# Elementary Science Fair Project Guide
# (Teacher Information Packet)

Dear Teachers,

Thank you for providing students with an opportunity to design and carry out a science fair project. This process helps students learn and apply the scientific method through the practice of inquiry. It will also help to support transition into Next Generation Science Standards and "doing science" rather than just "knowing science".

Appendix F of NGSS contains the Science 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

This booklet is provided as a resource as you guide your students through producing a science project, and also offers some information on conducting a science fair at your school site. If you have further questions or need additional support from Educational Services, please contact John Iwawaki at JIwawaki@wccusd.net .

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# SCIENCE SAFETY GUIDELINES

- Give explicit instructions regarding safe practices for science investigations.
- Encourage students to ask questions when they are not sure.
- Have students wear safety goggles when needed.
- Require students to keep work areas neat and clean.
- Assist in clean up any spills right away.
- Make sure students never taste or smell substances unless instructed to do so.
- Ensure that students handle sharp items and other equipment carefully.
- Ensure that students handle chemicals carefully and seek permission first.
- Have students put materials away when they finish.
- Require students to wash hands with soap and water when finished.

# COMPONENTS OF A SCIENCE FAIR PROJECT: THE "SCIENTIFIC METHOD"

1. **Title** (may be the same as the Problem)

2a. **Introduction**, or Background Information (optional, as needed)
- What gave the student the idea? Who helped the student? What research was done?
- Include background information needed to understand or explain the problem

2b. **Problem**
- Use question format. *Example: "Which materials conduct electricity?*

3. **Hypothesis**
- It is a prediction about the possible outcome, written before doing the experiment.
- **If…then** statements can be a helpful way to phrase a hypothesis.

**Examples:**
*a) "I think plants need sunlight because I noticed that plants on the sunny side of my house are larger than the plants on the shady side. If this is true, then if I place one plant in the sun and one plant in the dark closet, I predict the one in the dark will not grow." (primary grades)*
*b) "While experimenting with electromagnets, I discovered that more wire coils around the nail made the magnet stronger. I wonder if there were other ways to increase the strength of an electromagnet. An electromagnet has wire coils and an iron core. I think that if I wrap coils around a larger nail, then it will attract more paperclips than on a smaller nail." (upper grades)*

Notice that these hypotheses have the variable and the background, and the idea for the experimental design already built into them. Remember: the point is NOT to prove you are right; the results of the experiment may not support the prediction. Many important science discoveries and advances have been made because scientists were forced to rethink their predictions when things did not turn out as expected. Scientific inquiry is a process.

4. **Materials**
- List of all materials needed (including items such as scissors, containers, tape, etc.) and include the quantity of each item.

5. **Procedures**
- Should be written as detailed step-by-step instructions, and include repeated trials.
- Should include a control test when applicable. This shows that the outcome was a result of changing the variable—not a result of random chance.

**Example**: *If you are trying to prove chemical reactions happen faster at higher temperatures, you need to experiment at room temperature as well, and test each temperature multiple times.*

6. **Results**
- Graphs, charts, tables. Diagrams and/or photographs.

7. **Conclusion**
- Refer to the original question and examine the outcome compared to the hypothesis.
- Discuss any problems encountered during the procedure.
- Offer an explanation or further research or investigations.
- Suggest possible real world applications for expansion of the project.

# GUIDING STUDENTS THROUGH A SCIENCE FAIR PROJECT

**Purpose**: Science fairs provide an opportunity for students to be creative, to take pride in themselves and their work, and to experience the hands-on use of the scientific process.

- To provide an additional opportunity for students to actively apply their knowledge and learn methods of critical thinking through problem solving in math and science.
- To give students and teachers an opportunity to meet with other students, teachers and professional scientists and engineers to share common interests and methods of solving problems, which in turn encourages youths to enter scientific careers.
- To afford parents and the community an opportunity to examine another aspect of the academic performance of students.
- To provide an opportunity to integrate curriculum, i.e., science with the “three Rs” and study/research skills.

