Venturing & Sea Scouting Supernova Activity Topics

Science Technology Engineering Mathematics

Each STEM field — science, technology, engineering, mathematics — offers a choice of three Supernova activity topics. These are two-part, hands-on, high-level activities created to challenge you and help you continue along your STEM journey to excellence. Part 1 involves research, preparation, set up, coordination, and/or organization. Part 2 includes elements such as analysis, reflection, experimentation, design, or invention, and culminates in a report created by you.

Report Format Options

No matter what STEM activity you choose, you will need to create a report. Reports are a regular part of the work of professionals in various STEM fields, so these tasks will be good preparation for future career demands. Notice that it doesn't say write a report. You are not restricted to just writing a report, although you may choose to do so if you like. Any report will probably involve some writing on your part, but the report itself may be created and presented in any number of ways. Use your imagination!

You may choose from any of the formats below for your report, or you may create a combination of these formats. You may create something entirely new as long as your Supernova mentor approves. The objective is for you to communicate what you have learned to others in a way that helps them understand what you learned and how you learned it.

- Oral report
- Written report
- Poster presentation
- Virtual poster
- Video production
- Multifaceted format
- Any format of your own design, with your mentor's advance approval

The report must provide sufficient detail so that someone unfamiliar with the topic can understand the content. For each format, you are encouraged to incorporate a variety of ways to present your information and to use technology to create a polished presentation. For example, an oral report might include a PowerPoint presentation as a visual aid, or a poster presentation might include a slide show of your activity. Be creative.

A Note About Resources

The books and websites provided for each supernova activity topic are presented as optional resources and are merely suggestions. In most cases, they are not crucial to the corresponding activities. Scouting America makes no guarantee that they will be available in local public libraries, from booksellers, or online.

The resources represent examples of the types you might use to support your work on a particular activity. You may very well find alternative and/or additional resources that serve you as well or better than those presented here.

Supernova Activity Topic: Science

If you are fascinated by how things work and you want to help contribute to a better planet Earth, the Supernova activity topic choices for science give you a hands-on chance to:

- Reduce your environmental impact on Earth.
- Explore the wonders of space technology.
- See why carbonation and candy create an explosive experiment.

Choose any *one* of these activities and discover how it drives your imagination, your curiosity, and your fascination with science.

Environmental Science: New Things From Old

This activity can be done individually or in a group. Your task is to investigate the logistics and environmental value of recycling and repurposing used items into new products and to invent a product that is predominantly made from used item(s).

Part 1: Research

1. Find two products made primarily from recycled materials. Describe the recycling process and the production process for each of these products. Discuss with your mentor:
   A. The impact of these recycled products on the environment compared with the impact of the same products made with all-new materials

   B. The environmental impact of the two products regarding pollution control and remediation, such as hazardous byproducts in the air, water, and waste

   C. The environmental impact of the two products regarding resource conservation and management, such as animal life, plant life, water, fuel, and protected lands/sites

   D. The environmental impact of the two products regarding production infrastructure, such as land use, municipal planning, transportation, and energy

Part 2: Product Invention and Report

1. Develop your own design for a product that can be made by recycling or repurposing other items. The items being recycled or repurposed should form the bulk of the new product. For instance, avoid designs that are 5 percent recycled and 95 percent new materials. Use ONE of the following two approaches.
   A. Find an item that isn't environmentally friendly, doesn't break down easily, and is typically thrown away. Invent a new product that would repurpose that item. The recycling of tires into road surfacing material and into playground mulch is an example of this approach.

   B. Think of an often-used product that is typically made with all-new materials. Develop a way to make that product out of recycled or repurposed materials. (The production of paper grocery bags made from recycled paper instead of "new" paper is an example of this approach.)

2. Summarize design specifications of the product you invented for requirement 1, and create a drawing, model, or prototype. What resources would be needed to carry out a large-scale production of your invention? Speculate on the environmental impact of using your product over a comparable product made with all-new materials. Create a report that includes your design specifications, photos or illustrations, a summary of how your product can be mass produced, and a case for the environmental soundness of your product.

