, have you completed several preliminary designs?  
  Yes / No

**Data**

Data is the raw measurements after the procedure has been completed. The raw data is then compiled into charts, tables, and/or graphs to show changes that occurred.

**Data Checklist**

- Have you selected the appropriate graph type for the data you are displaying?  
  Yes / No
- Does your graph have a title?  
  Yes / No
- Have you placed the independent variable on the x-axis and the dependent variable on the y-axis?  
  Yes / No
- Have you labeled the axes correctly and specified the units of measurement?  
  Yes / No
- Does your graph have the proper scale (the appropriate high and low values on the axes)?  
  Yes / No
- Is your data plotted correctly and clearly?  
  Yes / No