Diocese of St. Petersburg STEM Fair – Teacher Guidelines

Introduction

Science fairs have always been an integral part of science class. It teaches the student about the natural world, enhances math skills, and taps into their creativity. However, too often this experience fails to expose the student into authentic scientific inquiry. Science, technology, engineering, and mathematics, STEM, investigations take the benefits of self-directed investigations into a new level. STEM, encourages the student to solve authentic problems, work with others, and find real world solutions while still using the scientific method. Students may follow one of two types of investigations, the experimental investigation or the engineering design investigation. Due to the extensive limitations and restrictions of using live animals and/or microorganisms we are strongly discouraging investigations of this nature.

The Diocese of St. Petersburg, will host the first STEM Fair on January 14, 2017 and would like to invite all of our middle schools to participate in the fair. The goal of the fair is to increase interest in STEM investigations, increase STEM literacy amongst the students, and expose students to the wide array of career opportunities that can arise from STEM programs. This event is not only a competition but a showcase of the ingenuity and creative minds of our students.

Teachers are asked to evaluate their STEM Fair projects and assess if their student project will be adequate to present in the Hillsborough or Pinellas County Regional Fairs.

Timeline for STEM Fair

Date	Timeline
August 15	**Website will be set up for schools and teachers to register for participation in STEM Fair.**
August 29	**Students must begin brainstorming for ideas; have logbook and begin research.**
September 12	**Soft deadline for review of literature.**
September 19	**Soft deadline for research plan; experimentation can begin.**
October 24	**Soft deadline for data collection; students work on display.**
December 5	**Site based finalists are identified by schools.**
December 14	**Forms are to be completed; reviewed by committee.**
January 14, 2017	**STEM Fair at Bishop McLaughlin High School 13651 Hays Rd, Spring Hill, FL**

Teacher Guidelines for Experimental STEM Investigations

This is the most common type of science project. The experimental approach involves the design of an original experiment to test a specific hypothesis in which the student identifies and controls all significant variables. The experiment also involves accurate data collection, analysis, and presentation. All students will keep a logbook which will reflect every aspect taken in the investigation from beginning to end.

The following is the suggested approach for this type of investigation.

I. **Selecting the topic and researching a topic**
   a. Students will select a topic that interest them within the field of science
   b. The topic must must be a "real world problem" that **can be tested.**

II. **Background Research**
   a. Student will use several major references (e.g. science journal articles, books, internet sites, magazines, newspapers, personal interviews, etc.) from literature review.
      i. Must contain current, authoritative cited research from at least six books, scientific publications, vetted internet sources, or interview with scientists or credentialed experts in their pertinent fields.
   b. All research and investigations must be recorded in the student's log book.
   c. A good topic must align itself with a "need" that can benefit our world today.
      i. Examples of STEM topics:
         1. Water quality – The effect of phosphate runoff on algal growth

III. **Composing a testable question**
   a. The question asked will reflect the problem the student wants to solve
   b. The answer will not be one that is obvious or is already known in the scientific community.
      i. Examples of STEM questions:
         1. What is the best design for a dual compartment salt shaker?
         2. How does arch curvature affect load carrying strength?
         3. How does the amount of carbon dioxide affect atmospheric temperature?
         4. What is the effect of various wavelengths of light on current produced by a solar cell?

IV. **Forming a Hypothesis**

a. The hypothesis will be written as an if-and-then statement based on the background research.
b. The statement will be followed by the expected prediction and should reflect any expected relationship or trend. A rationale is offered in the hypothesis.
c. The hypothesis includes both dependent and independent variables
    i. Examples of STEM hypothesis:
        1. If temperature in Lake Maggiore increases due to global warming, then the metabolic rate of aquatic fish increases as well. As lake temperatures increase, the increase in metabolic rate of aquatic animals will be detrimental to their health. This will lead to a loss of diversity and will cause a direct impact on the food web of the lake.