Resources

Susan Casey. *Kids Inventing! A Handbook for Young Inventors* (for younger youth). Jossey-Bass, 2005.

Russel Gehrke. *Recycling Projects for the Evil Genius* (lots of how-tos). McGraw-Hill/ TAB Electronics, 2010.

Garth Johnson. *1000 Ideas for Creative Reuse: Remake, Restyle, Recycle, Renew* (pretty pictures, good inspiration, no how-tos). Quarry Books, 2009.

Movie "Science": Misconceptions, Misunderstandings, and Mistakes

This activity can be done individually or in a group. There are many popular movies and television shows with plots that involve space travel in the near or distant future. Your task in this activity is to watch one such production and identify scientific or technological advances that appear to be possible and those that appear to be impossible and explain.

Part 1: Research

1. View a movie or television show involving space, space travel, or life in space. In the movie or show, identify two instances of scientific "principles" or technological "advances" that violate currently accepted scientific principles or misrepresent currently available technology. Discuss the following with your mentor:
   A. The scientific principle that is violated and how. Describe the technology that is misrepresented and how.

   B. Two potentially plausible technological or scientific advances in your chosen movie—show and explain how these could potentially come to be in the future. Discuss the hurdles that would have to be overcome in order to develop those advances.

   C. The scientifically based reasoning that leads you to believe scientists, engineers, mathematicians, and technology specialists can overcome these hurdles.

Part 2: Report

Create a report that is addressed to the producers of your chosen movie or show, from the perspective of a scientist hired as a consultant on the production. Include suggestions for the producers to make the movie more scientifically or technologically accurate, realistic, and plausible.

Resources

Jeanne Cavelos. The Science of Star Wars: An Astrophysicist's Independent Examination of Space Travel, Aliens, Planets, Robots as Portrayed in the Star Wars Films and Books. St. Martin's Griffin, 2000.

Michio Kaku. Physics of the Impossible: A Scientific Exploration Into the World of Phasers, Force Fields, Teleportation, and Time Travel. Anchor, 2009.

Lawrence M. Krauss. The Physics of Star Trek. Basic Books, 2007.

Tom Rogers. Insultingly Stupid Movie Physics: Hollywood's Best Mistakes, Goofs and Flat-Out Destructions of the Basic Laws of the Universe. Sourcebooks Hysteria, 2007.

Household Chemistry: Diet Coke and Mentos Explosions

This activity can be done individually or in a group, but it is much more fun as a group. For this experiment, you will investigate how and why dropping a Mentos candy into a two-liter bottle of Diet Coke creates a massive explosion.

Part 1: Research and Experiment Design

Research this Diet Coke and Mentos phenomenon by doing the following:

1. Find out what others have discovered about how and why this experiment works. Note who discovered what about the experiment. Keep track of your references and resources.

2. Formulate a hypothesis that you would like to test.

3. Design an experiment to test your hypothesis. Be sure to get approval from your mentor prior to conducting your experiment. Make sure your plans for the experiment include an outside location, a list of supplies needed (which should be inexpensive, readily available, and safe), adequate safety protocols and equipment (safety goggles, etc.), plans for accurate and precise measurements, a list of stepby- step procedures, number of trials, and plans for recording and analysis of data.

Part 2: Experiment and Report

Conduct your experiment. You might want to videotape your experimental trials and include some video clips in your final report.

1. Discuss the following with your mentor:
   A. What happened during the experiment.

   B. How the evidence supported or contradicted your hypothesis.

   C. Whether the experiment raised any new questions for you.

   D. Whether something unexpected happened during the experiment. Tell how what happened might suggest about a future experiment on this same phenomenon.

2. Create a report that describes your hypothesis, experiment, and conclusions. (For guidance, see “Report Format Options” earlier in this section.)

Resources

Theodore Gray. *Theo Gray’s Mad Science: Experiments You Can Do at Home- But Probably Shouldn’t.* Black Dog & Leventhal Publishers, 2011.

