IMPETUS

for Career Success

Funded by NY State Education Department

Discovery Challenge

RESEARCH
And
POSTER
GUIDE

2018-2019

Clarkson UNIVERSITY

defy convention®

This program is made possible by funding through the
New York State Department of Education Science & Technology Entry Program.

Purpose and Program Services

To increase the number of historically underrepresented and economically disadvantaged students prepared to enter college, and improve their participation rate in mathematics, science, technology, health related fields and the licensed professions

STEP provides academic enrichment in science and mathematics content areas. Projects consist of academic year and summer components including:

- Core subject instruction/Regents exam preparation
- Supervised practical training
- Supervised research training
- College admissions counseling
- Standardized tests preparation
- Career awareness/development activities

Specific Goals and Requirements for the 2016-2020 funding cycle

- ✓ Increased recruitment and retention
- ✓ Improved 8th grade test scores on the NYS math and science exams
- ✓ Improved skills and aptitudes to pursue a postsecondary education leading to careers in scientific, technical, health-related, and licensed professions
- ✓ Increased student involvement in research, internships, college level coursework, and/or service learning
- ✓ Improved math and science skills in accordance with the Advanced Regents Diploma
- ✓ Strong parent involvement

IMPETUS
for Career Success
Funded by NY State Education Department

Table of Contents

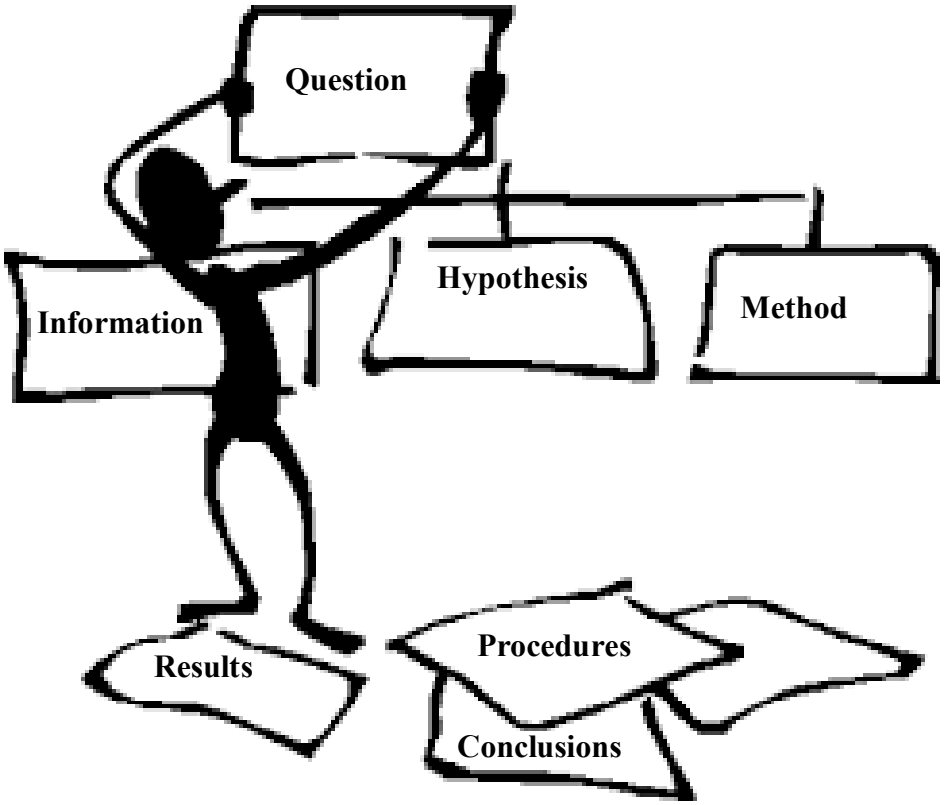
	Page
Introduction	4
Scientific Method	5
Choosing a Topic	6
Research Questions	7
Hypothesis	8
Procedure	9, 10
Data	11
Analysis	12
Conclusion	13
Abstract	15 - 18
Poster	19 - 21
Poster Worksheet Sample	22
Sample Poster	23

