SECTION 3
Useful Information for Adult Sponsors and Students Participating in NJAS Science Fairs

Table of Contents

Title

Why Have Students Do Scientific Research?

According to national reports many of the students presently in school today will be functionally illiterate when they graduate. The fundamental premise of the AAAS's Project 2061 was that teachers need to focus on what is essential to scientific literacy and teach it more effectively. The project recommended changes in curriculum and teaching methods that contribute to a common core of learning for scientific literacy emphasizing thinking skills, connections between disciplines, and relationships between science and math. If we are serious about improving science education in Nebraska, then we have to recognize that the *Nebraska L.E.A.R.N.S.* and the *National Science Education Standards* imply changes in our science curriculum, instruction, and assessment.

Content standards in the *National Science Education Standards* outline what students should know, understand, and be able to do in the natural sciences. One of the eight content areas is **Science as Inquiry**. Standards presented in the *Nebraska L.E.A.R.N.S.* (Leading Educational Achievement through Rigorous Nebraska Standards) includes section 12.2.1 **Science as Inquiry** stating "By the end of twelfth grade, students will develop the abilities needed to do scientific inquiry.

Student demonstrations in Section 12.2.1 **Science as Inquiry** include:

- Identify questions and concepts that guide scientific investigations;
- Design and conduct scientific investigations;
- Use technology and mathematics to improve investigations and communications;
- Formulate and revise scientific explanations and models using logic and evidence;
- Recognize and analyze alternative explanations and models;
- Communicate and defend a scientific argument.

Science as Inquiry is an integral part of science education. Students doing experimental research exemplifies what is intended by both the State and National Science Standards. The Nebraska Junior Academy of Sciences provides support for students to problem solve, plan and conduct research investigations, and use appropriate tools to gather and analyze data. The Junior Academy provides an audience of peers, adults, and scientists for the students to communicate the results of their investigations at the regional, state, and national levels.

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NJAS Science Project Categories With Descriptions

The Nebraska Junior Academy of Sciences (NJAS) uses the same category names and descriptions as the Intel International Science and Engineering Fair (ISEF). Projects are grouped by category for judging at most NJAS Regional Science Fairs.

- **Behavioral and Social Sciences**: Human and animal behavior, social and community relationships--psychology, sociology, anthropology, archaeology, ethology, ethnology, linguistics, learning, perception, urban problems, reading problems, public opinion surveys, educational testing, etc.
- **Biochemistry:** Chemistry of life processes--molecular biology, molecular genetics, enzymes, photosynthesis, blood chemistry, protein chemistry, food chemistry, hormones, etc.
- **Botany:** Study of plant life--agriculture, agronomy, horticulture, forestry, plant taxonomy, plant physiology, plant pathology, plant genetics, hydroponics, algae, etc.
- **Chemistry:** Study of nature and composition of matter and laws governing it--physical chemistry, organic chemistry (other than biochemistry), inorganic chemistry, materials, plastics, fuels, pesticides, metallurgy, soil chemistry, etc.
- **Computer Science:** Study and development of computer hardware, software engineering, internet networking and communications, graphics (including human interface), simulations / virtual reality or computational science (including data structures, encryption, coding and information theory).
- **Earth and Space Sciences:** Geology, mineralogy, physiography, oceanography, meteorology, climatology, astronomy, speleology, seismology, geography, etc.
- **Engineering:** Technology; projects that directly apply scientific principles to manufacturing and practical uses--civil, mechanical, aeronautical, chemical, electrical, photographic, sound, automotive, marine, heating and refrigerating, transportation, environmental engineering, etc.
- **Environmental Science**: Study of pollution (air, water, and land) sources and their control; ecology.
- **Gerontology:** Study of the aging process in living organisms.
- **Mathematics:** Development of formal logical systems or various numerical and algebraic computations, and the application of these principles--calculus, geometry, abstract algebra, number theory, statistics, complex analysis, probability.
- **Medicine and Health:** Study of diseases and health of humans and animals--dentistry, pharmacology, pathology, ophthalmology, nutrition, sanitation, pediatrics, dermatology, allergies, speech and hearing, etc.
- **Microbiology:** Biology of microorganisms--bacteriology, virology, protozoology, fungi, bacterial genetics, yeast, etc.
- **Physics:** Theories, principles, and laws governing energy and the effect of energy on matter--solid state, optics, acoustics, particle, nuclear, atomic, plasma, superconductivity, fluid and gas dynamics, thermodynamics, semiconductors, magnetism, quantum mechanics, biophysics, etc.
- **Zoology:** Study of animals--animal genetics, ornithology, ichthyology, herpetology, entomology, animal ecology, paleontology, cellular physiology, circadian rhythms, animal husbandry, cytology, histology, animal physiology, invertebrate neurophysiology, studies of invertebrates, etc.