V. **Design the experiment**

a. Students will consult safety concerns that must be addressed for their investigation.
b. The experiment will include:
    i. **Control** - what is used to compare to your independent variable
        1. Example - Algae without phosphate runoff
    ii. Identification of variables
        1. **Dependent variable** – what are they are measuring?
            a. Example – growth rate of algae
        2. **Independent variables** – what parts of the experiment will change
            a. Example – sampling of various areas of runoff
        3. Constants – the parts that stay the same to make the experiment fair
            a. Sampling the same amount of water, same species of algae, same time of day, etc.
c. Materials that are used; amounts/quantities/units are to be **metric**
d. Procedure - how did you perform the experiment?
    i. A list of steps used to perform the experiment.
    ii. It must follow a logical order
    iii. The experiment should be repeated **<u>as many times as possible</u>** for accurate results

VI. **Results** – State the facts of what happened in the experiment (just the facts)

a. **Data Table(s)** – Include table to show where all data gathered from the experiment is recorded.
b. **Graphs** – May be done by hand or on the computer
    i. Must include: a title, name, date, labeled axis lines, units, and possibly a key

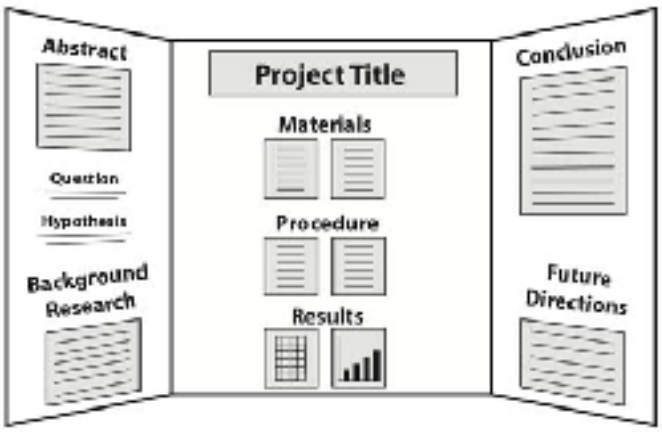
ii. Must be an appropriate type of graph (bar, line, pie/circle, etc.)
iii. Use of appropriate statistical analysis could be included (mean, median, mode, SD, etc)

VII. **Conclusion and Analysis of results** – include the following:

a. Must include **possible explanation(s)** for data trends.
b. Must show a clear relationship between the hypothesis and the results. Accept/reject.
c. Discussion of changes and follow-up questions that could be taken to further the research project
d. Include acknowledgements of mistakes they may have made

The Project Board for Experimental STEM Project

1. **Tri-fold project board**
    a. Project tri-fold boards may be Styrofoam or cardboard no larger than 36 in. x 48 in.
    b. Typed information must have a font size 14; double spaced
    c. Graphs must be neat and accurate
    d. See diagram below



2. **Follow the following display organization:**
    a. Left area:
        i. Abstract
        ii. Problem/need as question and hypothesis
        iii. Background research summary
    b. Central area:cc
        i. Project title
        ii. Design, Materials, Construction Process or Procedure
        iii. Results – data table, graphs, and description
    c. Right area:
        i. Analysis/Redesign of experiment, and testing.
        ii. Conclusion
        iii. Future Direction
    d. Works cited - in the back

3. Research paper and logbook will be placed on the table.

Physical Arrangement of the Experimental Research Paper

a. The paper will be typed, double spaced, and using font size 12, Times New Roman style and 8 ½" x 11" paper.
b. Student must use correct grammar and spelling.
c. Paper must be neat and legible.
d. The name of the main scientist will be placed on the upper right-hand corner of all pages.
e. Graphs will be properly labeled with correct axes, units, legend, and include a title.
f. Photographs must be of good quality.
g. Order of sections in the report:
    a. **Title page**
    b. **Abstract** – The concise summary of the work that is limited to 250 words or less. Abstract must be written in "past-tense" since the investigation has already been completed.
        i. Introduction – brief description of the purpose/objectives of the investigation.
        ii. Problem statement – Identify the problem investigated and the hypothesis.
        iii. Procedures – The approach of the investigation. Detail about materials is not necessary unless they are critical to the success of the project.
        iv. Results – what answers did the investigation produce
        v. Conclusion – were the objectives met?
    c. **Safety sheet** – All safety, hazard, and precautions taken during the investigations are found in this section. Please be mindful of MSDF data sheets.
    d. **Table of Content** – Include page numbers
    e. **Acknowledgements** – Give credit to those who helped.
    f. **Question and hypothesis** – Statements that show precisely the question the student is attempting to answer. The hypothesis and supporting details are included.
    g. **Background research** – The student will compose a section that shows their knowledge on the subject. This knowledge is based on all articles, documents, internet sites used in research.
    h. **Materials and Procedure** – Step-by-step account of all that was done and how the materials were used.
        i. Diagrams may be included
    i. **Results, Analysis, and discussion** – data tables and graphs
        i. Data well organized
        ii. Summary should follow the data
        iii. Data analysis – discussion of the results that include an evaluation and interpretation of the data/results of the investigation.