Clarkson
UNIVERSITY
defy convention ®

Introduction

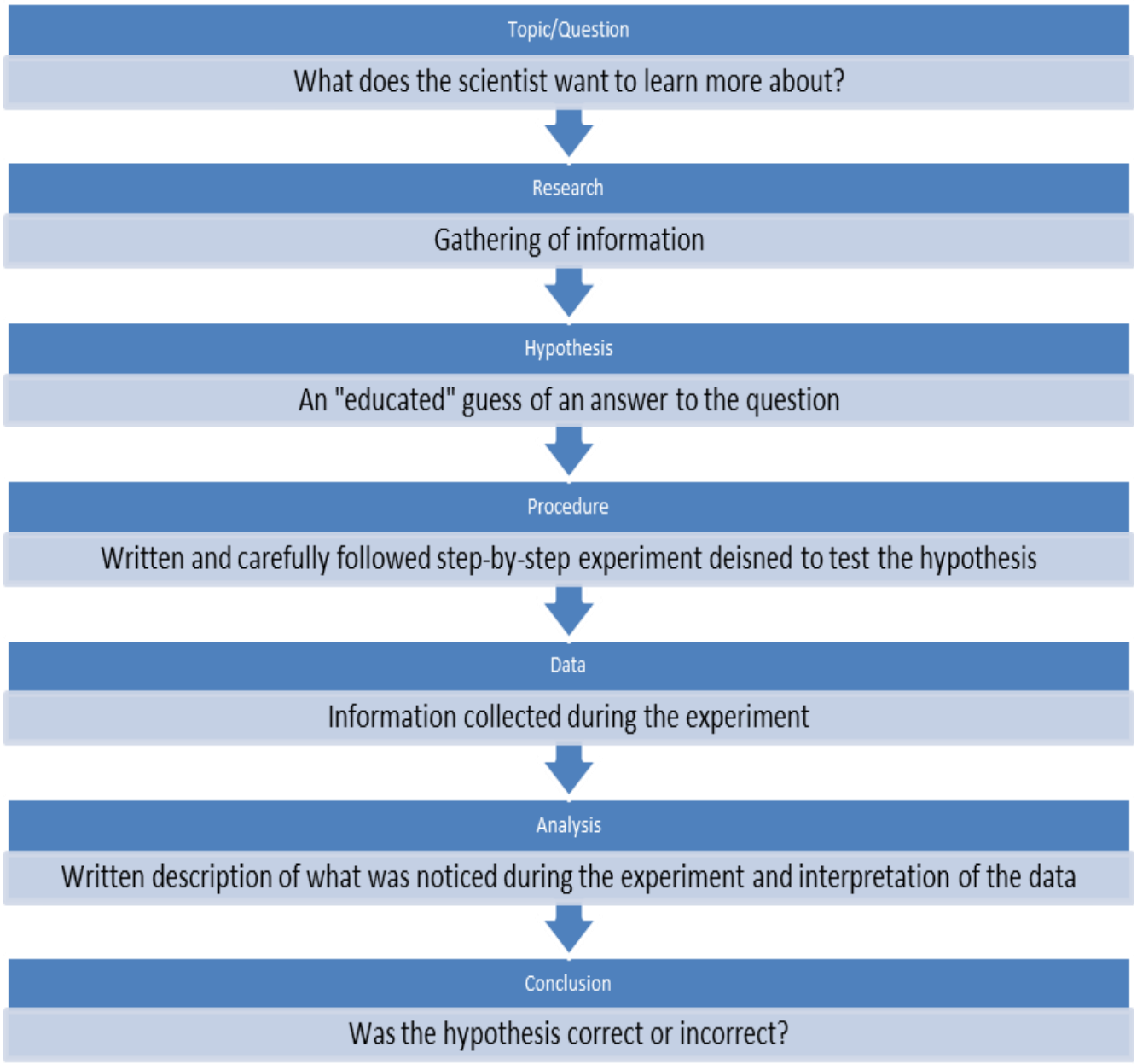
The purpose of this brochure is to assist IMPETUS researchers in conducting and presenting their research. You might wonder what exactly research is. Research is the creation of new knowledge. There are several forms of research: artistic, business, economic, social, scientific, and many more.

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 scientific method into a step-by-step process from choosing your topic to conducting your experiments analyzing your data and drawing conclusions.



The Scientific Method: Step by Step

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.