Steps to Doing Scientific Research

1. **Pick Your Topic**. Get an idea of what you want to study. Ideas might come from hobbies or problems you see that need solutions. Due to limited time and resources, you may want to study only one or two specific events.
2. **Research Your Topic**. Go to the library or internet and learn everything you can on your topic. Observe related events. Gather existing information on your topic. Look for unexplained or unexpected results. Also, talk to professionals in the field, write or email the companies for specific information, and obtain or construct needed equipment.
3. **Organize**. Organize everything you have learned about your topic. At this point you should narrow your hypothesis by focusing on a particular idea. Your library research should help you.
4. **Make a Timetable**. Choose a topic that not only interests you, but can be done in the amount of time you have. Use a calendar to identify important dates. Leave time to fill out the forms and to review the Research Plan with your Adult Sponsor. Certain projects require more time because they need prior approval before experimentation may begin. Allow plenty of time to experiment and collect data - even simple experiments do not always go as you might expect the first time or even the second
5. **Plan Your Experiments**. Once you have a feasible project idea, write a research plan. This plan should explain how you will do your experiments and exactly what it will involve. All students participating in the NJAS Regional Science Fair are required to complete the Research Plan (Form 1).
6. **Consult Your Adult Sponsor**. You are required to discuss your research plan with an Adult Sponsor and obtain a signature of approval. In reviewing the Research Plan (Form 1), your Adult Sponsor should determine if additional forms and/or prior approval from the NJAS Regional Director or ISEF Scientific Review Committee is needed.
7. **Conduct Your Experiments**. Give careful thought to experimental design. During experimentation, keep detailed notes of each and every experiment, measurement, and observation. Do not rely on your memory. Remember to change only one variable at a time when experimenting, and make sure to include control experiments in which none of the variables are changed. Make sure you include sufficient numbers of test subjects in both control and experimental groups. A group must have five or more subjects to be statistically valid.
8. **Examine Your Results**. When you complete your experiments, examine and organize your findings. Did your experiments give you the expected results? Why or why not? Was your experiment performed with the exact same steps each time? Are there other explanations that you had not considered or observed? Were there errors in your observations? Remember that understanding errors and reporting that a suspected variable did not change the results can be valuable information. If possible, statistically analyze your data.
9. **Draw Conclusions**. Which variables are important? Did you collect enough data? Do you need to conduct more experimentation? Keep an open mind – never alter results to fit a theory. If your results do not support your original hypothesis, you still have accomplished successful scientific research. An experiment is done to prove or disprove an hypothesis.

NJAS Guidelines For Field Research Projects

Many times important research is done outside the confines of the traditional setting. This type of research is often referred to as "field work" or "field research." Areas that often involve field research are listed below:

- **animal behavior**
- **archaeology**
- **geology**
- **paleontology**
- **atmospheric studies**
- **oceanography or hydrology**
- **environmental impact assessment**
- **environmental chemistry**
- **ornithology**
- **entomology**
- **parasitology**
- **marine biology**
- **plant population biology**
- **pollination ecology**
- **microbiology**
- **physiological ecology**
- **ecology of various geographic locations, e.g. rainforests**
- **remote sensing**
- **volcanology**

Field research involves making careful observations in a given locale, and sometimes, comparing this survey to known data from other locales. It may involve the making of a detailed inventory of the living and non-living objects, or their characteristics, in a given geographic location, or the interaction among the objects. It sometimes involves a testable prediction or hypothesis, but not always. It always involves looking for the patterns in a well-defined area and the keeping of detailed field notes. The "controls" in this type of study are in the observational techniques that are used. For example, sampling a number of square-meter areas within a large pasture to look for number and types of plant or insect species, must be controlled. This can be done by the use of a hoola hoop type device to define the square meter areas and a random way of tossing the hoop to get unbiased group of samples that are well distributed throughout the pasture. Another example of controls in sampling could involve careful water chemistry testing, where procedures for the tests are well replicated and repeated samples from the same location are taken over a period of time.

