Science Fair Strategies for the Teacher & Parent

A guide to help you assist your child/student prepare a project for the Greater Kansas City Science and Engineering Fair

INSPIRING SCIENTIFIC CURIOSITY AND LEARNING FOR A BETTER COMMUNITY

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INTRODUCTION

The Greater Kansas City Science and Engineering Fair is an exhibition of student projects in the fields of science, engineering, and invention technology. Every year more than 1,200 students come together to compete for prizes and cash awards. Each student project entered in the fair receives a ribbon based on the rating they receive. Each year, more than 200 students receive special recognition in the form of prizes and awards.

The Greater Kansas City Science and Engineering Fair is organized by grade level and category. Over 250 local scientists, engineers, physicians and teachers are assigned to judge the projects based on their field of study and level of expertise.

There are three grade divisions.

1. Intermediate - 4^{th} , 5^{th} and 6^{th} grades
2. Junior - 7^{th} and 8^{th} grades
3. Senior - 9^{th}, 10^{th}, 11^{th} and 12^{th} grades

The categories are as follows:

- **Behavioral and Social Sciences:** Study of human and animal behavior, social and community relationships—psychology, sociology, anthropology, archaeology, linguistics, learning, perception, reading problems, educational testing, etc.
- **Botany & Zoology:** <u>(Botany)</u> Study of plants and their life cycle, structure, growth, processes, and classification. Would include sciences of agriculture, agronomy, taxonomy, ecology, hydroponics, and related sciences. <u>(Zoology</u>) Study of animals, their life cycles, anatomy and classification. Animal ecology, physiology, animal husbandry, entomology, ichthyology, ornithology, herpetology, etc.
- **Molecular Biology:** <u>(Biochemistry)</u> Study of chemical substances and vital processes occurring in living systems, the processes by which these substances enter into, or are formed in, the organisms and react with each other and the environment; <u>(Microbiology)</u> Study of microorganisms at the molecular level, such as virus and bacteria as related to their life processes; <u>(Cellular Biology)</u> Study of the organization and functioning of the individual cell; <u>(Genetics)</u> The study of genetics focusing on the structure and function of genes; <u>(Medicine and Health</u>) Science of diagnosing, treating, or preventing disease and other damage to the body or mind.
- **Chemistry:** Study of the composition, structure, properties, and reactions of matter—analytical chemistry, physical chemistry, organic chemistry (other than biochemistry), inorganic chemistry, materials, plastics, pesticides, metallurgy, soil chemistry, etc.
- **Earth and Space Science:** <u>(Earth)</u> The study of sciences related to the planet earth. geology, mineralogy, physiography, oceanography, meteorology, climatology, speleology, sesismology, geography, atmospheric sciences; <u>(Space)</u> Anything in the universe beyond Earth such as the positions, dimensions, distribution, motion, composition, energy, and evolution of celestial bodies and phenomena.
- **Engineering:** The application of scientific and mathematical principles to practical ends such as the design, manufacture, and operation of efficient and economical structures, processes, machines and systems.– Civil, mechanical, aeronautical, chemical, electrical, photographic, sound, automotive, marine, heating and cooling, transportation, environmental engineering and robotics.
- **Environmental Science and Renewable Energy:** <u>(Environmental Science)</u> The analysis of existing conditions of the environment and the study of managing mans' interaction with the environment. <u>(Renewable Energy)</u> The study of green energy sources (solar, wind, geothermal), energy efficiency, clean transport, and alternative fuels.
- **Matter & Energy - Physical Science:** Study of cause/effect relationships dealing with principles of physical laws in electricity, heat, light, sound, magnetism, etc. 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.
- **Force & Motion – Physical Science:** Study of forces affecting motion of an object such as levers, pulleys, ramps, engines, gravity, inertia, friction, air pressure, and pendulums,

- **Computer Science & Mathematics:** (Computers) The study of information processes, the structures and procedures that represent processes, and their implementation in information processing systems. It includes systems analysis and design, data analysis, network design and operations, application and system software design, programming, and datacenter operations. (Math) The study of the measurement, properties, and relationships of quantities and sets, using numbers and symbols. The deductive study of numbers, geometry, and various abstract constructs, or structures. Mathematics is very broadly divided into foundations, algebra, analysis, trigonometry, geometry, and applied mathematics, which includes theoretical computer science. This category also includes bioinformatics.
- **Inventions:** Creation or modification of devices or processes that solve or alleviate problems in everyday life.