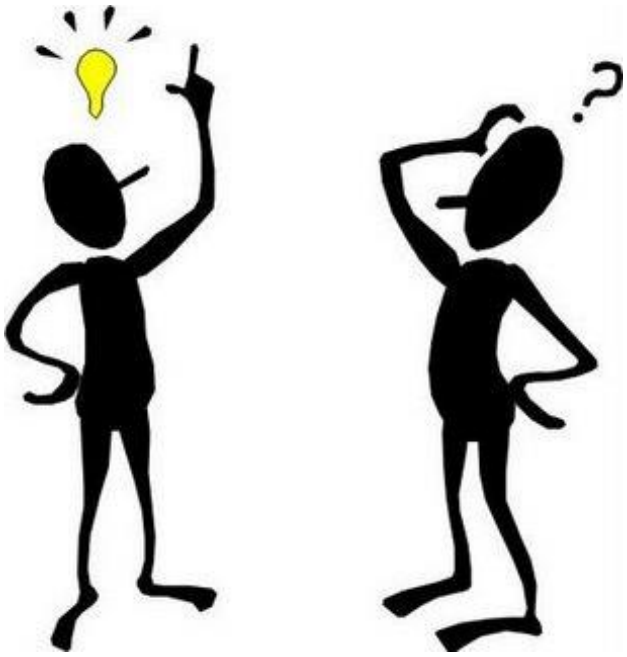
Choosing a Topic/Question

Choose a topic
The most important step in research is choosing a topic that is interesting to you. If the topic is not interesting it is less likely that the research will be enjoyable. It is often helpful to create a list of at least 5 different topics and go through the process of elimination until one seems most suitable.

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 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



Research

Now that you have decided on a topic and a question has been formed, it is necessary to perform research. This process can be done by building a research plan, a series of steps to accomplish your research.

Steps to follow:

- Identify and look up the keywords in your question.
- Generate research questions based on your keywords.
- Use all types of questioning words (what, where, why, how, …)
- Eliminate irrelevant questions and information.
- Look for research or experiments similar to your topic.
- If your topic has already been studied extensively, consider ways to make your research a little bit different. Or consider choosing a different topic.
- Talk with peers, teachers, and mentors to get help.

Question Words Table	
Why	Why does _____ occur? Why doesn't _____ do _____?
How	How does _____ happen? How does _____ work? How does _____ detect _____? How does one measure _____? How do we use _____?
Who	Who needs _____? Who benefits the most from _____?
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 uses does _____ have?
When	When does _____ cause _____? When will _____ occur?
Where	Where does _____ happen? Where can _____ be used?

Hypothesis

After thoroughly researching your question, the next task is to formulate a hypothesis. A hypothesis is an educated guess about what you think might happen. A hypothesis is often written in an "if-then" format.

A hypothesis must be testable. After conducting your experiments, the hypothesis is either confirmed or falsified. This result is stated in the conclusion of the experiment.

A hypothesis contains both the independent and dependent variable

- "If a plant receives fertilizer X, then it will grow to be bigger than a plant that receives fertilizer Y."
- In the above example, the independent variable is the fertilizer type and the dependent variable is the plant size.
- Variables should be easily measured.

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. If your question cannot be stated as a testable hypothesis, then you may need to rethink or rephrase your question.

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
Have you established your design criteria (for programming or engineering experiment)?	Yes/No/NA

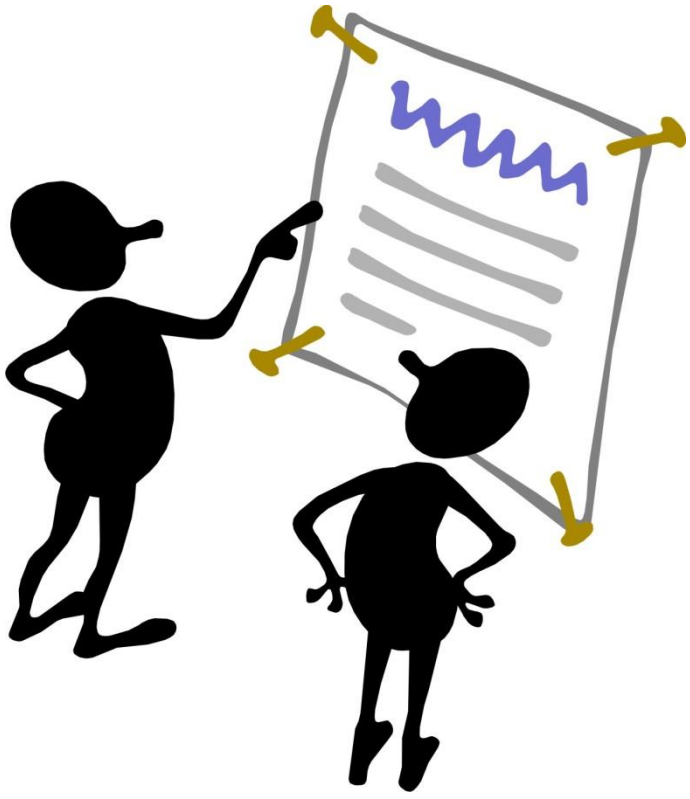
If you answered "No" to any of the above questions, revisit your research question and make the appropriate changes until you can answer "Yes" (or "NA") to these questions.