Steps In Doing Field Research:

When doing field research, **AT NO TIME SHOULD SPECIMENS OF ANY KIND BE REMOVED FROM THE TEST AREA EXCEPT UNDER THE DIRECTION OF A KNOWLEDGEABLE SUPERVISOR.** With the possible exception of small water or soil samples that are consumed in environmental chemistry or geoscience tests, no plant, animal, insect or fossil material should be disturbed. Observations may be made using detailed written descriptions, possibly accomplished by photographs, sketches or GPS positioning data for specimens examined. If it is believed that valuable, rare, or unusual specimens exist in the test area, a qualified scientist should be consulted regarding the disposition of such specimens. Detailed observations and accompanying documentation should be kept in a bound field notebook with numbered pages. This type of notebook often comes with a speckled black and white cover and is sold at discount stores or bookstores for several dollars. At no time should pages be removed from this field notebook. The use of three-ring binders or similar organizers is discouraged. If the test area involves private land or public land otherwise not open to the public, written permission to investigate the test area should be obtained and placed in the field notebook.

1. **Determine the Problem**
   - Select a well-defined geographic region
   - Decide what you want to know about this region
   - Do library/Internet research to find out what similar studies have been done in this region or other regions
   - State the limits of your study and if applicable an hypothesis or testable prediction
2. **Design the field protocol**
   - Determine a sampling technique
   - Decide if sampling will be done longitudinally over time or as a one-time "snapshot"
   - Define the observational methods to be used
3. **Conduct the field work**
   - Make careful observations
   - Construct detailed field notes of observations
4. **Analyze the results**
   - Organize data in appropriate tables, charts or graphs
   - Apply statistics as needed, e.g. percentages, averages
5. **Draw conclusions**
   - What does the data show?
   - What samples may need to be repeated?
   - What do you conclude?
   - Future investigations at this site
6. **Presentation of results**
   - A three-board display must be created; features such as maps or descriptions of the geographic location, tables, charts or graphs of results, photographs or sketches of types of specimens or observational techniques are all appropriate for this display
   - Field tools such as water testing kits, magnifiers, rulers, toss rings, etc. may be displayed if they contribute to the understanding of the project and *if they meet the safety guidelines as outlined in Chapter 10: NJAS Science Fair Display and Safety Regulations in either Section 1 or Section 2.*

Guidelines: Constructing A Visual Display of the Science Research Project

You want to attract and inform. Make it easy for interested spectators and judges to assess your study and the results you have obtained. Make the most of your space with a clear and concise display. Make headings stand out, and be sure the graphs and diagrams are clear and are labeled correctly. Leave your equipment, organisms, and chemicals at home.

Maximum Size of Visual Display for NJAS Regional Science Fairs:
Exhibit size for a display sitting on a table is limited to 76 cm (30 in.) deep, front to back; 122 cm (48 in.) wide, side to side; and 183 cm (72 in.) high. If the display is on the floor it is limited to 274 cm (108 in.) high from floor to top with the same depth and width as the table display. Any exhibit/display board exceeding these dimensions will be disqualified at the Regional Science Fair.

Helpful Hints for Visual Display:

- **A Good Title**
  Your title is an extremely important attention-grabber. A good title should simply and accurately present your research. The title should make the casual observer want to know more.
- **Take Photographs**
  Many projects involve elements that may not be safely exhibited at the fair, but are an important part of the project. You might want to take photographs of important parts/phases of your experiment to use in your display. Photographs or other visual images of human test subjects must have the Informed Consent Form.
- **Be Organized**
  Make sure your display is logically presented and easy to read. A glance should permit anyone (particularly the judges) to locate quickly the title, problem, hypothesis, experimental procedure, results, and conclusion. When you arrange your display, imagine that you are seeing it for the first time.
- **Eye-Catching**
  Make your display stand out. Use neat, colorful headings, charts, and graphs to present your project. Home-built equipment, construction paper, and colored markers are excellent for project displays. Pay special attention to the labeling of graphs, charts, diagrams, and tables. Each item must have a descriptive title. Anyone should be able to understand the visual without further explanation.
- **Correctly Presented and Well-Constructed**
  Be sure to adhere to the size limitations and safety rules when preparing your display. Make sure your display is sturdy, as it will need to remain intact for quite a while. Do not hesitate to ask for advice from adults if you need it. Display all required forms for your project.