Students may enter a project individually or as part of a team of no more than **3 students.**

Selecting a topic

Any question worth asking is worth finding an answer. Children can become more self-reliant by investigating topics they find of interest. Many hobbies or activities can provide perfect sources for a science experiment. Has your child ever asked a question that you did not know how to answer? If so, begin looking at how an answer could be found.

An idea for a Science Fair project can be discovered at school, while playing or even while doing household chores. For example, the simple task of raking leaves can lead to many experimental questions. Do certain types of leaves blow further from your yard than others? How could this be traced? Would color coding the leaves before they fall allow you to trace the path they take? How could you create an experiment to answer these questions?

This is just the start of the process on any topic or question that might arise from daily activities around home, school or play. The important thing is to ask a question that makes a difference to your child/student. As Isaac Asimov said: *Science does not occur when a scientist says EUREKA!, but when he says, that is strange*.

Two good rules of thumb in creating a project:

1. Keep it simple. Your child/student is more likely to get excited and stay motivated when he/she is not overwhelmed by a large project.

2. Focus not on *what* your child/student does, but *how* he/she does it. The goal of a science fair project is to learn the process skills necessary to solve a problem.

There are many sources for selecting a science fair topic. Sporting activities involve principals of physics, walking in the woods can spark an interest in biology, and ideas for inventions are all over your house. You and your child may wish to visit a public library together. Newspapers, magazines and books include ideas for topics.

Be aware that many books outline activities such as building models or doing demonstrations and call them experiments. A demonstration is simply watching something or creating something that has a predictable outcome. In contrast, an experiment is designed to ask a specific question based upon preliminary observations, and to use variables and controls to create a ***new*** *set of circumstances in which recorded data can lead to a conclusion.*

Statement of the Problem

In creating a good science experiment, it is necessary to ask a question that can be answered. The answer to the question should be something that can be measured quantitatively or objectively. Weight, length, distance, size, number of leaves, etc. are examples of quantitative or objective measures.

Projects that involve **product testing** are discouraged, but may enter if they comply with the following criteria, which are intended to make the experiment truly scientific.

Product testing is defined as an experiment in which a group of various commercially available products are compared against each other to test their ability to perform a function of that product. Comparing how white clothes get using different laundry detergents, timing how long different brands of batteries can light a bulb, testing how bacteria stand up to mouthwash, and counting the number of popcorn kernels that did not pop are all examples of **product testing**.

- A well formulated hypothesis must be clearly stated and tested by the experiment.
- Dependent and independent variables must be clearly and correctly identified in the abstract and write-up.
- There must be <u>at least</u> 10 tests of each variable. (This applies to product testing only.)
- Data must be quantifiable on some identified scale or comparison. The scale can be created by the student. For example, whiteness can be compared to a set of paint chips ranging from relative values of 1 for white to 8 for light beige. No opinion based results will be accepted.
- Data must be presented using graphs or charts which demonstrate that the hypothesis was tested and the conclusions drawn are reasonable given the data.

The more clearly the question is stated, the easier it will be to create a project.

The question should clearly identify what is to be measured.

The statement of the problem should identify two variables:

1. The ***independent variable***, or what is changed or manipulated.

2. The ***dependent variable***, or what happens and is measurable because of the change.

In our earlier example, the size of the leaves, *or* the shape of the leaves, *or* the kind of leaf could be the independent variable. The dependent variable would be how far they travel.

