Refrences

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.

Quantative 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.sciencebuddies.org/science-fair-projects/project_scientific_method.shtml

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

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

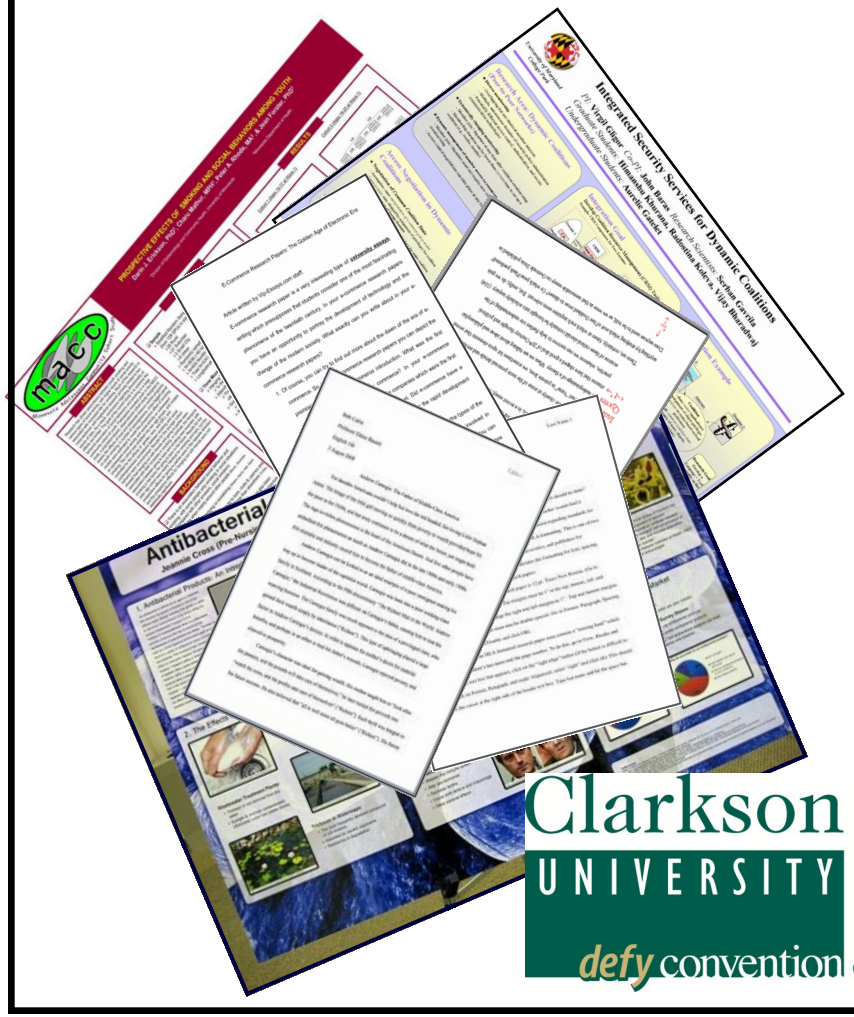
http://www.experiment-resources.com/drawing-conclusions.html

http://www.sciencebob.com/sciencefair/scientificmethod.php

http://srel.uga.edu/kidsdoscience/sci-method-planes/Sci-method-definitions.pdf

Now that you have the tools for a rocking research experience, go on and begin your own cool adventure!

IMPETUS Guide for Research Experiment and Poster Presentation



Clarkson UNIVERSITY

defy convention ®

Table of Contents

Poster

A poster tells a story

- Simplicity is the key
- The reader may only spend a few minutes looking at the poster
- Minimize clutter and maximize informative statements
  - You can communicate verbally the key points
- It needs to capture people's attention!

Presenting the poster

- Be prepared to sum up your ideas in 3-4 sentences
- Practice what you will say to people who are viewing your poster
- Anticipate people's questions and how you will answer them
- Think ahead about which parts of your poster will be difficult to explain

Kingda Ka

Question

Can selling on-ride photos pay back construction costs for the Kingda Ka roller coaster at Six Flags Great Adventure within five years?