Summary Of What To Include In Visual Display:

- Present the information that is the most important. The one idea to be emphasized should stand out in the display.

- Tables and graphs are used to show analyzed data; photographs and drawings illustrate experimental equipment, procedure(s) and results, especially since the equipment often cannot be shown during the oral presentation.
- Visual display is to be neat, uncluttered, easy to follow, and displayed creatively to make a good impression on the viewer.
- Visual display needs to include:
  - Title
  - Problem
  - Hypothesis
  - Materials and Procedure
  - Analyzed Results
  - Conclusion
- There are some things that may not go on the visual display, but they are done, placed on the display table and often used in the oral presentation. They include:
  - Logbook--record book of the project including all observations made during the experimentation.
  - List of variables that could not be controlled in the experiment with an explanation as to why the variable could not be controlled.
  - List of mistakes done during the experiment, why the mistake was made, and how it could have been corrected.
  - List of things that would be done differently if the research project were to be continued or redone.
- The student must provide an abstract to be displayed with the project. The abstract is displayed on the table with the display, but is not on the visual aid.

Self-Check Questions for Visual Display:

- Is the display neat, attractive, and eye appealing?
- Is spelling correct?
- Is grammar correct?
- Are all five parts included (Problem, Hypothesis, Procedure, Analyzed Results, and Conclusion)?
- Are the five parts arranged in logical, sequential order?
- Does the project have a title?
- Are the tables constructed to include daily observations and/or analyzed data needed to address the problem?
- Are the graphs constructed with analyzed data needed to address the problem?
- Do the tables and graphs have titles, labels, legends, and keys with data correctly displayed in a pleasing appearance?

Guidelines: Writing a Science Research Project Abstract

- Each student must submit a (maximum) 250-word abstract on the NJAS Abstract Form.

- An **abstract** is a brief summary of the *entire* project. It allows the reader to gain an "overview" of your specific research without reading a complete research paper or examining your visual aid in detail.

- After finishing the research and experimentation, students are required to write a (maximum) 250-word abstract. An abstract should include the (a) purpose of the experiment, (b) hypothesis, (c) procedure(s) used, (d) analyzed data, and (e) conclusion(s). It also may include any possible research applications. Only minimal reference to previous work may be included. The abstract should focus on work done and should not include: a) acknowledgments, or b) work or procedures done by a mentor.

Self-Check Questions for Abstract:

- Was the abstract done on the NJAS Abstract Form?
- Did you include purpose, hypothesis, condensed procedure, analyzed results, and conclusion?
- Did you use correct spelling?
- Did you use correct English grammar and sentence structure?
- Did you use 250 words or less?

Sample Abstract
Effects of SIERRA Antifreeze on the Micropropagation of Petunia Hybrida
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What effects will different concentrations of "environmentally -safer" SIERRA antifreeze have on the micropropagation of petunia? Past research has shown that SIERRA in concentrations higher than 1:50 have negative effects on seedlings planted in soil. Since the antifreeze mixed in the medium will have direct contact with leaf-cuttings, I hypothesized that all antifreeze-enhanced mediums will have negative effects on propagation of petunia. Setup consisted of controls without hormones, controls with 0.2-BA solution of hormones, and variable concentrations. Concentrations added to basal medium were 1:2000, 1:400, 1:200, 1: 100, and 1:50. I used a standard petunia procedure to sterilize and prepare petunia leaf-cuttings. I observed the rate of propagation of roots, shoots, and callus between each type of medium for 6 weeks. For analyzed data, I measured mass of individual leaf-pieces from each type of medium and compared the average masses to the average mass of leaf-cuttings from freshly-picked leaves. There wasn't a major difference in petunia mass of the concentrations between 1:2000 and 1:100. Overall, antifreeze concentrations appeared to have more beneficial effects on petunia mass when compared to the controls without hormones, but there wasn't a significant difference. O.2-BA controls with hormones had the most beneficial effects. The 1:50 medium was most harmful, because no propagation occurred and it caused distinct yellow discoloration. I concluded that concentrations stronger than 1:50 had destructive effects on petunia tissue when in direct contact, but concentrations weaker than 1:100 didn't severely affect petunia tissue.