Robert Bruce Thompson. *Illustrated Guide to Home Chemistry Experiments: All Lab, No Lecture.* O’Reilly Media, 2008.

Using your favorite search engine online (with your parent’s or guardian’s permission), enter search terms EepyBird, Mythbusters, and “Diet Coke and Mentos.”

Supernova Activity Topic: Technology

From the energy that keeps our homes comfortable and our lights on, to the communication that lets us talk to people around the world, to the special effects used in the movies, we depend on technology. Choose any one of the following projects and you will have fun while learning about today's technology.

Energy Technology

This activity can be done individually or in a group. The technology to harness energy has always been a significant factor in human progress. The harnessing of energy from wind, sun, water, biomass, fossil fuels, and other sources has evolved dramatically over time.

Part 1: Field Trip

Arrange and go on a field trip to a site where you can learn about innovative and/ or historical examples of energy production, storage, and use and the ways people are making such processes sustainable. Possible sites include power plants, fuel manufacturers or refineries, power generation sites, energy- or resource-efficient buildings, historical sites of energy use or production, educational centers, museums, and so on.

Part 2: Analysis and Report

1. Create a report that describes your field trip and what you learned.

2. For the energy production and/or use that you chose, find out about the current state of technology, its course in historical that led to today's technology, and future directions for this technology. Discuss the following with your mentor.
   A. The effect on the environment, our natural resources, and our economy of our current methods

   B. Whether current methods are sustainable over the long term

Resources

John Perlin. *From Space to Earth: The Story of Solar Electricity.* Harvard University Press, 2002.

Terry S. Reynolds. *Stronger than a Hundred Men: A History of the Vertical Water Wheel.* The Johns Hopkins University Press, 2002.

Robert W. Righter. *Wind Energy in America: A History. University of Oklahoma* Press, 2008.

Communication Technology

This activity can be done individually or in a group. It requires the participation of 20 to 30 people.

The scenario: You are the communication chair for a science fair being organized by your unit. Your responsibility is to gather contact information from all participants (contestants, judges, staff, and so on) and formulate a communication plan that will be effective for anticipated communications and necessary-but-unexpected communications as well. You will need to be able to communicate some information to everyone, other information to subgroups, and additional information to another group of individuals.

Part 1: Communication Plan

Before you get started, share your plan with your mentor. Then do the following:

1. Solicit volunteers to serve as participants. Give each participant a mock role in your mock science fair. You will need 20 to 30 such individuals.

2. From each participant, gather at least two ways to contact him or her, as well as an emergency contact. Participants should list their contact modes in order, from the most-likely-to-be-received to the least-likely-to-be-received.

3. Set up plans for how you will broadcast messages to various subgroups, how you will get emergency messages to groups or individuals who will have access to the contact information, how access will be maintained, and back-up plans in case you are suddenly unavailable.

Think about the kinds of information you will need to communicate. This sometimes influences the mode of communication and should also be a part of your communication plans.

1. Test your plan by playing a few Mad Libs via your communication plan. To test your communication plan, choose a particular Mad Lib and send out requests for various types of words (verbs, adjectives, nouns, and so on) to a group of individuals and subgroups. Make sure you cover your entire set of recipients or recipient groups and be sure to give everyone a deadline for a response.

If you don't get responses, follow up with additional messages, perhaps via different communication modes. When you have what you need, make sure you communicate the finished Mad Lib back to the relevant individuals.

A Mad Lib is an unfinished story that is complete except for missing words, indicated by blanks. The words for each blank are in categories such as verbs, nouns, and adjectives. Missing words are supplied by folks who don't know the story, thus creating a funny, crazy, mad story.

Part 2: Analysis and Report

Gather some statistics relevant to your communication plan and your participants. Then do the following:

1. Discuss with your counselor:
   A. The many distinct modes of communication your participants used

   B. Any modes of communication used but with which you were unfamiliar

   C. The technology used for your broadcast communication messages and whether that technology was the most effective mode of communication for one-on-one messages

2. Create a report that outlines your communication plan, how you implemented it, and how effective it was. Include information about the biggest hurdle, anything unexpected that happened, and what you would do differently if this had been a real assignment for you.