**Teacher’s Role**: The teacher is the key to student success in science fair projects.
- Instructing students in the scientific method.
- Supporting and providing encouragement for youngsters and a positive environment in which they can explore and experiment.
- Monitoring and working with students to develop a science project timeline and to monitor student progress on the science fair project.

**Techniques for Development of Process Skills in Science**:
- Involve students in observation – identifying objects and their properties using all five senses, noting changes, making controlled and objective observations.
- Conduct activities involving classification – sort objects, match by likenesses and differences, from simple to complex, etc.
- Provide opportunities for experiences in measurement – length, volume, weight, area, temperature, time, force, speed, etc.
- Involve students in the collection and organization of data – describing properties and changes, recording data in pictures, diaries, stories, putting changes or data in sequence, constructing graphs, reporting in writing all stages of an investigation.
- Provide experiences which require inferences and predictions – determining if . . . happens, then . . . will happen.
- Make students aware of the concept of variables: the identification and control of variables – independent vs. dependent (held constant vs. manipulated).
- Provide opportunities for students to make and test hypotheses, distinguishing from and developing these from simple observations, inferences, or predictions.
- Conduct a unit of study which brings together and applies all of the skills involved in the hierarchy, causing process integration, and culminate with a class project.

**Questions to Stimulate Inquiry**: As you work with students in science lessons and with science fair projects, ask these kinds of open-ended questions:

- What has happened?
- Why do you think it has changed?
- How can we find the answer?
- What do we need to test this?
- What might we do to find out more?
- What changes should we make in our experiment?
- How shall we begin?
- How can we prove what this is true?
- What conclusions can you make?

## Example: Outline of a Beginning Project

**Question**: Do bean seeds have a top and bottom – does it matter how they are planted?

**Hypothesis**: I think that people who grow large gardens or farmers planting large numbers of bean plants don't have time to look at each seed and make sure it is planted in the correct position. This makes me think that it doesn't matter in which position beans are planted. If so, then bean seeds planted with one side up will grow equally well as those planted with the other side up.

**Experiment**: Get nine of the same plant containers. Fill them with the same amount of the same soil. Plant three beans in three containers in exactly the same way, with one end up. In the second three containers plant them with the other end up. In the last set of three containers, plant them with the middle of the bean up. Give all plants the same amount of water and same amount of sunshine. Everything in the experiment is the same, or constant, except for the direction of the beans.

**Observation**: Watch the plants as they grow. Measure growth. Record drawings in a notebook every few days. Write down thoughts. Take pictures. Create a graph that shows the averages of the results.

**Conclusion**: All the plants grow up out of the soil to about the same height – it doesn't matter how the seeds are planted. Bean seeds do not have a top or bottom.

**Further questions**: Do different types of beans have different results? What if the beans shifted when they were watered? What happens if the seeds are planted deeper? What about plants with bulbs – do they have a top or bottom?

## Doing Background Research / Getting Advice:

Before starting the project, a background review should be conducted. Make observations about things in their daily life. Ask questions of adults and to other students. Students may also do research on the Internet. The student also can talk with other teachers or people working in the field of interest concerning types of projects, set-ups of experiments, conducting tests, and presentation of projects. Many professionals in science, engineering, mathematics, and computer science are willing to provide help and guidance.

A quick way of finding background information is through an Internet search. It is a valuable experience to learn how to use the Internet as a tool. The Internet is a good place to find ideas for projects. It includes science demonstrations for primary grades, or may stimulate ideas for those in upper grades. Remember that in upper grades, 4-6, students should begin investigating a "testable question", designing an experiment where they test the effect of a controlled variable.

But the best projects are those which come from the students own interest, like "I wonder what would happen if I …?" or, "I wonder which is the best … for …?" or "What is the effect of … on …?" Let students make observations about the world around them, or their own personal experiences, and from that, develop a testable question.