Guidelines: Writing A Science Project Research Paper

A research paper should be prepared and available along with the other project work. A research paper helps organize the data as well as thoughts. A good paper includes the following sections:

- **Title Page**. Center the project title, and put your name, address, school, and grade at the bottom center.
- **Table of Contents**. Include a page number for the beginning of each section.
- **Introduction**. The introduction sets the scene for your report. The introduction includes an explanation of what prompted your research, and what you hoped to achieve and background information on your independent and dependent variables.
- **Problem**. State the problem in the form of a question or the purpose in the form of a statement.
- **Hypothesis**. State the hypothesis (logical and complete in thought). Support the hypothesis with evidence gathered from the background research.
- **Experiment**. Describe in detail the methodology used to collect your data or make your observations. Your report should be detailed enough so that someone would be able to repeat the experiment from the information in your paper. Include detailed photographs or drawings of self-designed equipment.
- **Discussion**. The discussion is the essence of your paper. The results and conclusions should flow smoothly and logically from your data. Be thorough. Allow your readers to see your train of thought, letting them know exactly what you did. Compare your results with theoretical values, published data, commonly held beliefs, and/or expected results. Include a discussion of possible errors. How did the data vary between repeated observations of similar events? How were your results affected by uncontrolled events? What would you do differently if you repeated this project? What other experiments should be conducted?
- **Conclusion**. Briefly summarize your results. Be specific, do not generalize. Never introduce anything in the conclusion that has not already been discussed.
- **Acknowledgments**. You should always credit those who assisted you, including individuals, businesses, and educational or research institutions. Identify any financial support or material donations received, but do not put on display board.
- **References**. Your reference list should include any documentation that is not your own (i.e., books, journal articles). See an appropriate reference for format. Example: Foley, J.D. (1987). Interfaces for Advanced Computing. "Scientific American," 257: 127-135

Self-Check Questions For Research Paper:

- Did you have a title page that included your name?
- Did you include **all** parts including introduction and bibliography?
- Did the "Results" section include tables and graphs of analyzed data with a written summary of descriptive data on dependent variables to interpret your analyzed data and justify your conclusion?
- Was your bibliography done following a format?
- Were the sections of the paper in logical and sequential order?
- Did you use correct spelling?
- Did you use correct English grammar and sentence structure?

Guidelines: Oral Presentation of Science Research

<u>Parts Included in Oral Presentation</u>:

- **Introduction:**
  - Share how you got interested in the topic that you chose.
  - Include background information on the topic and on the independent and dependent variables.
- **Problem:**
  State the problem in the form of a question.
- **Hypothesis:**
  State the hypothesis including the background information that supports it.
- **Procedure:**
  - What did you do?
  - When did you do it?
  - How was it done?
- **Results:**
  - Show/explain the table(s) of recorded observations that is on the visual display, on the display table, or in logbook.
  - Show/explain your analyzed data--all tables and graphs--that are displayed on the visual display, on the display table, or in the logbook.
  - Discuss why you feel that you got the results that you did; what caused the observed results?
- **Conclusion:**
  - What was it?
  - Explain how you arrived at the conclusion.
  - Give evidence to support the conclusion.
- **List of "others" that are often included in the oral presentation:**
  - List of variables that could not be controlled in the experiment with an explanation as to why they could not be controlled.
  - List of mistakes done during experiment including why the mistake was made and how it could have been corrected.
  - List of things that would be done differently if the research were to be redone.
  - List of ideas or problems (questions) developed from this research for future research.

<u>Summary of Oral Presentation</u>:

- Use visual aides/display during the oral presentation.
- Begin the presentation with an introduction of background information.
- State the problem.
- State the hypothesis with evidence to support it.
- Briefly outline the procedure to answer the "what did you do", "when did you do it", and "how was it done" questions.