Procedure

The procedure is a step-by-step set of instructions. These instructions tell you how to conduct the experiment that will test the hypothesis. The purpose of having a procedure is to make sure you do things in a certain order and to allow duplication of the experiment by others.

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.
- Your procedure should state how many times you will conduct the process or how many trials will be run.
  - A typical experiment should be repeated AT LEAST three times for accuracy.
  - Example: If growing plants, cultivate 3 or more in separate pots.
  - Replications allow for more than one trial to be conducted at the same time.
  - If the experiment involves surveying people, repeating is not necessary. But having a sufficient number of participants is very important.



Procedure Checklist

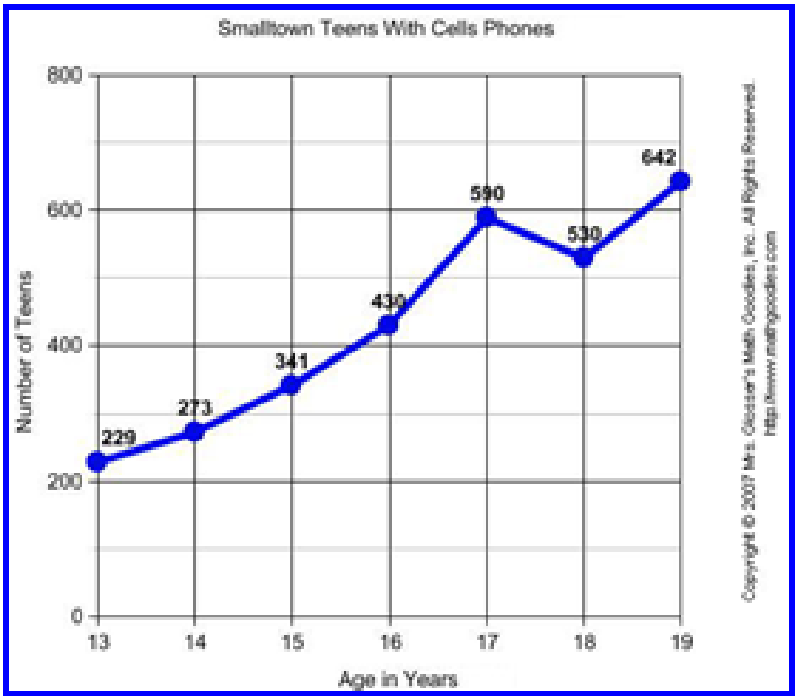
Have you included a description and size for all experimental and control groups?	Yes/No
Have you included a step-by-step list of all procedures?	Yes/No
Have you described how to change the independent variable and how to measure that change?	Yes/No
Have you explained how to measure the resulting change 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? 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
Have you completed several preliminary designs (for programming or engineering projects)?	Yes/No/NA

Data

Data are 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
Do your figures and tables have titles?	Yes/No
Have you placed the independent variable on the x-axis and the dependent variable on the y-axis?	Yes/No/NA
Have you labeled the axes correctly and specified the units of measurement?	Yes/No/NA
Does your graph have the proper scale?	Yes/No
Is your data plotted clearly and correctly?	Yes/No



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 help show trends or patterns in the data.
- Discuss whether or not the results were what had been expected.
- Include sample size to help determine if there is enough data for reliable results.
- Be sure to verify all calculations. Check all your math several times!

Analysis Checklist	
Is there sufficient data to know whether your hypothesis is correct?	Yes/No
Is your data accurate and reliable?	Yes/No
Have you summarized your data with the appropriate statistics and representations?	Yes/No
Do your statistics and visualizations specify the correct units of measurement for all data?	Yes/No
Have you verified that all calculations are correct?	Yes/No/NA

Conclusion

The purpose of a conclusion is to summarize 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 the original hypothesis.
- Explain possible sources of error, what could have been different, and provide possible reasons for unexpected results.

