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

9/18/2013

The New K-12 Next Generation Science Standards state:

<u>Science Education for all K-12 students should be built around these "Scientific and Engineering Practices"</u>

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

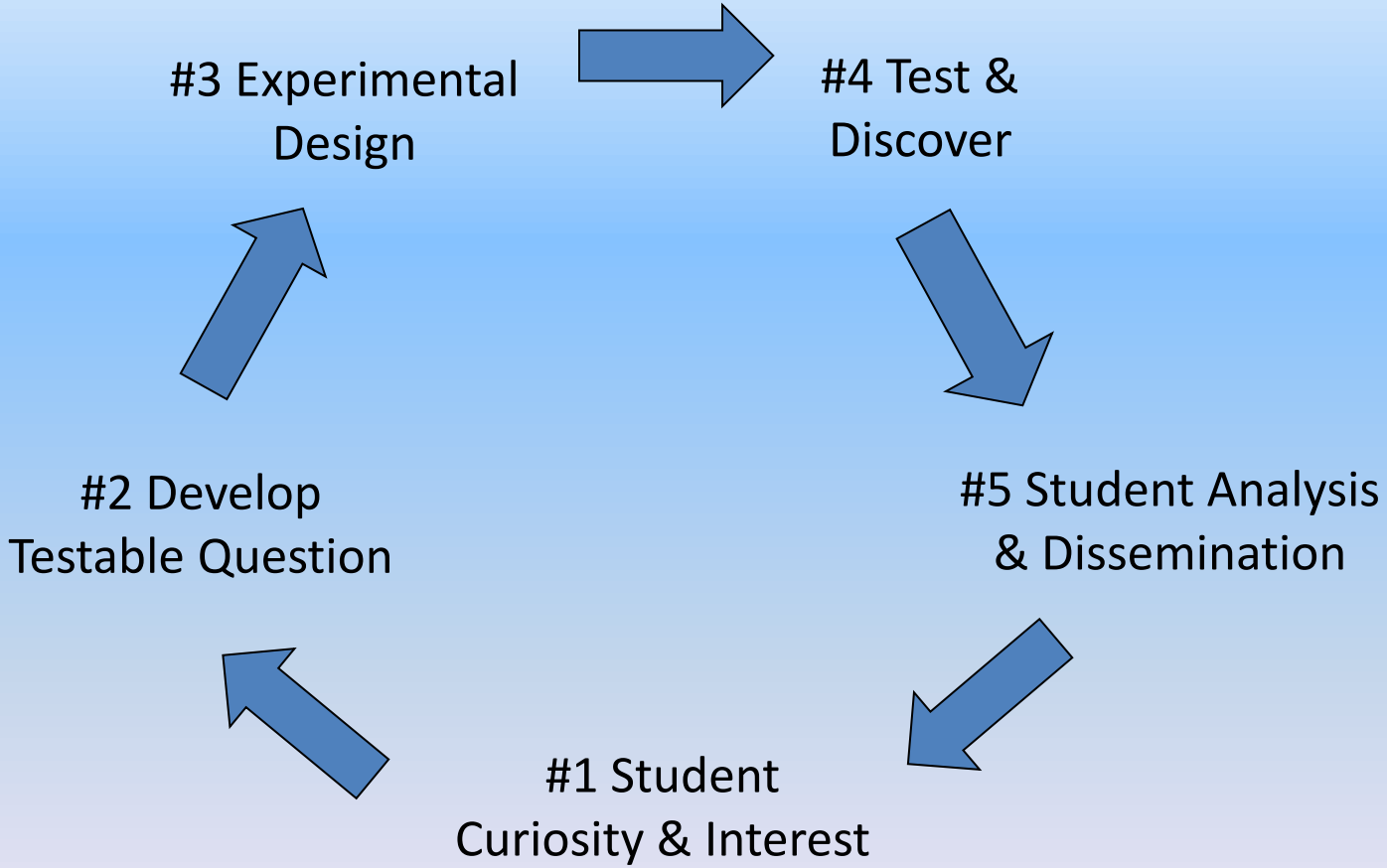
- Scientific is hypothesis driven and includes experimental design and execution to test hypothesis
- Engineering involves addressing a problem/objective by designing, constructing and testing a solution.