- Explain and interpret the analyzed data.
- State the conclusion and justify it.
- Address and include the “List of Others”
- End the presentation by asking “Are there any questions?” and answer the questions addressed to you.
- Speak in a voice that can easily be heard and is pleasing to listen to.
- Make good eye contact with the audience when speaking.
- Do NOT read from a prepared written speech.
- Do not chew gum during the presentation time
- Practice your presentation and be sure it is within the time limitations.

Judging Criteria for NJAS Science Fairs

Judges evaluate and focus on 1) how well a student followed the scientific methodologies; 2) the detail and accuracy of research as documented in the data book; and 3) whether experimental procedures were used in the best possible way.

Judges look for well thought-out research. They look at how significant the project is in its field as well as how thorough it was. Judges applaud those students who can speak freely and confidently about their work. They are not interested in memorized speeches - they simply want to TALK with the student about their research to see if they have a good grasp of the project from start to finish.

Judging Criteria:

Following is a list of questions for each of the criteria used in evaluating student projects.

I A. **Scientific Method** (If a Field Research Project all questions should be appropriate with the exception of number 3. If an Engineering Project, the more appropriate questions are those found in Engineering Goals in section I B.)

- Is the problem stated clearly and unambiguously?
- Was the problem sufficiently limited to allow plausible attack?
- Is the hypothesis clearly defined? (may not be applicable to all Field Research Projects)
- Did the procedure that was followed apply to the problem?
- Are the variables clearly recognized and defined?
- If controls were necessary, did the student recognize their need and were they correctly used?
- Is there evidence that demonstrates proper data were collected?
- Is there evidence the data were analyzed (i.e., percentages, statistics, graphs, tables, or other appropriate illustrations) ?
- Are there adequate data to support the conclusions?
- Does the student recognize the data's limitations?
- Does the student have the required laboratory, computation, observational and design skills to obtain supporting data?
- Where did the equipment come from? Was it built independently by the student? Was it obtained on loan? Was it part of a laboratory where the student worked?
- Is the conclusion logical and related to the original purpose?
- Is the research that was done relevant and significant?
- Does the student understand the project's ties to the related research?
- Does the student have an idea of what further research is warranted?
- Is there evidence that library research was done and, if so, were the resources documented?
- Did the student cite scientific literature, or only popular literature (i.e., local newspapers, Reader's Digest)?

I B. **Engineering Goals**

- Does the project have a clear objective?
- Is the objective relevant to the potential user's need?
- Is the solution workable? Acceptable to the potential user? Economically feasible?
- Could the solution be utilized successfully in design or construction of an end product?
- Is the solution a significant improvement over previous alternatives?
- Has the solution been tested for performance under the conditions of use?

II **Communication Skills**

Oral Presentation:

- How clearly does the student discuss his/her project and explain the purpose, procedure, and conclusions? Watch out for memorized speeches that reflect little understanding or principles.
- How clearly are the data presented?
- How clearly are the results presented?
- Are the important phases of the project presented in an orderly manner?
- Was the oral presentation well organized and concise?
- Was the presentation done in a forthright manner, without tricks or gadgets?
- Were the responses clear and accurate to questions that were asked?

Written Research Paper:

- Was the research paper organized and complete?
- Does the written material reflect the student's understanding of the research?

Visual Display:

- How well does the project display explain the project?
- Are visuals aides clear, neat, organized and complete?

III **Personal Growth**

- Does the project show creativity ability and originality in the questions asked? -the approach to solving the problem? - the analysis of the data? - the interpretation of the data? - the construction or design of new equipment? Creative research should support an investigation and help answer a question in an original way. When evaluating projects, it is important to distinguish between gadgeteering and ingenuity.
- Was the purpose carried out to completion within the scope of the original intent?
- How completely was the problem covered?
- Is the conclusion based on a single experiment or replication?
- How complete are the project notes?
- Is the student familiar with scientific literature in the studied field?
- How much time and effort did the student spend on the project?