Resources

Roger Price. *Best of Mad Libs.* Price Stern Sloan, 2008.

Roger Price and Leonard Stern. *More Best of Mad Libs.* Price Stern Sloan, 2009.

For information about Mad Libs, go to www.madlibs.com. Click on the "Mad Libs Online Widget" to try it out.

Entertainment Technology

This activity can be done individually or in a group. Many of today's movies involve extensive use of technology to create illusions of magnificent landscapes, mythical beasts, epic battle scenes, and so on. This activity involves learning about some of these technologies and applying them in a real-life setting.

Part 1: Building Knowledge

Choose a favorite, recent movie that is heavily laden with special effects, available for home viewing, and accompanied by supplemental material that describes and shows how the special effects were created. After you have chosen a movie, do the following:

1. Watch and study the material on the special effects.
2. Do some supplemental research on some of these special effects to build your understanding of them.
3. Choose one scene in the movie, or even one frame, and describe in detail to your mentor how that scene or frame was put together using various special effects.
4. Discuss with your mentor which of the special effects you would implement (even if just crudely) if you were to take a still photo or make a short video and wanted to give the illusion of something magnificent or unusual happening.

Part 2: Creating a Grand Illusion

Develop a plan for creating a still photo or a short video that would require special effects to convey the image or action that you desire to show. Be sure you share your plan with your mentor before you get started. For a still photo, make a crude sketch of what you want the photo to look like. For a video, make a storyboard of the action sequence.

A storyboard is a sequence of rough illustrations that depict the primary scenes or action shots of your story.

In either case, describe the special effects you would use to create each element of the piece. Discuss the following with your mentor:

1. What you would do first and how.
2. The sequence of special events and how everything goes together in the end. Do as many of the parts of the photo or video yourself as possible and describe what would best be done by highly trained and/or educated professionals.

The elements of the video/photo that you created must be planned and implemented using the highest safety protocols. Have your mentor examine your plan and suggest improvements. Your mentor must approve it before you get started. Create a report that shows your understanding of special effects and how they might be applied to the photo or video that you envisioned.

Resources

Troy Lanier and Clay Nichols. *Filmmaking for Teens: Pulling Off Your Shorts.* Michael Wiese Productions, 2010.

Richard Rickett. *Special Effects: The History and Technique.* Billboard Books, 2007.

Steve Wolf. *The Secret Science Behind Movie Stunts & Special Effects.* Skyhorse Publishing, 2007.

Supernova Activity Topic: Engineering

Have you ever studied how your bicycle works? To learn how a bicycle is put together (or engineered), here is a project for disassembling one. Or what about making a high-performance paper glider? Or having a contest to see who can drop a raw egg without breaking it? Choose any one of these activities to learn more about engineering.

Deconstruct and Analyze: Mechanical Designs

This activity can be done individually or in a small group. Your task is to take apart a bicycle (or other suitably complex mechanical device; see the note below), analyze the components, and describe how the components work (both separately and together).

Part 1: Preplanning and Set-Up

1. Do the following:
   A. With your mentor's assistance, choose an unwanted older bicycle—or any other complex mechanical device—perhaps not completely in working order, that is a bit beyond what you feel comfortable dismantling.

   B. Find a location for the project where you can take things apart, leave the pieces undisturbed, and come back another time.

   C. Determine and gather the necessary tools. You are encouraged to find resources to help you with the deconstruction, such as written instructions or a repair specialist willing to volunteer his/her time. (The specialist cannot touch the object or the parts or handle the tools during dismantling. You and any fellow youth must do all of the dismantling.)

Part 2: Deconstruction, Analysis, and Report

This next phase involves deconstructing the device. Take pictures as you work and make notes of what is happening in each picture.