Hypothesis

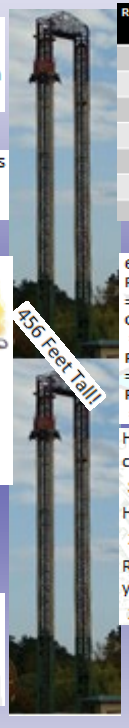
No, I think it would take longer than five years to pay back the construction costs of the Kingda Ka roller coaster.

Research & Experiment

How much did it cost to build ride?
– Look up online
How much is an on-ride photo?
– observation
How many people buy on-ride photos per ride?
– Observation
How long does it take for one ride to go?
– Observation
How many days a year is the park open?
– Look up online

Construction Cost: $25,000,000
Cost to buy on-ride photo: $4.00

•Park hours of operation: 9:00 am – 4:00 pm = 7 hours
•Park is open: May – September ≈ 153 days
•Average seconds per ride = 184.8571 ≈ 185
•Average number of on-ride photos per ride = 2



Data

Ride Number	Ride Length (seconds)	Number of On Ride Photos Bought
1	192	1
2	179	2
3	181	4
4	178	2
5	189	0
6	186	3
7	189	2

Analysis

60 sec/min * 60 min/hr = 3600 sec/hr
Rides per hour
= 3600s ÷185s = 19.45946 ≈ 19
On Ride Photos profit from each ride
= $4.00 * 2 = $8.00
Profit of On Ride Photos per hour
= 19*$8.00 = $152.00
Profit per day
= $152.00 * 7 hours = $1064.00

How many days will it take to pay for construction?
$25,000,000.00/ $1064.00 ≈ 23496 days
How many years is that?
23496 days /365 days per year = 64 years!!
Remember → Park is only open 153 days a year:
23496 days/153 days per year=154 years!!

Conclusion

It will take approximately 154 years to pay back the $25,000,000 from the construction of Kingda Ka. This is much larger than the five years posed in the original question thus confirming the hypothesis.

Future Work

How many bags of popcorn/cotton candy must the park sell to pay for ride?
What are the operating costs of the ride and how does the park pay for that?
Has the park benefited from constructing the ride or not?

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.

Abstract

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?

Introduction

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 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.

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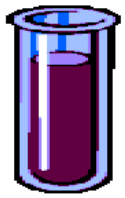
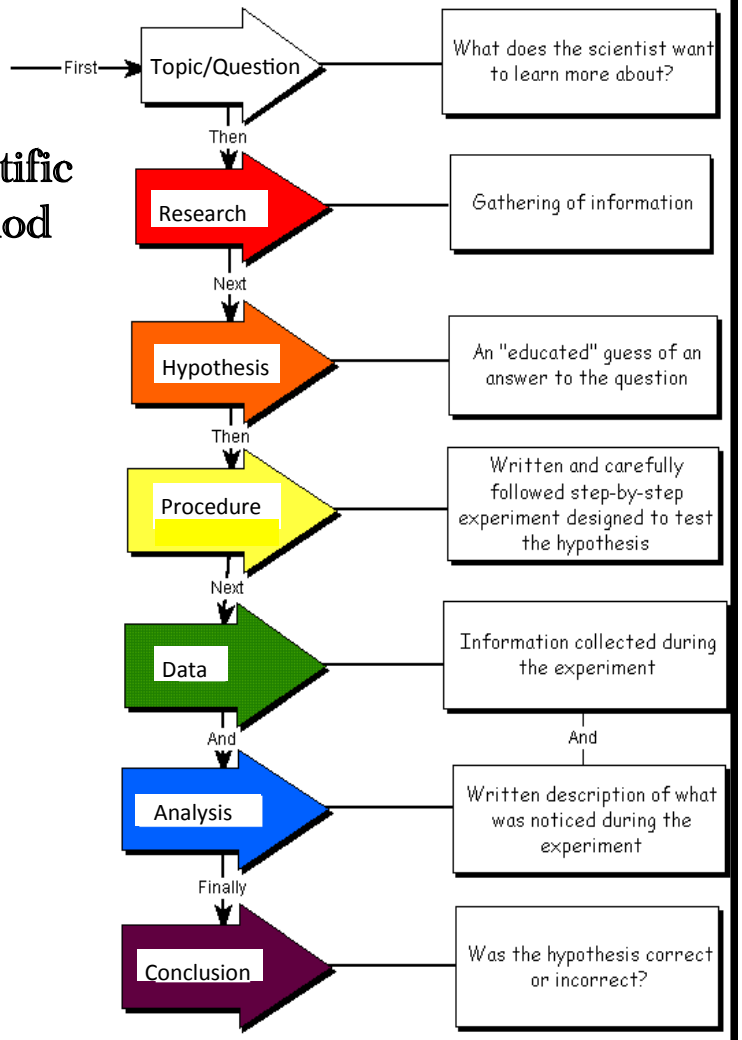