Comparison of the Methods

The Scientific Method	The Engineering Process
State your question	Define a need
Do background research	Do background research
Formulate your hypothesis, identify variables	Establish design criteria
Design experiment, establish procedure	Prepare preliminary designs
Test your hypothesis by doing an experiment	Build and test a prototype
Analyze your results & draw conclusions	Test & redesign as necessary
Present results	Present results

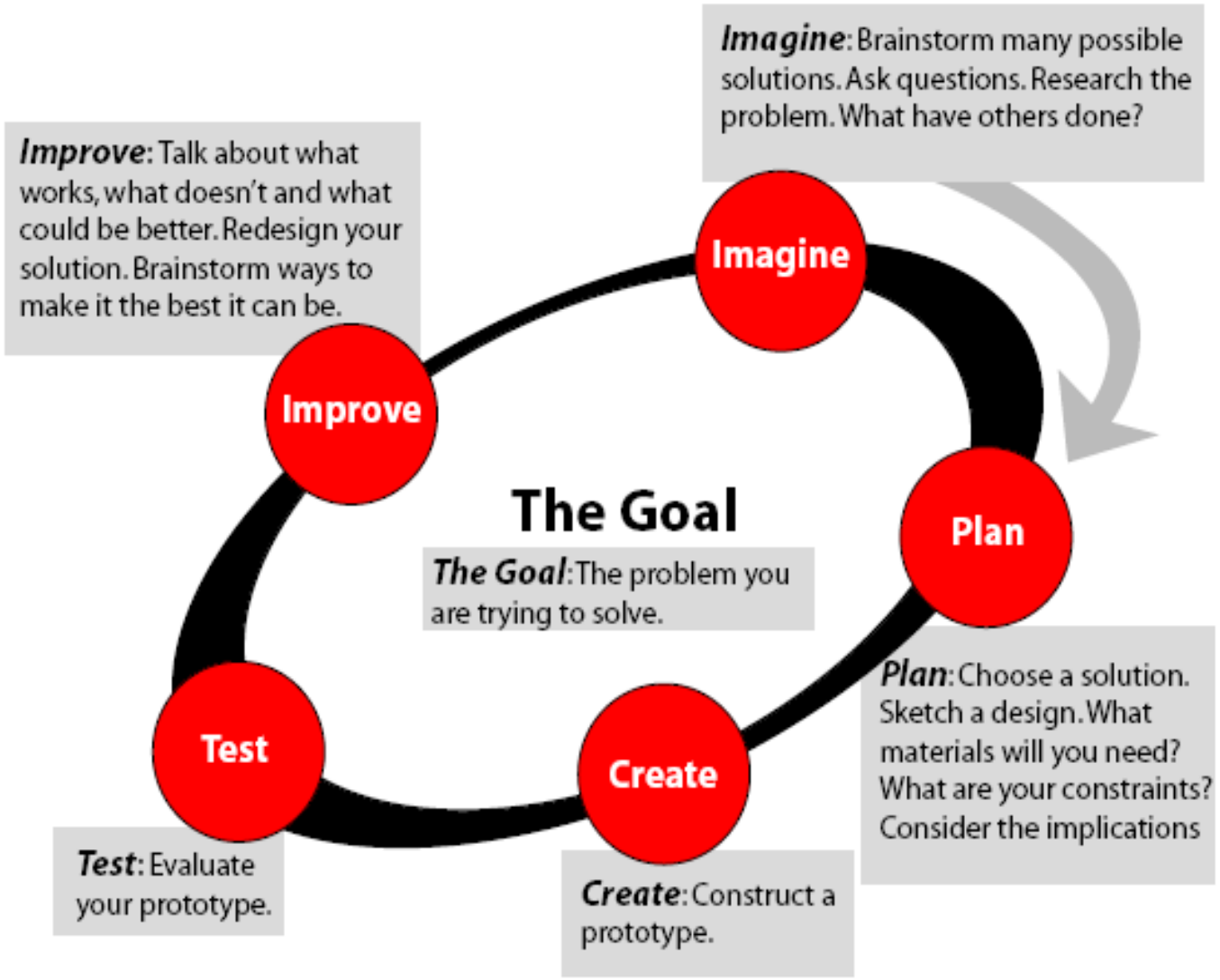
How is Research Done?