1. Determine the following:
   A. The major components of the bicycle

   B. What parts make up each component

   C. How the components work together

   D. The mechanical or electronic advantages that a minimum of three parts or circuits convey

   It is not crucial for the object you deconstruct to be a bicycle. Any mechanical device, machine, or tool will do, as long as it is suitably complex for your abilities and knowledge and is approved by your mentor. Examples include but are not limited to manual typewriters, old clocks, old sewing machines, and so on.

   If you wish to deconstruct something that is electronic in nature (rather than just mechanical), then you will need to learn about additional safety protocols that must be observed while deconstructing electronics. Your mentor may suggest and help to secure the help of a qualified electronics expert for those projects. You must demonstrate to your mentor that you know and understand these additional safety protocols prior to beginning your deconstruction.

   Whatever you choose to deconstruct, you must adapt the questions above to suit the object you are deconstructing and address those questions in your report.

2. Discuss the following with your mentor:
    A. What might cause a failure in one of the components

    B. The kinds of failures that can be fixed if you are using the device away from home (for example, if you are out mountain biking)

    C. The basic elements of keeping the device well maintained

    D. Considering the intended owner/user and uses of this device, discuss improvements to the design that could be made.

3. Create a report that communicates your understanding of the experience and addresses the following points.
    A. Document the deconstruction process, your analysis of the components, and how they work together

    B. Document your analysis of failure possibilities plus maintenance requirements, and what these suggest about design improvements

Resources

Bryan Bergeron. *Teardowns: Learn How Electronics Work by Taking Them Apart.* McGraw-Hill/TAB Electronics, 2010.

Naval Education and Training Program. *Basic Machines and How They Work.* Dover Publications, 1997.

Build and Test: High Performance Paper Gliders

This activity can be done individually, but works much better with at least two people. Your task is to measure how differences in design affect the flight characteristics of a glider. You will accomplish this by building and testing some high-performance paper gliders. These gliders use a laminated construction method that helps simulate a real glider much more closely than a simple folded piece of paper.

Part 1: Background Research, Baseline Design Selection, and Test

1. Research and discuss the following with your mentor:
    A. The fundamental parts of a glider

    B. The basic elements of the physics of stable flight

2. Choose a glider design from a kit or plans. (You do not need to design the glider yourself.) Then do the following:
    A. Identify one quantitative characteristic to test, such as flight distance, flight time, average flight speed, and so on. Then identify one qualitative characteristic to test, such as presence of a stall, dive, flip, left turn, right turn, and so on.
    B. Hypothesize how variations in one part of the glider, such as wing size, fuselage length, center of gravity, flap size, and so on, might influence these characteristics of the glider's performance.

    C. Build four high-performance gliders, identical except for variations in the relevant glider part.

D. Establish a consistent method to measure each characteristic during a test flight. Then find a way to launch the gliders in a consistent manner so that they are launched at the same speed every time. You should perform test flights with each model five to six times to account for variations in flight performance. Try to keep the conditions of each test flight the same as for all the other test flights. Keep records of the results for each test flight.

Part 2: Analyze and Report

Present to your mentor your recorded data in a tabular format as well as a graphical format. (You may use Excel if you wish.) Then do the following:

1. Evaluate the data and determine how the variations in the tested glider part influenced the flight characteristics you observed. Based on the data you gathered, predict how the glider would perform relative to the flight characteristics you observed if you were to build a glider with another variation in the same glider part.

2. Suggest an ideal design of your tested glider part that would maximize the glider's performance relative to the flight characteristics you observed and explain your reasoning for this design.

3. Create a report that describes your glider, the flight tests, the flight data, and your conclusions. Include the procedures you followed to ensure consistent test conditions.

4. Share the flight records and data you have gathered with your mentor. Discuss what you have learned.

Source: The idea for this activity is based on the work of Andrew Olson, Ph.D., Science Buddies, What Makes a Good Aerodynamic Design? Test Your Ideas with High-Performance Paper Gliders. Visit http://www.sciencebuddies.org/science-fair-projects/project_ideas/Aero_p009.shtml.

Resources

Science 85 Magazine. *The Paper Airplane Book: The Official Book of the Second Great International Paper Airplane Contest* (best book for laminated paper techniques). Science 85 Magazine, 1985.