Conclusion Checklist	
Did you summarize your results and use it to support your findings?	Yes/No
Do your conclusions state that you proved or disproved your hypothesis?	Yes/No
Did you meet your design criteria (programming and engineering projects)?	Yes/No/NA
Did you state the relationship between the independent and dependent variables?	Yes/No
Did you summarize and evaluate your experimental procedure, making comments about its success and effectiveness?	Yes/No
Did you suggest possible changes to the experimental procedure and possibilities for future study?	Yes/No

REMEMBER: You cannot find support for your hypothesis with a single run of an experiment because there is a high chance 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.

GET READY TO SHOW OFF YOUR WORK!

Now that all the pieces of the puzzle are intact, it's time to show the world your hard work! The way to demonstrate that you are an accomplished researcher is by completing the Clarkson Discovery Challenge. Your next step is to write an abstract and create a poster that includes all the components of your research. Your abstract should be insightful and your poster interesting to look at. Let your intellect and creativity shine!

Winners will be eligible to attend the New York State STEP Conference in Albany to present their work at the state-wide competition!

YOUR ABSTRACT

Your 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 typically **150 - 250 words** long and written in a **specific format.**

Purposes for Abstracts: Abstracts usually serve five primary goals:

1. Help readers decide if they should read an entire article
2. Help readers and researchers remember key findings on a topic
3. Help readers understand a text by acting as a pre-reading outline of key points
4. Index articles for quick recovery and cross-referencing
5. Allow supervisors to review technical work without being bogged down by specific 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?
Tell or inform others about the problem.

3. How did approach 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 conclusions or answers?
How significant was this research and how important are the impacts?

STEP Conference Abstract Outline

Problem Statement/Introduction

- Why is this research project relevant?
- What practical, theoretical, or scientific gap is your research filling?
- What is the problem or question to be addressed in the project?
- What connections can be drawn between the problem, the context, and the purpose of the investigation?

Methods/Procedures

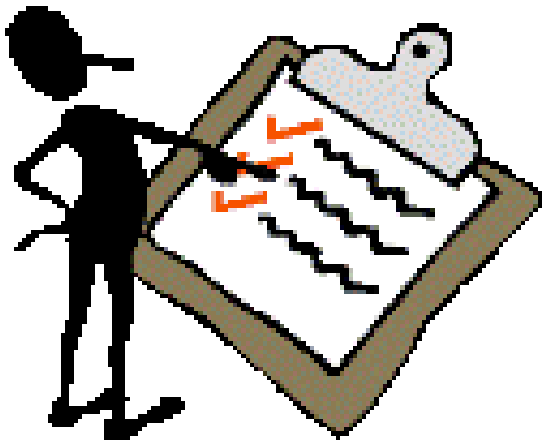
- What steps did you take to complete this research project?
- What materials and instruments did you utilize to conduct your research?
- What did you do to analyze your data?
- Should be specific and concise.

Results/Findings

- As a result of completing the above procedures, what did you learn, invent, or create?
- Summarize the major results. Be specific and concise.

Conclusion/Implications

- What were your research findings? What are the larger implications of your findings?
- Provide an interpretation and relate back to the problem.
- State the relevance and significance of your results to a broader context of the topic of interest.
- Make recommendations or state implications for future work



Abstract Checklist

Is your abstract 150 words or less (not counting names and school information)?	Yes/No
Does your abstract have all presenter's names? (A maximum of 4)	Yes/No
Have you included your title? Institution and grade level?	Yes/No
Did you include your poster division (Middle, Junior, Senior)?	Yes/No
Did you include your poster abstract number (1, 2, or 3)?	Yes/No
Do you have your problem statement, methods, materials, results, and conclusion?	Yes/No
Have you checked for typos and grammar?	Yes/No

STEP Conference Bibliography Requirements

A bibliography is a reference list that identifies books, articles, peer-reviewed journals, etc. that are mentioned, referenced, or used in a text.

All references should be in APA style. Please reference the tutorials below to help you create your bibliography:
http://www.apastyle.org/learn/tutorials/basics-tutorial.aspx
https://owl.english.purdue.edu/owl/resource/560/01/

Bibliography Checklist

Is your bibliography one page long?	Yes/No
Is your bibliography double-space?	Yes/No
Did you include one-inch margins for your bibliography?	Yes/No
Did you use Times New Roman font (12 pt.)?	Yes/No

POSTER

A poster tells a story

- Simplicity is key.
- The reader may only spend a few minutes looking at the poster.
- Minimize clutter and maximize informative statements.
- You can verbally communicate the fine details.
- 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 with prepared answers to several.
- Think about which parts of your poster might be difficult to explain and plan and practice your explanation.