Scientific Method



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

IMPETUS for Career Success
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Pose a Question / Describe a Problem

Can selling on-ride photos pay back construction costs for the Kingda Ka roller coaster at Six Flags Great 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 Kingda Ka roller coaster.

Design the Experiment

Data to be collected: cost to build ride, cost of on-ride photo, # of on-ride photos per ride, length of one ride, how many days per year the park is open?

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

(1) At the park find out how much an on-ride photo costs at the booth
(2) Use a stopwatch to see how long it takes riders to get on/off (ride length) the ride. Do this at least 6 or 7 times
(3) Watch how many people buy an on-ride photo at the photo booth. Do this at least 6 or 7 times.
(4) On Great Adventure's website look up how many days the park is open.
(5) On Great Adventure's website look up how much the construction costs of the ride were

Conduct the Experiment + Collect the Data / Attract

Ride Number	Time (seconds)	# of on-ride photos sold
1	192	1
2	179	2
3	181	4
4	178	2
5	189	0
6	186	3
7	189	2

Cost to buy on-ride photo on Kingda Ka: $400

Used up: At Clarkson

Construction Cost: $25,000,000
Park is open 9am - 4pm: 7 hours
Park is open May - September: 153 days

Summarizing Data:

Average time per ride = 185 s
Average # of on-ride photos = 2

Analyze the Results

Calculate rides per hour:
(1) 60 seconds/min * 60 min/hour = 3600 sec
(2) 3600 sec/hour / 185 sec/ride ≈ 19 rides per hour

Profit on-ride photos per ~~average~~ day
(1) $4 * 2 photos/ride = $8.00 per ride
(2) 19 rides/hour * $8.00 per ride = $152 per hour
(3) $152 per hour * 7 hours/day = $1064 dollars/day

How many days?
$25,000,000 ÷ $1064 = 23496 days
How many years?
23496 / 365 days = 64 years?
* Park is only open 153 days a year

This is an example of a completed research sheet. This is what your worksheet should look like after completing the scientific method.

State Conclusions

It will take approximately 154 years to pay $25,000,000 from the construction of Kingda Ka. This is much longer than the five years posed in the original question thus 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

Topic / Question

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. Its is often helpful to create a list of at least 5 topics and go through the process of elimination.

Asking the right question

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 lacks 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.

Research

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.
  -efficient way to induce plant growth
- Generate research questions based on your keywords.
  -why is _____ efficient.
  -What is the difference between ____ & ____?
  -Use all "questions words" (what, where, why, how..)
  -Get rid of irrelevant questions or information.
- Look for research or experiments similar to your topic.
- Network and ask for help (Peers, Teachers, Mentors)

Question Words Table

Why	Why does _____ happen? Why does _____ _____?
How	How does _____ happen? How does _____ work? How does _____ detect _____? How does one measure _____? How do we use _____?
Who	Who needs _____? Who discovered _____? Who invented _____?
What	What causes _____ to increase (or decrease)? What is the composition of _____? What are the properties and characteristics of _____? What is the relationship between _____ and _____? What do we use _____ for?
When	When does _____ cause _____? When was _____ discovered or invented?
Where	Where does _____ occur? Where do we use _____?

Conclusion

The purpose of a conclusion to sum up the process in which your hypothesis was either **confirmed** or **falsified** based one 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

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

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

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

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

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

If you can answer "yes" for all four questions then you'll have a solid hypothesis!

Procedure

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