Hubert Smith. *The Illustrated Guide to Aerodynamics* (for background research). McGraw-Hill Professional, 1991.

NASA Beginner's Guide to Aeronautics

Website: http://www.grc.nasa.gov/WWW/K-12/airplane/guided.htm (For background research, look at the gliders section.)

The Online Paper Airplane Museum
Website: http://www.theonlinepaperairplanemuseum.com (free glider plans)

Zovirl Industries
Website: http://www.zovirl.com (For glider plans, click on the Paper Airplanes tag.)

Design and Redesign: Egg Drop Contest

This is a group activity and requires at least two youth. Your task is to design a container in which to place a raw egg, so that when the container with the egg is dropped, the egg survives the impact without breaking.

Part 1: Research, Design, and Contest Set-Up

Research and describe to your mentor:

1. The physical forces affecting the outcome of an egg drop test
2. Desirable characteristics of container materials
3. Rules for other egg drop contests. (With your parent's or guardian's permission, search online.)
4. As a group, come to a consensus about the constraints and rules for your egg drop contest. Adopt, adapt, or make up your own rules. You might want to break into divisions, each with its own rules. (Youth with stronger STEM backgrounds should adopt more challenging constraints and rules.) Here are some guidelines. You must:
   A. Agree on constraints that the egg container must meet, such as dimensions, weight, allowable materials, disallowed elements, and so on.
   B. Agree on rules to ensure fairness, such as judging decisions, conditions for elimination, scoring system, how to win, and so on. You may wish to have several different ways to win.
   C. Communicate the constraints and competition rules to all participants.
   D. Design and build your container.
   E. Have fun—conduct the contest!

Part 2: Analysis, Redesign, and Report

Analyze how your container performed and discuss with your mentor your design strategy and how well the container you designed performed. Then do the following:

1. Given your container's performance, your knowledge of the physical forces acting on it during a test drop, and your observations of other participants' containers and results, redesign your container. Your redesigned container should still fit within the contest constraints but offer improved performance.
2. Consider whether you would alter the constraints, how, and why. Create a report that communicates your understanding of the experience and addresses the following points.
   A. Describe your original egg container, your original design strategy, and your analysis of its performance.
   B. Describe your redesigned container and the reasoning that led to your new model.

Resources

Do an internet search on "egg drop challenge" to find multiple resources

Supernova Activity Topic: Mathematics

Have you ever watched bungee jumpers and wondered why they don't hit the ground? You can make a model of your own and figure it out. Or, what about the Yellowstone geyser Old Faithful—how can you tell when it will erupt? What about voting—can you imagine how so many people in so many states can go in, cast a vote, and come out with a fair result? Mathematics is the key. Choose any one of these projects to learn how it's done.

From Simulations to Real Life: Modeling Bungee Jumping

This activity requires at least two people and works much better with a group of three to six people.

The scenario: The Acme Daredevil Adventure Company provides rock climbing, skydiving, extreme skiing, and cliff diving adventures to the public. To appeal to a broader market, the board decided to add bungee jumping to its list of offerings. The details of this new venture now need to be worked.

The company has several sites planned for bungee jumping, and each site has a different jump height. Your task is to simulate bungee jumping using rubber bands and an action figure (doll) to determine the ultimate length, or the number of rubber bands to be used with your action figure at any given height to guarantee a safe jump. For maximum thrills, the jump must allow your action figure to come as close to the floor as possible.

Part 1: Set-Up and Simulation

Tape a weight(s) to the doll's back so that it is heavy enough to stretch the rubber band "bungee cord." Tie one or two rubber bands (the unstretched size should be about 4 inches) to the doll's feet and drop it, headfirst, from various heights. Keep raising the jump height until the head no longer hits the floor.

Once you reach this height, perform three trials, measure the height of the drop each time, calculate the average, and calculate the maximum error between the average and the drop heights used to find that average. (Conduct a test drop several times to practice taking readings.)