POSTER CATEGORIES

Biological/Life Sciences

Investigate some aspect of life – Biology, Botany, Ecology, the Environment, Molecular and Cellular Biosciences, etc.
Examples: Genetics and Heredity, Effect of Sound on Plants

Human Services

Study human conditions pertaining to disease, families, children, safety, wellness, aging, human service agencies and their impact on the community, etc.
Example: Health Department's Study about Bacterial Meningitis and Teenagers

Physical Sciences

Research modern findings in Astronomy, Chemistry, Earth Science, Material Sciences, Physics, history and policy of science, etc.
Example: Observation of Freezing Rates of Water on Different Starting Temperatures

Social Sciences

Explore important subject matter in Anthropology, Sociology, Psychology, Political Science, History, Geography, etc.
Examples: Violence in Middle and High Schools, Effects of Media and Pop Culture on Students

Technology

Analyze technological advances such as robotics, fiber optics, computer science and programming, computer games, engineering, architecture, engineering technology, Computer Aided Design (CAD), graphics, etc.
Example: Virtual Homework Lockers for Students and Teachers

STEP Conference Poster Requirements

A poster is MANDATORY for the Research Poster Competition

Details:

⇒ **36 x 48 inches (Clarkson will print them)**
Automatic five point deduction if measurements exceed this

⇒ Display board must be freestanding

⇒ Students are allowed only one poster and are responsible for any special equipment (i.e., display boards, extension cords, laptops, iPads, projector, Internet access, etc.)

⇒ Poster should include the abstract, poster division, category of presentation, and bibliography

⇒ Poster should be clearly laid out, so as to be easily followed by someone without your help

⇒ **Text should be clear and readable at a distance of three feet**

⇒ Background should not be distracting

⇒ **All figures and tables should be properly labeled**

⇒ Any photos, tables, graphs, or visual aids should improve understanding and enhance the visual appeal of the poster

⇒ **Check for spelling and grammar issues**

⇒ Define all acronyms at the first instance they are used

References

Websites:

- https://undsci.berkeley.edu/article/howscienceworks_01
- 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
- https://sciencebob.com/science-fair-ideas/the-scientific-method/

Parts of the Research Poster

1. **Introduction and Hypothesis**
   Provide relevant and well summarized background information.
   Make clear connections to previous literature and broader issues.
   Include a goal or logical hypothesis that shows clear relevance.
   Clearly state the broad impact beyond the project.
2. **Methods and Experimental Logic**
   Include all methods utilized within the experiment.
   Be sure the methods used were the best possible choices to address the hypothesis (goal of the project).
3. **Procedures**
   Be sure all procedures were carried out correctly.
   Provide clear discussion and conclusion of controls and comparative groups.
4. **Results**
   Present substantial amounts of high quality data.
   Be sure your data visualizations are clear, thorough, and logical.
   Be sure your data is sufficient to support and address the hypothesis.
   Include potential problems and alternative approaches.
5. **Discussion and Conclusions**
   Give reasonable conclusions that are strongly supported with evidence. Make sure your conclusion connects the project hypothesis.
   Discuss relevance of results in a wider context

Presentation Guidelines

- Maintain eye contact with audience members
- Do not consult notes too often
- Be relaxed and self-confident
- Make as few mistakes as possible in what you are saying and how you say it
- Demonstrate a strong, positive feeling about the topic
- Use a clear voice with correct, precise pronunciation of terms
- All audience members should be able to hear you
- Demonstrate full knowledge of your topic
- Be able to answer any questions with explanations and elaboration
- Present in an organized, logical, and interesting sequence (follow the abstract)
- Use organization aids (announcing topics, transitions, summaries) to help audience members understand relationships among ideas
- Effectively convince the audience to recognize the validity of your research

IMPETUS for Career Success
Funded by NY State Education Department

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 / At Park

Ride Number	Time (seconds)	# of on-ride photos sold
1	197	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 Kingda Ka: $40.00

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

Profit on-ride photos per day
(1) $4 * 2 rides/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

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.

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

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?

IMPETUS

for Career Success

Funded by NY State Education Department

Dr. Ben Galluzzo
CDC Director

Dr. Katie Kavanagh
Dr. Michael Ramsdell
IMPETUS Directors

School of Arts and Sciences
Clarkson University
Potsdam NY 13699
Emails: bgalluzz@clarkson.edu
kkavanag@clarkson.edu
ramsdemw@clarkson.edu

Shipley Center for Innovation
Clarkson University
Dr. Mary Margaret Small
(315) 268-3791

Clarkson UNIVERSITY

defy convention ®