The Scientific Cycle



North Carolina Science and Engineering Fair

or Engineering Design Cycle



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/
- Use online guides
  - Intel ISEF Science Project Planner
    - http://www.societyforscience.org/isef/participate
  - Science Buddies (Project Ideas, Project Guide, “Ask an Expert”, and Resources)
    - http://www.sciencebuddies.org/mentoring/science-projects.shtml

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

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)!

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

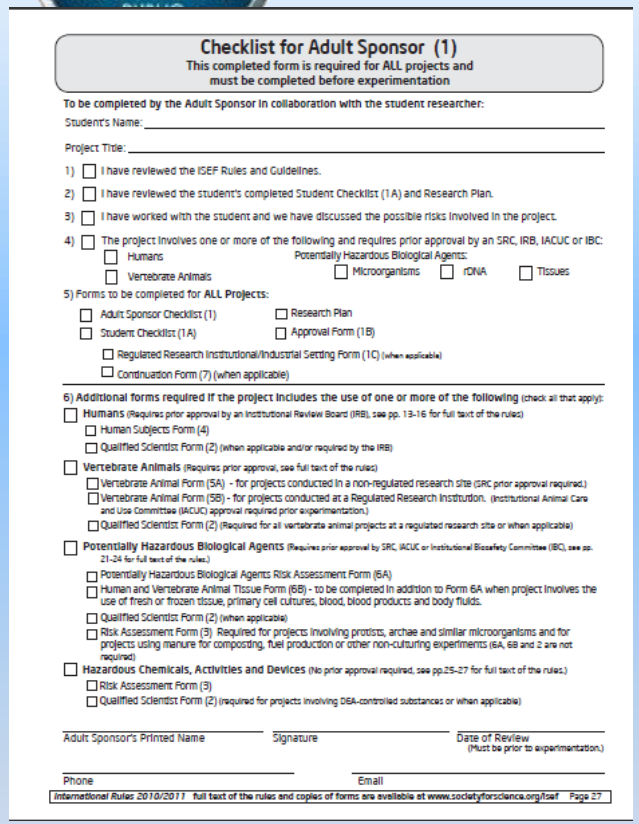
ISEF Rules Wizard

- 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
- 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.

Forms required for all projects



Checklist for Adult Sponsor (1)
This completed form is required for ALL projects and must be completed before experimentation

To be completed by the Adult Sponsor in collaboration with the student researcher:

Student's Name: _____

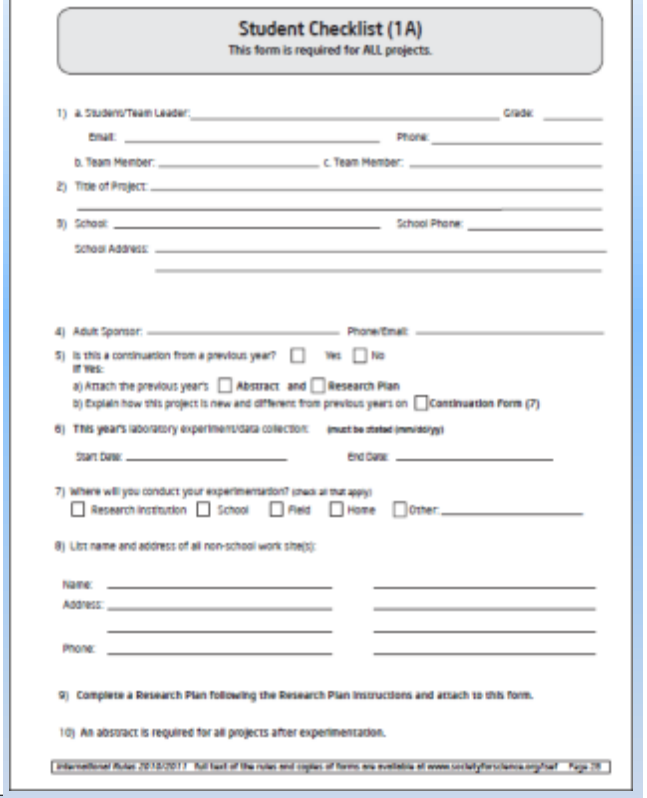
Project Title: _____

1) ☐ I have reviewed the ISEF Rules and Guidelines.
2) ☐ I have reviewed the student's completed Student Checklist (1A) and Research Plan.
3) ☐ I have worked with the student and we have discussed the possible risks involved in the project.
4) ☐ The project involves one or more of the following and requires prior approval by an SRC, IRB, IACUC or IBC:
☐ Humans ☐ Vertebrate Animals
Potentially Hazardous Biological Agents: ☐ Microorganisms ☐ rDNA ☐ Tissues
5) Forms to be completed for ALL Projects:
☐ Adult Sponsor Checklist (1) ☐ Research Plan
☐ Student Checklist (1A) ☐ Approval Form (1B)
☐ Regulated Research Institutional/Industrial Setting Form (1C) (when applicable)
☐ Continuation Form (7) (when applicable)
6) Additional forms required if the project includes the use of one or more of the following (check all that apply):
☐ Humans (Requires prior approval by an Institutional Review Board (IRB), see pp. 13-16 for full text of the rules)
☐ Human Subjects Form (4)
☐ Qualified Scientist Form (2) (when applicable and/or required by the IRB)
☐ Vertebrate Animals (Requires prior approval, see full text of the rules)
☐ Vertebrate Animal Form (5A) - for projects conducted in a non-regulated research site (SRC prior approval required.)
☐ Vertebrate Animal Form (5B) - for projects conducted at a Regulated Research Institution. (Institutional Animal Care and Use Committee (IACUC) approval required prior experimentation.)
☐ Qualified Scientist Form (2) (Required for all vertebrate animal projects at a regulated research site or when applicable)
☐ Potentially Hazardous Biological Agents (Requires prior approval by SRC, IACUC or Institutional Biosafety Committee (IBC), see pp. 21-24 for full text of the rules.)
☐ Potentially Hazardous Biological Agents Risk Assessment Form (6A)
☐ Human and Vertebrate Animal Tissue Form (6B) - to be completed in addition to Form 6A when project involves the use of fresh or frozen tissue, primary cell cultures, blood, blood products and body fluids.
☐ Qualified Scientist Form (2) (when applicable)
☐ Risk Assessment Form (3) Required for projects involving protists, archae and similar microorganisms and for projects using manure for composting, fuel production or other non-culturing experiments (6A, 6B and 2 are not required)
☐ Hazardous Chemicals, Activities and Devices (No prior approval required, see pp.25-27 for full text of the rules.)
☐ Risk Assessment Form (3)
☐ Qualified Scientist Form (2) (required for projects involving DEA-controlled substances or when applicable)

Adult Sponsor's Printed Name | Signature | Date of Review (Must be prior to experimentation.)

Phone | Email

International Rules 2010/2011 full text of the rules and copies of forms are available at www.societyforscience.org/isef Page 27



Student Checklist (1A)
This form is required for ALL projects.

1) a. Student/Team Leader: _____ Grade: _____
Email: _____ Phone: _____
b. Team Member: _____ c. Team Member: _____
2) Title of Project: _____
3) School: _____ School Phone: _____
School Address: _____
4) Adult Sponsor: _____ Phone/Email: _____
5) Is this a continuation from a previous year? ☐ Yes ☐ No
If Yes:
a) Attach the previous year's ☐ Abstract and ☐ Research Plan
b) Explain how this project is new and different from previous years on ☐ Continuation Form (7)
6) This year's laboratory experiment/data collection: (must be stated (mm/dd/yy))
Start Date: _____ End Date: _____
7) Where will you conduct your experimentation? (check all that apply)
☐ Research Institution ☐ School ☐ Field ☐ Home ☐ Other: _____
8) List name and address of all non-school work site(s):
Name: _____
Address: _____
Phone: _____
9) Complete a Research Plan following the Research Plan instructions and attach to this form.
10) An abstract is required for all projects after experimentation.

