Gregg Anderson Academy PTA STEM Fair
Project Guide

Step 1: Question / Problem:

- Think about a topic that interests you. Sample Topic: "Cooking Chemistry".

- After choosing a topic, form a question that you'd like to find the answer to, or a problem you would like to solve.

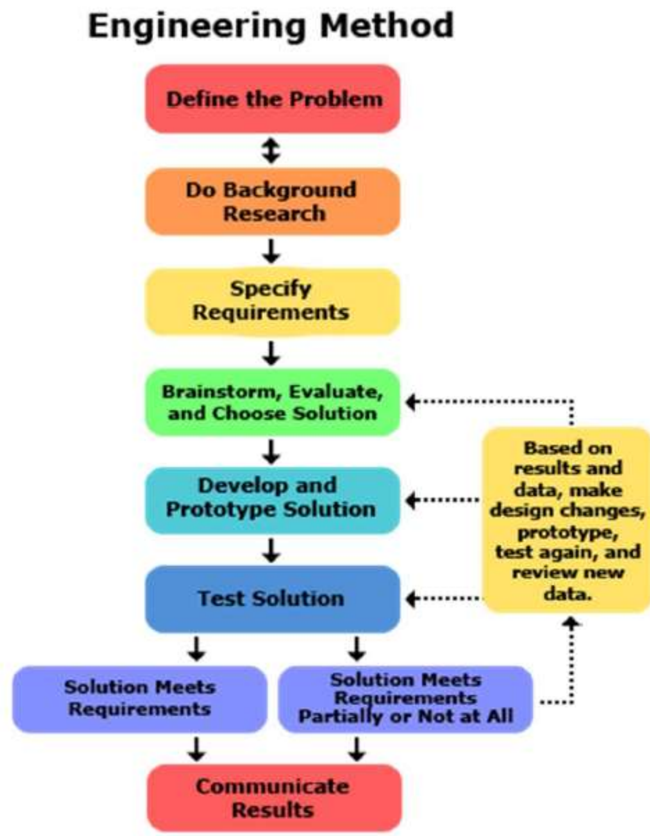
    - Sample Question (Scientific Method): "Will altering the amount of baking soda in my brownies make them not fall and be doughy in the middle?" The question needs to be one that can be answered by controlled experiment(s) that the student designs and performs.

    - Sample Problem (Engineering Design Process): My brownies always fall in the middle. I need a recipe that makes it so they do not fall and are not doughy in the middle.

To help find a question or problem, do some research (find out more information about the topic). This can help you form your question and will give you background information which will be needed later to help you predict the answer to your question.

Tip: Lots of topic and question ideas can be found online, in books teachers have in their classrooms or at the school or public library. To determine if you have a good question, ask: Is this something I would like to find the answer to? Would others be interested in knowing? Choose something appropriate for the student's grade level & ability – neither too difficult nor too easy. The best projects ask an interesting question or pose and interesting problem, then, explain in detail the steps of their discovery and the conclusion (the answer) they came up with.

**** Based on the above, determine whether to follow the Scientific or Engineering Process. ****



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Scientific Method Steps

Step 2: Background Research

- Do research to learn about your topic - gather background information from reference books or use the Internet. You need to have enough background information to make an educated 'guess' as to the outcome of your experiment.

Step 3: Hypothesis

- This is your prediction – your best guess of what you think will happen during your experiment. Write a sentence stating your guess. Remember, it's only a guess. You will find out the actual answer when you perform your experiment. The Hypothesis becomes what you will be testing with your experiment.
    - ***Important:*** It's OK if your hypothesis doesn't match the answer you get from your experiment.
    - Sample Hypothesis: Increasing baking soda in my brownies will help them to not fall and be less doughy in the middle.

Step 4: Procedure

- This is the experiment you will perform! It will give you the information (called Data) that you'll need to answer your Question.

- Plan Your Experiment**:**

    - Design a controlled experiment that will tell you the answer to your Problem.
    - Controlled experiments test only one thing at a time and have Constants (Control items or groups) and Test items or groups that receive a Variable.
    - A Variable is something that can be changed in the experiment.
    - Constants (Control items or groups) are the same as the Test items or groups. The Constants receive the same attention as the Test items/groups but do not receive the Variable (the change).

- Example:

1. I am going to make 3 batches of brownies.
2. I am going to start with the normal recipe (the control), then bake two more, each one increasing the baking soda by ½ tsp. I will then measure each pan to determine how far they have fallen, evaluate the middle for doughiness, and evaluate the brownies for taste on a scale 1 (yuck!) to 5 (yum!).
3. To control all the other variables (other than the amount of baking soda), I will:
    - Keep all the other ingredients the same.
    - Mix each batch for the same amount of time.
    - Bake each batch immediately after mixing.

   - Bake each batch for exactly the same amount of time in an oven at the same temperature.

4. I will then measure the brownies for 'fall' in the middle and have 5 independent people 'taste test' each batch of brownies and rate them from 1-5 for taste and texture and write down any observations as to the actual taste/texture of the cookies.