## Areas of Focus:

Categories in the WCCUSD Science Fair for secondary schools, as well as in the Bay Area Science Fair include:

- o Behavioral
- o Biological
- o Physical
- o Math/Computers

At the elementary level, it may be appropriate to judge projects in categories, or simply all together. Students should feel free to investigate and experiment on any topic that is of interest to them.

## CRITERIA FOR EVALUATION OF EXPERIMENTS

Evaluation should be done after comparing a given student's project with all other experiments in the class and also with regard to absolute standards of quality and excellence, keeping the skills and knowledge appropriate for a given grade level in mind. Guiding questions to consider are as follows:

Project Components:

- Title/Problem: Does the student clearly state what he/she is trying to find out? Is it in the form of a question?
- Hypothesis: Does the student clearly state a hypothesis and offer a reason?
- Experimental design and rationale: Does the student clearly explain how the experiment will answer the question and test the accuracy of the hypothesis posed?
- Procedures: Are the procedures clearly described, and are they appropriate for the question and hypothesis posed? Are the methods described step by step? Is there a control (if applicable)?
- Does the technique and skill put into the experiment indicate a serious level of effort, or was the experiment quickly thrown together at the last minute without much thought?
- Observations: Does the student collect his/her own data (as opposed to something read out of a book or seen on television)? Has the student used the senses of sight, hearing, touch, and smell in a manner related to the problem?
- Did the student measure with reasonable accuracy?
- Did the student do only a single experiment or were experiments repeated to verify?
- Conclusions: Are the student's own observations and data used to reach conclusions? Does that data support the conclusions drawn?

Presentation of Project:

- Is the experiment neatly, logically, and attractively presented on the display board? Are pictures and drawings used to enhance the presentation?
- Are graphic organizers used effectively (tables, graphs, charts, diagrams)?
- Is the written material clear and easy to understand?
- Is outside help acknowledged?
- Is there a bibliography?
- Was the hypothesis or question verified?
- Is the summary report included?

# Science Fair Judging Guidelines

When checking projects into the fair, make sure the student's name only appears on the back of the project board.  Assign each project a number and keep a master list with student name, grade level, teacher's name, and project number in order to ensure impartiality during the judging process.  Group projects by grade level so that judges can easily be assigned a set of projects within the same grade level to evaluate.

As a general rule of thumb, each project should be evaluated independently by multiple judges.  Average the scores for final results.  In cases where there is a large discrepancy between two judges' scores, a third judge should evaluate the project before averaging the results.

When recruiting judges, consider the following sources:

- Fellow teachers at your site
- Retired teachers or friends of teachers
- Parents – especially those who may work for or know others who work for science or technology companies
- Students from a high school science class
- College students in a science major

On the next few pages are some examples of judging forms and rubrics that can be used to evaluate projects.

# ELEMENTARY SCIENCE FAIR JUDGING FORM

## SCIENCE FAIR JUDGING FORM: GRADE ___ PROJECT # _____

GENERAL INSTRUCTIONS TO JUDGES

Award a number from 1 to 10 for each category, with 1 as the lowest and 10 the highest. In each category to be evaluated there are questions to guide you in making your evaluation. Don't try to determine the best at this point, simply award points as merited by each project. If a project lacks one of the components then give it a 0 for that category. Thank you so much for your time and effort!

