Inspiring innovation in student research!

Guiding Student Research

Planning and organizing student independent research for curriculum and competitions

Judy Day - judy_day@mac.com
www.ncsciencefair.org

NC Science and Engineering Fair
Science Education for all K-12 students should be built around these “Scientific and Engineering Practices”

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information
Scientific Thought vs Engineering Goals

- Scientific is hypothesis driven and includes experimental design and execution to test hypothesis.
- Engineering involves addressing a problem/objective by designing, constructing and testing a solution.
## Comparison of the Methods

<table>
<thead>
<tr>
<th>The Scientific Method</th>
<th>The Engineering Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>State your question</td>
<td>Define a need</td>
</tr>
<tr>
<td>Do background research</td>
<td>Do background research</td>
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<tr>
<td>Formulate your hypothesis, identify variables</td>
<td>Establish design criteria</td>
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<tr>
<td>Design experiment, establish procedure</td>
<td>Prepare preliminary designs</td>
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<tr>
<td>Test your hypothesis by doing an experiment</td>
<td>Build and test a prototype</td>
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<tr>
<td>Analyze your results &amp; draw conclusions</td>
<td>Test &amp; redesign as necessary</td>
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<tr>
<td>Present results</td>
<td>Present results</td>
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How is Research Done?

The Scientific Cycle

#1 Student Curiosity & Interest

#2 Develop Testable Question

#3 Experimental Design

#4 Test & Discover

#5 Student Analysis & Dissemination

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**The Goal**

**Improve:** Talk about what works, what doesn’t and what could be better. Redesign your solution. Brainstorm ways to make it the best it can be.

**Imagine:** Brainstorm many possible solutions. Ask questions. Research the problem. What have others done?

**Plan:** Choose a solution. Sketch a design. What materials will you need? What are your constraints? Consider the implications.

**Create:** Construct a prototype.

**Test:** Evaluate your prototype.
Where can a research project be done?

1. Home
2. School
3. University
4. Laboratory
5. Industrial Setting
6. Medical Center
7. Field
How do I get started?

- Visit the NC Science and Engineering Fair Web Site
  - [http://www.ncsciencefair.org/](http://www.ncsciencefair.org/)

- Use online guides
  - Intel ISEF Science Project Planner
    - [http://www.societyforscience.org/isef/participate](http://www.societyforscience.org/isef/participate)
The Process at a Glance

**Teachers**
- Set time line
- Form review committees
- Get parental support
- Culturally responsive
- Plan for differentiation
- Collect and copy forms
- Mentor students
- Science and Engineering Fair
  - set-up
  - scoring

**Students**
- Start Journal on research
- Topic selection
- Background research
- Develop questions
- Develop a research plan
- Experiment
- Write
- Display
- Present research

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Teachers Make a Time Line

- Plan time for each portion of the research
- Set up schedule for review of research plans prior to experimentation
- Develop time line for designing experiment and methods, experimentation, and analysis.
- Reserve time for putting together paper or project board
- Look at schedule for school and higher level competitions
Getting Parental Support

• Educate parents concerning student’s projects (not parent’s projects!)

• Provide information as to scientific investigation (not cookbook lab)

• Stress support roles of parents

• Request volunteers for mentoring and science competitions
Developing the Project
Students Make a Time Table

• Topic should not only interest you - but be do-able in the time that you have

• Develop time line for developing experiment and methods, experimentation, and analysis.

• Reserve time for putting together paper or project board

• Time table may be directed by teacher/mentor
Pick your topic

• Most difficult part
• Should come from something of great interest - hobby or topic know something about
• Should not be too broad that it can not be answered through the investigation
• Begin keeping your journal/research log!
• Good resource is the “Topic Wizard” on www.sciencebuddies.org
Research your topic

- Use internet - but look at sites, should look for “.edu” or “.gov”. NOT ALL INFORMATION IS CORRECT ON WEB! (Try using Googlescholar.com for journals)

- Use libraries – local resources and at NC State (as well as community and other colleges and universities)

- Talk to experts in the field - local and distant (NC State, Science Buddies, etc.)

- Create a bibliography of your sources

- Look for questions that you would like to answer.
Organize

• Look at what you have learned
• Think of questions that weren’t answered.
• Narrow your focus for your topic to a particular idea.
• Develop that “testable” question!
Develop Research Plan

Components of a Research Plan:

• Question being addressed
• Hypothesis/Problem/Goal
• Description in detail of method/procedures
• Any possible safety issues and how they will be handled
• How will you analyze the data that you collect
• Bibliography - at least 5 sources (will allow 3 for elementary)!