j. **Conclusion** – A well summarized evaluation and interpretation of the results. The conclusion should refer to the purpose and hypothesis of the investigation.

k. **Bibliography** –
    i. Uses APA style citations.
    ii. Is typed, double spaced, and contains one-inch margins on each side of standard paper, and may be double sided. Has a font style appropriate for a scientific paper (Times New Roman, Sans Serif, Tahoma) and has an appropriate font size (12-14).
    iii. Has correct spelling and grammar, and is neat and legible.
    iv. Uses a consistent third-person voice.
    v. Is revised and rewritten, as needed.

Teacher Guidelines for Engineering /Design STEM Investigations

Students often have difficulty distinguishing between science and engineering. Where traditional science employs the scientific method to answer a question, engineering often employs innovation, prototype building, testing, improving, re-designing, and data analysis. This approach can be fun for the student who wants to build or design something that will make life easier for himself or others. The design aspect of the STEM investigation will parallel the steps an engineer would follow to find a solution to a problem. The scientific process is different from the traditional science fair approach but if the student understands the scientific method, the engineering design will be easy to conceptualize. Students should use the following steps:

I. **Define the problem or need**
   a. Students will use a logbook to keep track of the project.
   b. Students will select a topic that interest them.
   c. Instead of stating a question, they should state a **"need"**; who will benefit and why.
   d. The topic must must be a "real world problem" that **can be tested.**
      i. Examples of STEM topics:
         1. Bridge design – build a cost effective bridge that can take an earthquake or hurricane winds.
         2. Computers – speed of computers
         3. Cost effective green energy techniques
         4. Consumer products – a better juice box, better product packaging
         5. Engineering – Effect of varying wheel ratios on distance traveled by motorized wheelchairs
   e. The student will describe in detail the problem and how the design will solve it.

II. **Background Research**

Student will use several major references (e.g. science journal articles, books, internet sites, magazines, newspapers, personal interviews, etc.) from literature review. Student should identify:

   a. Speak with scientists and/or people with background on the field.
   b. Must contain current, authoritative cited research from at least six books, scientific publications, vetted internet sources, or interview with scientists or credentialed experts in their pertinent fields.
   c. The target user for the project.

d. Study the science behind the area they want to design an object for.
e. Find out what is used today to address the problem.
f. Research the types of products that are currently in the market for that particular need.
g. Research what will be needed to design the object.
h. The research is contained within the written logbook.

III. **Design Criteria** – Specify Requirements
   a. Students will consult safety concerns that must be addressed for their invention.
   b. Brainstorm ideas. Student should develop as many ideas as possible or build on the ideas of others.
   c. The logistics of the project are outlined here: what is the size, weight, cost, and materials needed.
   d. Student should develop a preliminary design.

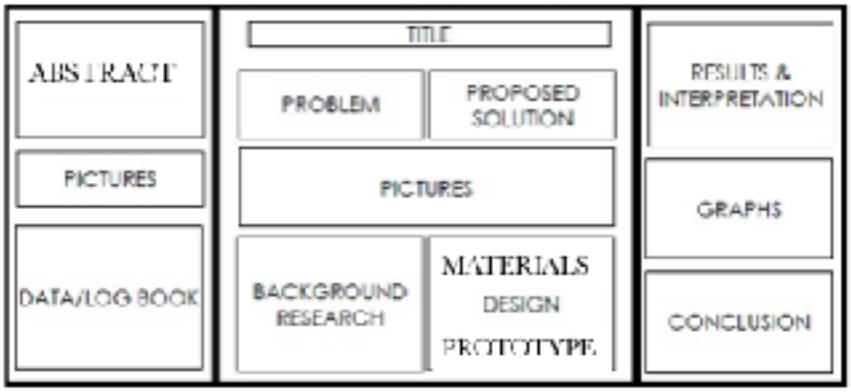
IV. Prepare and Test the Prototype
   a. The student puts forth his ideas into a prototype based on the specifications outlined during the designing phase.
   b. The student will build the designed prototype.
   c. Test the prototype
   d. Did the prototype work? The student is to test and analyze the performance of the prototype.
   e. Photos should be taken.