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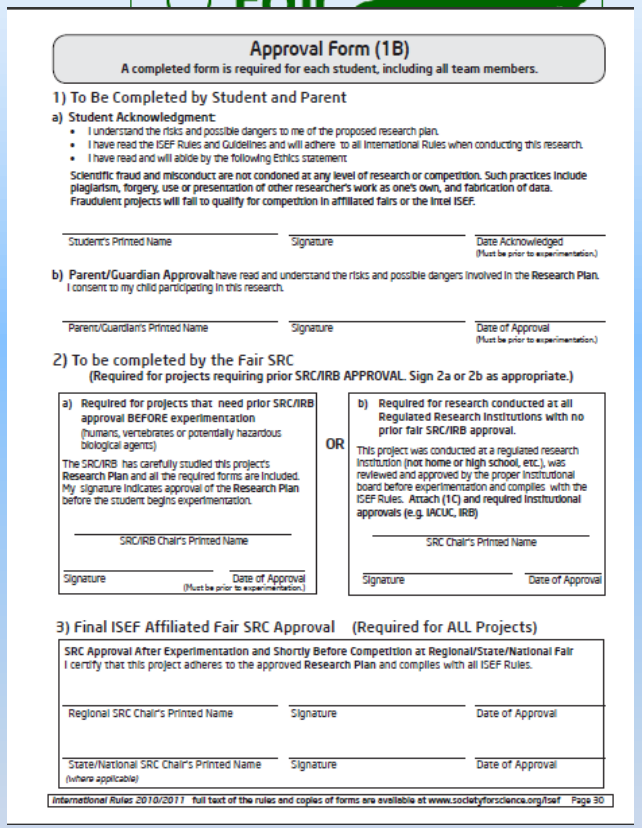


Approval Form (1B)
A completed form is required for each student, including all team members.

1) To Be Completed by Student and Parent

a) **Student Acknowledgment:**
- I understand the risks and possible dangers to me of the proposed research plan.
- I have read the ISEF Rules and Guidelines and will adhere to all International Rules when conducting this research.
- I have read and will abide by the following Ethics statement

Scientific fraud and misconduct are not condoned at any level of research or competition. Such practices include plagiarism, forgery, use or presentation of other researcher's work as one's own, and fabrication of data. Fraudulent projects will fail to qualify for competition in affiliated fairs or the Intel ISEF.

Student's Printed Name | Signature | Date Acknowledged (Must be prior to experimentation.)

b) **Parent/Guardian Approval** have read and understand the risks and possible dangers involved in the **Research Plan**. I consent to my child participating in this research.

Parent/Guardian's Printed Name | Signature | Date of Approval (Must be prior to experimentation.)

2) To be completed by the Fair SRC
(Required for projects requiring prior SRC/IRB APPROVAL. Sign 2a or 2b as appropriate.)

a) **Required for projects that need prior SRC/IRB approval BEFORE experimentation** (humans, vertebrates or potentially hazardous biological agents)
The SRC/IRB has carefully studied this project's **Research Plan** and all the required forms are included. My signature indicates approval of the **Research Plan** before the student begins experimentation.
SRC/IRB Chair's Printed Name
Signature | Date of Approval (Must be prior to experimentation.)

OR

b) **Required for research conducted at all Regulated Research Institutions with no prior fair SRC/IRB approval.**
This project was conducted at a regulated research institution (**not home or high school, etc.**), was reviewed and approved by the proper institutional board before experimentation and complies with the ISEF Rules. **Attach (1C) and required institutional approvals (e.g. IACUC, IRB)**
SRC Chair's Printed Name
Signature | Date of Approval

3) Final ISEF Affiliated Fair SRC Approval (Required for ALL Projects)

SRC Approval After Experimentation and Shortly Before Competition at Regional/State/National Fair
I certify that this project adheres to the approved **Research Plan** and complies with all ISEF Rules.