There is a third factor that also must be considered, the ***controlled or constant variables***, i.e. those things that are kept the same to make sure the results of the experiment are accurate. Examples of controls could be the start and stop times of the measurement period, the time of day the measurements are taken, and the height of the marked leaves from the ground. The more controls placed on the experiment, the more accurate the results will be.

A statement of the problem is usually in question form. A cause/effect format is helpful.

A simple fill-in-the-blank method of creating a statement of problem is as follows:

Does the **<u>(independent variable)</u>** change the **<u>(dependent variable</u>**)?
OR
What effect does the **<u>(independent variable)</u>** have on the **<u>(dependent variable)</u>**?

An example from our leaf experiment might involve the size of the leaf affecting the distance that the leaf will travel. For example:

Does the size of the leaf affect the distance the leaf will travel?
OR
What effect does the size of a leaf have on the distance the leaf will travel when the wind blows?

Review of the Literature

In order to create a good experiment it is necessary for your child to do some fact-finding to increase his or her understanding of the topic. Reading about the topic, asking questions of the experts, and talking about the topic helps form opinions of what will result. This process of asking a question, finding information from various sources, and employing a step-by-step approach to solving problems is a skill that will be invaluable to your child in the years ahead.

Fact-finding can be done in a variety of ways. Books, newspapers, magazines, trade literature from companies, personal interviews with experts or mentors, on-line searches, television documentaries, science books or lab manuals, and encyclopedias are all valid sources of information.

All of the sources including Internet sites should be recorded in a bibliography. Although each school may have a different format for the bibliography page, the information should always include enough details about authors, titles and publishers that the source could be readily identified.

This is an excellent opportunity for you to provide not only the means of transportation to the library, but your broader base of knowledge that can help your child pinpoint some topics he or she might not have considered. You could help identify key words to begin the search for facts. Some key words from our sample problem might be leaves, wind, aerodynamics, etc.

Also, there is nothing wrong with helping your child/student find an expert to assist them with the project. Very few people have the knowledge necessary to cover all the areas in which questions are asked by a curious child. Science Pioneers offers a **Professional Mentor Directory** with a listing of over 60 professional scientists, engineers and physicians. You may request assistance in finding a mentor, or request a copy of this directory by contacting our office at (816) 460-2261 or admin@sciencepioneers.org.

Hypothesis

The hypothesis is a tentative explanation for the outcome of the study. After researching the topic, it is easier to predict what might happen.

One method of stating the hypothesis follows the if... then... pattern.
If **(independent variable)**, then **(dependent variable)**, will **(prediction)**.

For our example:
If the size of the leaf is increased, **then** the distance the leaf travels **will** increase when the wind blows.

Procedure

It is very important to record each step of the experiment in enough detail that it could be repeated again by anyone reading the experiment. The more detailed the steps, the easier it is to follow.

An easy way to do this is to talk through what is being done, as it is being done. This is a great place for a parent helper. As the experiment is in process, have your child talk through the experiment as you record it. You might even turn your back to what is going on to make sure the description is clear to you.

If it is impractical to be present or take notes during the experimentation, read the steps to see if you understand the procedure. If you do not understand what is being done, then the explanation is probably not as clear as it could be. Have your child/student explain the step again and make changes as necessary. Each step should be clear and repeatable. This is a very important part of the experiment.

If the experiment takes longer than one session, it is a good idea to keep a journal. By keeping a journal, the information is organized in one place, and follows some type of chronological order. This can be helpful in collecting the data and analyzing the results.

Some important points to note for a good procedure:

- Decide ahead of time what is going to be measured, how often and in what units.

- At the elementary level it is suggested that a minimum of three tests of the variable for an experimental project be done. The number for junior or senior should be adequate to prove or disprove the hypothesis. This ensures that the information collected is related to the changed variable and not to an external source.

Results

This section of a project is a written report on the data collected in the experiment and describes what is found in the charts and graphs in the paper.

After all tests have been conducted, it is a good idea to organize the recorded measurements into groups or tables. The average of many trials will help determine if a statistically significant change did take place. Sometimes it is necessary to conduct more tests, or take different measurements to show what is really happening.