V. Redesign and Retest
   a. Photos should be taken.
   b. Data tables to track results are used. Analysis of results.
   c. Redesign of the prototype is carried out to increase performance.
   d. Data analysis of results are added to the redesign.

VI. Conclusion
   a. Analysis of the performance criteria is clear.
   b. How successful was the prototype?
   c. Did the prototype perform as it was expected?
   d. What were the challenges that were or were not overcome?
   e. How could the design be improved with further testing?

The Project Board for Engineering Design STEM Project

1. **Tri-fold project board**
    a. Project tri-fold boards may be Styrofoam or cardboard no larger than 36 in. x 48 in.
    b. Typed information must have a font size 14; double spaced
    c. Graphs must be neat and accurate
    d. See diagram below



2. **Follow the following display organization:**
    a. Left area:
        i. Background research leading to the design.
        ii. Design process beginning to end.
        iii. Photographs
    b. Central area:
        i. Project title
        ii. Problem / Need
        iii. Materials and Logistics required to complete the prototype
    c. Right area:
        i. Building procedure
        ii. Results / Graphs / any pertinent data
        iii. Analysis/Redesign of prototypes, and testing.
        iv. Conclusion
        v. Future Direction
    d. Works cited - in the back
3. Research report and logbook will be placed on the table

Physical Arrangement of the Engineering Design Report

a. Paper size – 8 ½" x 11"
b. The paper will be typed, double spaced, and using font size 12, Times New Roman style.
c. Student must use correct grammar and spelling.
d. Paper must be neat and legible.
e. The name of the main scientist will be placed on the upper right-hand corner of all pages.
f. Graphs will be properly labeled with correct axes, units, legend, and include a title.
g. Photographs must be of good quality.
h. Order of sections in the report:
    a. **Title page**
    b. **Acknowledgements** – Give credit to those who helped.
    c. **Abstract** – The concise summary of the work that is limited to 250 words or less. Abstract must be written in "past-tense" since the investigation has already been completed.
        i. Introduction – brief description of the problem/need of the prototype.
        ii. Summary of what was built to address the need. This will include specifications used to build the prototype.
        iii. Results – was the prototype successful, perform as expected, and did it require redesign.
    d. **Safety sheet** – All safety, hazard, and precautions taken during the investigations are found in this section. Please be mindful of MSDF data sheets.
    e. **Table of Content** – Include page numbers for each section:
        i. **Problem** or **need** – define the purpose of the prototype.
        ii. **Background research** – The student will compose a section that shows their knowledge on the subject. This knowledge is based on all articles, documents, internet sites used in research.
        iii. **Prototype Design** –
            1. Final design diagram
            2. List of materials that were used.
            3. Step-by-step account of all that was done.
            4. Final product - Diagrams and/or photos may be included
        iv. **Testing of the prototype** – results with data tables, photos, analysis of performance.
        v. **Redesign and retesting**
        vi. **Conclusion** – A well summarized evaluation and interpretation of the results. The conclusion should refer to the purpose and hypothesis of the investigation.

vii. **Bibliography** –

1. Uses APA style citations.
2. Is typed, double spaced, and contains one-inch margins on each side of standard paper, and may be double sided. Has a font style appropriate for a scientific paper (Times New Roman, Sans Serif, Tahoma) and has an appropriate font size (12-14).
3. Has correct spelling and grammar, and is neat and legible.
4. Uses a consistent third-person voice.
5. Is revised and rewritten, as needed.

Teacher Guidelines for Required Forms

Students who are candidates for the Regional County Fairs must complete and e-mail all forms by December 13, 2016 to tlusk@stpaul1930.org All guidelines and forms can be found at the Intel International Science and Engineering Fair, ISEF, website, however, the most notable forms are included with this document: https://student.societyforscience.org/intel-isef-forms