***SCIENTIFIC METHOD*** [NOTE: K – 3 projects may be demonstrations, 4-6 must involve problem solving.]

1. Is the **PROBLEM** clearly stated in the form of a question? Is it a testable problem? _____/10

2. Is a **HYPOTHESIS** offered? Is their reasoning explained? (I think… because…) _____/10

3. Is the **PROCEDURE** explained in terms the student and you can understand? Are the methods described step by step? Are the **MATERIALS** listed? Is the procedure appropriate for the question and hypothesis given? _____/10

4. Are the **RESULTS** easy to understand? If appropriate, are the graphs and charts clearly labeled? For measurements, are the appropriate units given? If there is no way to represent the results in chart or graph format, is there some kind of graphic display? _____/10

5. Is the **CONCLUSION** supported by the results? Does the conclusion relate back to the hypothesis? If the hypothesis is not proven correct by the results, is there an attempt to explain this, or a suggestion of further research that would be needed? _____/10

6. Was the experiment controlled – i.e. was there a comparison made to show that the variable under investigation was in fact responsible for the results, and that it was not merely coincidental? _____/10

7. Were multiple trials done to verify results? Was it an appropriate number of trials? _____/10

***SCIENTIFIC ACCURACY and KNOWLEDGE***

8. Did the student give credit to sources of any information used? Is the factual information correct? Are any calculations done correctly? Is the spelling correct? _____/10

***NEATNESS, TIME, EFFORT, and CREATIVITY***

9. Are the labels and title neat? Is it typed, or the handwriting as neat and legible as you could expect for grade level? Is the board layout and design as attractive as might be expected for grade level? Are there props, pictures or sketches included? _____/10

10. Is it apparent that the student used creativity and put appropriate effort into the project? _____/10

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**Total Score _____/100**

Judge Sign-off: ______________________________________

Comments: ______________________________________________________________

______________________________________________________________________

# RUBRICA PARA JUECES

## FERIA CIENTÍFICA: GRADO ___ PROYECTO # _____

Instrucciones Generales Para Jueces

***Método científico*** [NOTA: K – 3 proyectos pueden ser demostraciones, 4-6 necesitan resolución de problema]

1. ¿Está escrito el problema en forma de pregunta? Es experimentable? _____/10
2. ¿Hay una hipótesis? ¿Explican la razón? _____/10
3. Esta escrito el procedimiento de manera que el estudiante lo pueda entender? ¿Están escritos los métodos paso a paso? ¿Están listados los materiales? Es el procedimiento apropiado para la pregunta e hipótesis? _____/10
4. ¿Son los resultados fáciles de entender? ¿Si es apropiado, están las gráficas tituladas correctamente? ¿Para medidas, incluyen las unidades correctas? ¿Si no hay forma de representar los resultados en gráfica, hay algún tipo de representación visual? _____/10
5. ¿Es la conclusión apoyada por los resultados? ¿Está relacionada con la hipótesis? ¿Si la hipótesis no es probada por los resultados, hay algún atento de explicarlo, o una sugerencia para más investigación? _____/10
6. ¿Fue el experimento controlado – ex, hubo comparación para demostrar la variable cambiada fue responsable por los resultados, y que no fue coincidencia? _____/10
7. ¿Fueron múltiples pruebas? ¿Usaron una cantidad de pruebas apropiadas? _____/10

***EXACTITUD y CONOCIMIENTO CIENTIFICO***

8. ¿Dio el estudiante crédito a fuentes usadas? Es la información usada correcta? ¿Están hechos los cálculos correctamente? ¿Está la gramática correcta? _____/10

***NITIDAD, TIEMPO, ESFUERZO y CREATIVIDAD***

9. ¿Están los títulos claros? ¿Está escrito a máquina, o escrito a mano de manera fácil para leer como para el grado? ¿Está la cartulina y el diseño bien arreglados para el grado? ¿Hay fotos o dibujos incluidos? _____/10
10. ¿Es aparente que el estudiante uso creatividad y puso el esfuerzo apropiado para el proyecto? _____/10