Remember, only results should be reported in this section. Interpretations of the results should be saved for the next section.

Drawing Conclusions

This is the discussion section in which the student determines whether the results of the experiment support the hypothesis. If they do not, why not? What could have caused the results to come out the way they did? It is important to emphasize that results that do not support the hypothesis are just as good as those that do. The point of an experiment is to *test* your hypothesis.

What does the experiment say about the topic in general? Is there something that happens in everyday life that is similar to the experiment or are there other applications that might make a difference in the way something happens? Answers to these kinds of questions are all good to include in a conclusion.

Constructing an Exhibit

Science Pioneers provides a creative booklet titled ***How to Construct a Science Fair Exhibit***. It is available on our website, *www.sciencepioneers.org*.

1. All work on exhibits must be done by the exhibitors. Sponsors/parents may only provide advice.

2. The exhibit must be a completely self-contained unit. Many students give stability to their exhibits by constructing it as one transportable unit and mounting it on a suitable base.

3. The exhibit must be no larger than 81cm (32 in) deep x 76cm (30 in) wide. Students in grades 7-12 are allowed a width of 122cm (48 in).

4. Each exhibit is to be accompanied by a written paper that explains in detail what the exhibitor did throughout his/her research study. Science Pioneers provides a booklet titled ***A Style Manual for Writing a Science Paper***. It is available on our website, *www.sciencepioneers.org*, or you may request a copy by contacting us at (816) 460-2261 or admin@sciencepioneers.org.

Safety Rules

1. Exhibits requiring electrical current for operation or illumination must be designed for operation on alternating current at 110 volts. If batteries are used, they should be storage batteries to ensure continuity of operation.

2. Only suitably rated UL 110 volt toggle or push button type switches mounted on panels or switch boxes are allowed.

3. All wiring, switches, and metal parts carrying 110 volt current must be grounded properly and out of reach of visitors.

4. All electrical points must be soldered and taped properly (following UL regulations.)

5. Only use porcelain or other approved types of insulators for fastening wires.

6. All wiring must be properly insulated for voltage used.

7. Dangerous chemicals, open flames, flammable liquids, and explosives are strictly prohibited.

8. If bacteria are displayed, they must be in sealed containers and prior approval is required. See Form 4.

9. No live animals, vertebrate or invertebrate, are to be displayed at the Fair.

The Greater Kansas City Science and Engineering Fair

Setting up at the Fair

The student, parent or teacher can set up the project. ***(Not: project set-up requires approximately 15-20 minutes.)***

When setting up a project, students must bring:

a. Their paper
b. The display board and any accessories or models
c. The project number sent to their teacher by Science Pioneers. This number identifies the placement of the projects within the exhibit hall.

Judging and Awards

Each project is reviewed by three judges.

Academic judges evaluate each project based on how well experimental, computer science, engineering or invention processes and principles were followed. See the Judge Scoring Guide for a complete description of how the project is judged. Each project is given a gold, silver or bronze rating based on the marks received on the scoring guide and the appropriate ribbon will be awarded. In addition, the top projects in each grade level and category will be given **Academic Awards**. Students winning Academic Awards will be asked to attend the Charles N. Kimball Awards Ceremony to receive recognition for their accomplishments.

The **Pioneer in Science Award** is given to the top five senior projects. The goal of the award is to recognize more outstanding examples of student research, innovation and design.

The **Grand Award** is given to the two best ISEF eligible projects in the Senior Level. Students winning the grand award will receive an all-expense paid trip to the International Science and Engineering Fair in May.

Special Award judges evaluate the projects based upon their organization's interest and priorities. Each organization determines its own awards including plaques, cash and scholarships. Students winning Special Awards are asked to attend the Charles N. Kimball Awards Ceremony to receive their award from the sponsoring organization. A list and description of Special Awards organizations and description of criteria may be found on the Science Pioneers website at www.sciencepioneers.org.