NJAS JUDGE'S SCORE SHEET

Total Score _____ Place _____ Judge's Signature ______________________

Student's Name ____________________________ Region _______ Exhibit # _____

Grade __________ School ___________________ Category___________________

Project Title ____

(Two choices of judging format are provided below.)

SCIENTIFIC METHOD

[- o +] **1. Initial Observations and Identifying the Problem** 1 2 3 4 5
(Observations and Problem are clearly stated.)

[- o +] **2. Hypothesis Formation** 1 2 3 4 5
(Initial Hypothesis clearly defined.)

[- o +] **3. Experimental Design and Procedure** 1 2 3 4 5
(Procedure followed applies to the problem and uses controls)

[- o +] **4. Collection of Data** 1 2 3 4 5
(Evidence of proper data collection is demonstrated.)

[- o +] **5. Analysis of Data** 1 2 3 4 5
(Graphs, percentages, statistics, or other appropriate illustrations used.)

[- o +] **6. Conclusions** 1 2 3 4 5
(Conclusions are logical, related to original purpose, and supported by data.)

[- o +] **7. Background Research (Bibliography)** 1 2 3 4 5
(Use of library and resources are documented.)

[- o +] **8. Scientific Value of Project** 1 2 3 4 5
(Information presented is relevant and significant.)

COMMUNICATION SKILLS

[- o +] **9. Oral Presentation** 1 2 3 4 5
(Presentation is well organized, clear, and concise.)

[- o +] **10. Ability to Answer Question** 1 2 3 4 5
(Responses are clear and accurate.)

[- o +] **11. Visuals** 1 2 3 4 5
(Visuals aides are clear, neat, organized and complete.)

[- o +] **12. Written Work** 1 2 3 4 5
(All written material is organized and complete.)

PERSONAL GROWTH

[- o +] **13. Creativity and Originality** 1 2 3 4 5
(Does project show a creative approach to the problem.)

[- o +] **14. Knowledge Gained** 1 2 3 4 5
(Understanding of concepts is appropriate to grade level.)

[- o +] **15. Effort and Attitude** 1 2 3 4 5
(Adequate time, effort and attitudes are demonstrated.)

Student's Name ___________________________ School ______________________

Strengths:

Areas that need improvement:

BOOK REFERENCE LIST FOR INQUIRY-BASED INVESTIGTIONS

Scientific Research/Science as Inquiry:

- Abbgy, Theordore. How the Scientist Works (Grades 5-8). 1998. Publisher unknown; available through Nasco, 901 Janesville Avenue, Fort Atkinson, Wisconsin 53538-0901; phone: 1-800-558-9595; website: www.eNASCO.com; email: info@eNASCO.com
- Bochinski, Julianne. The Complete Handbook of Science Fair Projects. (Grades 7 and Up) Copyright date unknown. Publisher unknown; available through Ward's, P.O. Box 92912, Rochester, New York 14692-9012; phone: 1-800-962-2660; website: www.wardsci.com
- Bombaugh, Ruth. Science Fair Success. Copyright date unknown. Publisher unknown; available through Nasco, 901 Janesville Avenue, Fort Atkinson, Wisconsin 53538-0901; phone: 1-800-558-9595; website: www.eNASCO.com; email: info@eNASCO.com
- Bonnet, Robert and Daniel Keen. Science Fair Project Series. Copyright date unknown. Publisher unknown; available through Nasco, 901 Janesville Avenue, Fort Atkinson, Wisconsin 53538-0901; phone: 1-800-558-9595; website: www.eNASCO.com; email: info@eNASCO.com
- Brisk, Marion. 1001 Ideas For Science Projects (3rd Edition). 1999. Publisher unknown; available through Carolina, 2700 York Road, Burlington, NC 27215-3398; phone: 1-800-334-5551; website: www.carolina.com
- Carnahan (Science Supervisor). Prentice Hall Physical Science Fair Manual (Independent Research Guide). 1988. Prentice-Hall Inc., Englewood Cliffs, New Jersey, 07632.
- Coffin, Marilyn. Team Science: Organizing Classroom Experiments That Develop Group Skills. 1996. Publisher unknown; available through Nasco, 901 Janesville Avenue, Fort Atkinson, Wisconsin 53538-0901; phone: 1-800-558-9595; website: www.eNASCO.com; email: info@eNASCO.com
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