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**Total _____/100**

**Comentarios:**_______________________________________________

_______________________________________________

_______________________________________________

_______________________________________________

# SCIENCE FAIR JUDGING RUBRIC: GRADE _______ PROJECT # ________

## PART 1 – SCIENTIFIC METHOD

| Statement of Problem / Purpose of Investigation | | | | Score |
|---|---|---|---|---|
| **3 pts.** The question that the investigation was designed to answer is well articulated and is testable. | **2 pts.** The question is testable, but not clearly stated. | **1 pt.** The question is stated, but it is not testable. | **0 pts.** Not done | |
| **Hypothesis / Educated Guess** | | | | |
| **3 pts.** Hypothesis is clearly stated and shows a relationship between the independent and dependent variables (cause and effect reasoning). | **2 pts.** Hypothesis is stated but is not reasonable or only mentions one of the variables. | **1 pt.** The hypothesis is stated but doesn't show a relationship between variables. | **0 pts.** Not done | |
| **Method / Procedure** | | | | |
| **3 pts.** Procedure is easily understood, is written in step-by-step format, and includes a materials list. | **2 pts.** Two out of the three criteria are present. | **1 pt.** One out of the three criteria is present. | **0 pts.** Not done | |
| **Results / Data** | | | | |
| **3 pts.** Results are easily understood, given in chart and / or graph format, and are accurate and quantified, including correct units as appropriate. | **2 pts.** Two out of the three criteria are present. | **1 pt.** One out of the three criteria is present. | **0 pts.** Not done | |
| **Conclusion / Application** | | | | |
| **3 pts.** Stated conclusion is consistent with results, is relevant to the hypothesis, and suggests further research or real world application. | **2 pts.** Two out of the three criteria are present. | **1 pt.** One out of the three criteria is present. | **0 pts.** Not done | |

For parts 2 and 3, use the following scoring:

| | | | | | |
|---|---|---|---|---|---|
| **5 pts.** impressive | **4 pts.** very good | **3 pts.** adequate | **2 pts.** minimally adequate | **1 pt.** very poorly done | |

## PART 2 – ORIGINALITY / CREATIVITY

| | |
|---|---|
| Project is clearly the ***work of the student*** – i.e. input by adults appears limited to encouragement and assistance in obtaining materials. The topic chosen is original, or is approached in a creative way. | |

## PART 3 – EFFECTIVENESS OF DISPLAY

| | |
|---|---|
| Project is visually appealing, neat, well organized, and includes props, photographs or sketches. | |

Total points for project (out of a possible 25)……………………………………………….. _______

Total score as % of 100 (multiply points by 4) ………………………………………….... _______

**Judge Sign-off:** ___________________________

**Comments**: ______________________________________________________________

______________________________________________________________

______________________________________________________________

## Science Fair Judging Rubric

Grade: _____ Project #: _____ Room #: _____ Teacher: ______________________

| Judge Initials: ___________ | Project Title: ________________________________________ | | | | |
|---|---|---|---|---|---|
| **Part I. Scientific Method** | **Excellent** | **Good** | **Adequate** | **Minimal** | **Missing** |
| Clear & specific Question | 4 | 3 | 2 | 1 | 0 |
| Clear & specific Hypothesis | 4 | 3 | 2 | 1 | 0 |
| Complete materials list | 4 | 3 | 2 | 1 | 0 |
| Complete & thorough Method (Step by Step) | 4 | 3 | 2 | 1 | 0 |
| Complete & thorough Data (logs, graphs, tables, photos…) | 4 | 3 | 2 | 1 | 0 |
| Conclusion supported by Data | 4 | 3 | 2 | 1 | 0 |
| Conclusion relevant to Hypothesis | 4 | 3 | 2 | 1 | 0 |
| **Part II. Originality and Presentation** | **Excellent** | **Good** | **Adequate** | **Minimal** | **Missing** |
| Original topic or approach | 4 | 3 | 2 | 1 | 0 |
| Neatness and clarity of overall project | 4 | 3 | 2 | 1 | 0 |
| **Subtotals:** | | | | | |

**Grand Total:** ___________

Comments:

___________________________________________________________________________

___________________________________________________________________________

___________________________________________________________________________