- Make a list of all the Materials needed for the experiment.
- Decide how you will record the information. For example, will you take pictures with a camera or draw pictures? If you will be making charts or graphs from your information, be prepared to write data down so you can create the charts/graphs from it later.

Step 5: Perform your experiment and record results

- Gather all the Materials you will need.
- Have your paper ready to use for writing down your information.
- If you are using a camera, have it ready or if drawing pictures, have your paper and drawing materials ready.
- Set up your Materials and perform your experiment! Make sure to record your Data!

Step 6: Analyze Data & Draw Conclusions

- Look at the Results of your experiment – the Data you collected.
- What is the answer to your Problem? Write a sentence stating your answer.
  - Was your Hypothesis correct? (Don't worry if it's not. Finding out your hypothesis is wrong is just as valuable as finding out it is right.)
  - If your experiment results are the same as your Hypothesis, then it's said they support your hypothesis. If results are different from your Hypothesis, state why you think your guess was different from your results. You can also make comments on what you learned.
  - Example Conclusion: Increasing the baking soda in brownies did make them fall less and turn out less doughy, but it negatively affected taste.

Step 7: Create Tri-Fold Display to Communicate Results

- See formatting suggestions at the end of this document.

Engineering Design Process Steps

Step 2: Background Research

- Background research is especially important for engineering design projects, because you can learn from the experience of others rather than blunder around and repeat their mistakes. Some suggestions of information to research:

  1. Identify questions to ask about the products that already exist to solve the problem you defined or a problem that is very similar.
  2. Plan to research how your product will work and how to make it.
  3. Network with other people with more experience than yourself: your mentors, parents, and teachers.

Step 3: Specify Requirements

- **Design requirements** state the important characteristics that your design must meet in order to be successful.
- One of the best ways to identify the design requirements for your solution is to use the concrete example of a similar, existing product, noting each of its key features.

  Example: What are the requirements for my 'perfect' brownies?
    - They will not fall in the middle.
    - They will be consistently done throughout (no doughiness)
    - They will taste great!

Step 4: Brainstorm, Evaluate & Choose Solution

- #1 Rule when creating alternative solutions: **DON'T SETTLE FOR YOUR FIRST IDEA!**
- Good designers try to generate as many possible solutions as they can before choosing one that they feel is the best.
- Some possible helps to generate more ideas:
    - Examining existing solutions
    - Creating and using analogies
    - Conducting brainstorming sessions
    - Sketching and doodling
- After brainstorming possibilities, choose the 'best' solution.
- First, look at whether each possible solution met your design requirements. Consider solutions that did a much better job than others and reject those that did not meet the requirements.
- It helps to compare solutions in a **decision matrix**—a chart with the requirements and criteria on one axis and the different solutions on the other.
- If your requirements and solutions are relatively simple, you can sometimes just list the **pros** and **cons** for each solution. Pros are good things about a solution and cons are bad things.

Step 5: Build a Prototype

- A **prototype** is an operating version of a solution. It is often made with different materials (cheaper and easier to work with) than the final version.
- Prototypes allow you to test how your solution will work and even show the solution to users for feedback.
- Creating prototypes may involve using readily available materials, construction kits, storyboards, or other techniques that help you to create your solution quickly and with little cost. Keep in mind that these don't necessarily need to be a finished product but are instead mockups of your final solution!

Step 6: Test & Redesign

- The design process involves multiple loops and circles around your final solution.
- Once you have a workable prototype, you need to test your solution.
- You need to design tests that will determine if your solution meets the requirements you outlined in Step 3.
- If the prototype does not meet all the requirements, then you must find the problems and make changes.
- This results in a new and improved prototype that is then put through the same tests.
- Once your prototype meets the requirements or is as close to them as you feel is truly possible, then you have reached your final design.

Step 7: Communicate Results

- Did your final design meet the required specifications? Why or why not?
- Are there any changes you feel need to be made if further design efforts were made?
- What did you learn through your design/redesign process?

Step 8: Create Tri-Fold Display

See formatting suggestions at the end of this document.

Science/Math Tri-Fold Suggestion

Question Research Hypothesis	**Title** Materials/Variables (Pictures)	Experiment Procedure Tables and Graphs Results/Conclusion

Engineering/Technology Tri-Fold Suggestion

Define Problem Research Specify Requirements	**Title** Create/Diagram (Pictures)	Build Prototype Test/Redesign Results/Conclusion

- **Note for both Engineering and Science Projects:** Must include Student's First and Last Name, Grade and Teacher's Last Name and Project Type (e.g.: Engineering/Science) **behind the tri-fold board (not in the front)**. Student must submit the tri-fold project board along with the project otherwise will be disqualified.

Student work:

- All work presented must be the student's work.
- Parents can be guides. Adults can supervise the investigation, but not take part except in cases of safety.
- Parents should not participate in the preparation or presentation, except to help with materials and act as an audience for practice.
- Students must cite research.