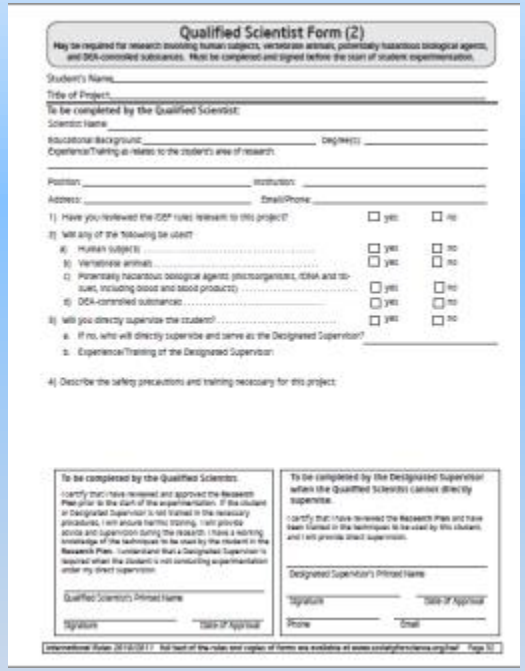
Regional SRC Chair's Printed Name | Signature | Date of Approval
State/National SRC Chair's Printed Name (where applicable) | Signature | Date of Approval

International Rules 2010/2011 full text of the rules and copies of forms are available at www.societyforscience.org/isef Page 30

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


Qualified Scientist Form (2)

May be required for research involving human subjects, vertebrate animals, potentially hazardous biological agents, and DEA-controlled substances. Must be completed and signed before the start of student experimentation.

Student's Name_____

Title of Project_____

To be completed by the Qualified Scientist:

Scientist Name_____

Educational Background_____ Degree(s)_____

Experience/Training as relates to the student's area of research:

Position_____ Institution_____

Address:_____ Email/Phone:_____

1) Have you reviewed the ISEF rules relevant to this project? ☐ yes ☐ no

2) Will any of the following be used:

a) Human subjects ☐ yes ☐ no

b) Vertebrate animals ☐ yes ☐ no

c) Potentially hazardous biological agents (microorganisms, rDNA and tissues, including blood and blood products) ☐ yes ☐ no

d) DEA-controlled substances ☐ yes ☐ no

3) Will you directly supervise the student? ☐ yes ☐ no

a. If no, who will directly supervise and serve as the Designated Supervisor?

b. Experience/Training of the Designated Supervisor:

4) Describe the safety precautions and training necessary for this project:

To be completed by the Qualified Scientist

I certify that I have reviewed and approved the Research Plan prior to the start of the experimentation. If the student or Designated Supervisor is not trained in the necessary procedures, I will ensure he/she is properly trained. I will provide advice and supervision during the research. I have a working knowledge of the techniques to be used by the student in the Research Plan. I understand that a Designated Supervisor is required when the student is not conducting experimentation under my direct supervision.

Qualified Scientist's Printed Name

Signature Date of Approval

To be completed by the Designated Supervisor when the Qualified Scientist cannot directly supervise.

I certify that I have reviewed the Research Plan and have been trained in the techniques to be used by this student, and I will provide direct supervision.

Designated Supervisor's Printed Name

Signature Date of Approval

Phone Email

International Rules 2016/2017 - Not each of the rules and copies of forms are available at www.societyforscience.org/isef Page 32

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
  - Problem
  - Background
  - Hypothesis/Problem
  - Experiment
  - Results
  - Conclusions
  - 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
- Science Buddies: www.sciencebuddies.org, information for students, teachers, and parents
- ISEF Get Started:
  - http://www.societyforscience.org/isef/participate
- ISEF Rules and Guidelines:
  - http://www.societyforscience.org/isef/rulesandguidelines
- ISEF Rules Wizard: http://apps.societyforscience.org/isef/students/**wizard**/index.asp