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Considerations for the Research Plan

• Make an experimental design BEFORE collecting data!
• Explain what you are going to do, what will be involved, and what you are trying to find out. (remember that “testable” question!)
• Need to have controls and document factors that influence experiment.
• Need to have limited variables so that you know what is changing and why.
• Design the process of your experiment

• Experiment should have large enough numbers to be valid.

• List materials needed

• List any safety issues and precautions

• Review types of data expected and how it will be analyzed
ISEF Rules Wizard

• ISEF rules wizard can be useful to determine forms needed
• http://apps.societyforscience.org/isef/students/wizard/index.asp
What are ISEF Forms

• Requiring ISEF Forms protects students and school.
• Forms must be reviewed **BEFORE** Experimentation
• [http://ncsciencefair.org/index.php/students-a-parents/forms](http://ncsciencefair.org/index.php/students-a-parents/forms)
• Local fairs can save paper by using an online system for Forms 1, 1A and 1B. Research plans, abstracts, and other forms need to be in hard copy.
• Students who win and go on to the next level will need hard copies of all forms.
A **Research Plan** is required that must incorporate all of the relevant topics listed in the Research Plan Instructions. Additionally an **Abstract** on the official form must be submitted.
Adult roles and Responsibilities

• Adult Sponsor
  – Oversees project
  – Parent, teacher, youth leader, scientist

• Qualified Scientist
  – Required for some projects (Form 2)

• Projects involving:
  – BSL-2 biological agents
  – DEA-controlled substances
  – human participants (dependent on project)
  – vertebrate animal studies
Setting up an Online Research Documentation for Elementary Schools

• https://docs.google.com/spreadsheet/embeddedform?formkey=dHJyT08xaEFmaDZPYzg5bXFnNEtaTHc6MQ
Before Experimenting!

✓ Have research plan reviewed by teacher (mentor) and get any approvals needed by ISEF rules or other groups’ regulations before beginning project!

All NC students must use the ISEF Forms 1, 1A, 1B, plus any required ISEF special forms. Please review NCSEF web site for additional information: www.ncsciencefair.org/index.php/students-a-parents/forms
Begin the experiment

- Keep detailed notes of every step and experiment in your journal/research log.
- Use data tables or charts as you proceed to help you see trends in data.
- Have quantitative data, but also record observational data.
Analyze Results

• After experiments, examine and organize findings
• Use graphs to show data
• Identify patterns in data
• Look for experimental error and where they could occur.
• Look at statistical relationships in data.
Draw Conclusions

• Did the variables that you tested show or cause a change?
• Were you able to see relationships?
• Did you collect enough data?
• Was your hypothesis supported?
• How did your data fit previous information that you found in your background research?
• What are practical applications or inferences that you can make?
• How would you change the experiment or future research area?
Present Findings

• Write an abstract of your project.
• Prepare a scientific paper, PowerPoint, or poster to present your findings.
• Present your project to class, school, or organization.
Project Display

• Review rules for display and safety
• Provide data notebook and research paper
• Board should have:
  – Title  - Experiment
  – Problem  - Results
  – Background  - Conclusions
  – Hypothesis/Problem  - Abstract (on table)

• Use more photographs instead of stuff!
  – Identify who took the photographs and all graphics
  – Have photo permissions for everyone besides the investigator
Science Competitions

• Local, Regional, State, and International Science Fairs
• Broadcom MASTERS (Middle School)
• I-SWEEEP (International Energy, Environment, and Engineering) and 3E Sustainable Future Challenge
• GENIUS Olympiad (High School)
• Student Academy of Science Competition
• Junior Science & Humanities Symposium
• Intel Young Scientist’s Award (Senior Year)
• NC International Science Challenge (High School)
• Siemen’s Competition (High School)
Top Resources

- NC Science and Engineering Fair:  [www.ncsciencefair.org](http://www.ncsciencefair.org)
- Science Buddies:  [www.sciencebuddies.org](http://www.sciencebuddies.org), information for students, teachers, and parents
- ISEF Get Started:  
  - [http://www.societyforscience.org/isef/participate](http://www.societyforscience.org/isef/participate)
- ISEF Rules and Guidelines:  
  - [http://www.societyforscience.org/isef/rulesandguidelines](http://www.societyforscience.org/isef/rulesandguidelines)
- ISEF Rules Wizard:  
  - [http://apps.societyforscience.org/isef/students/wizard/index.asp](http://apps.societyforscience.org/isef/students/wizard/index.asp)