Continue adding rubber bands to see what the average drop height will be for different numbers of rubber bands. Do the experiment with at least six different numbers of rubber bands. Use a tabular chart to help you organize and record your data. (You may use Excel or create your own tables.)

What Is a Scatter Plot? Scatter plots use horizontal and vertical axes on a graph to plot data points and show how much one variable (or measurable "value") is affected by another. Each variable can be represented on the scatter plot with a dot. Once the scatter plot has been filled in with a number of dots, you should be able to see how the variables are "scattered" to show a trend. For more information about scatter plots, use your favorite search engine on the Internet (with your parent's or guardian's permission), or ask your mentor.

Part 2: Analysis and Report

1. Create a scatter plot of ordered pairs of the type (number of rubber bands, average drop height). You may do this by hand or using data analysis software, such as Excel.

2. Using the scatter plot you have created, determine whether the points appear to lie on or near a line. Find such a line. If your mathematics background is not yet extensive, then find such a line by "eyeballing it" and drawing it onto the scatter plot with a ruler. If your mathematics background is extensive, then use a graphing calculator or data analysis software of your choice to find the line of best fit for your data.

3. Describe to your mentor how to use the line (graphical form or symbolic form) to make predictions. Then complete the following sentence (hypothesis): "If the height of the drop is _____, then I predict that the number of rubber bands needed is _____."

4. Test your prediction and analyze the outcome. Determine whether the prediction matched reality, how far off the prediction was, and what errors or issues arose that may have thrown off the results of your simulation. Test and analyze three more predictions.

5. Analyze the maximum errors found in your tests. Then find out the height of your favorite location (such as the Statue of Liberty, Eiffel Tower, or Golden Gate Bridge). If you drop your action figure from the top of that location, how many rubber bands would you need for a safe drop from that height? What would you expect to be the maximum error in your prediction?

6. Now, consider the realities of bungee jumping with real human beings using real bungee cords and equipment. Discuss the following with your mentor:
   A. The factors that need to be considered when testing this equipment to develop safety protocols

   B. Reliable statistics on the risk of serious injury or death while bungee jumping

   C. Bungee jumping is one of the high-adventure activities that is expressly not allowed by Scouting America. What do you think of this policy?

7. Create a report addressed to the Risk Management Board of the Acme Daredevil Adventure Company. In your report, include the following:
   A. A description of your simulation

   B. Your simulation data displayed in a chart and graph

   C. How your data led to your ability to make predictions about safe bungee jumping heights

   D. The variables that might have affected your predictions Share your report with your mentor.

Source: The ideas for this activity are based on multiple versions of an activity available online titled Bungee Barbie and Kamikaze Ken. The originator of the idea for this activity is unknown.

Linking the Past to the Future: Predicting Old Faithful's Next Eruption

This activity can be done individually, but works much better with three to six people.

The scenario: You have lined up a summer job as a junior park ranger at Yellowstone National Park, where you know many visitors come to see the geyser Old Faithful. Many visitors arrive just after Old Faithful has erupted and they typically ask a nearby ranger when it is next expected to erupt. Your task is to analyze past data on Old Faithful's eruptions in order to devise a strategy for predicting the next eruption.

Part 1: Data Gathering and Initial Analysis

1. Gather information about geysers in general and their behavior.
   A. Find data on intervals (length of time) between eruptions for Old Faithful. Be aware that Old Faithful's eruption behavior has changed over the years. Use the most current data you can find. For your analysis and to test your prediction strategy, you will need information on all of the intervals for three consecutive 24-hour periods, plus intervals for the fourth consecutive 24-hour period. Each additional youth must use intervals for different days.

   B. Create two graphical displays of the data from three days of eruptions, analyze the patterns, and formulate your initial prediction strategy.

Part 2: Further Analysis, Refinement of Prediction Strategy, and Report

1. Do the following:
   A. Using the data you have collected for part 1, determine how much variability you see from day to day. How much variability is there within a single 24-hour period? Is knowledge of one interval sufficient to predict the next eruption? Why or why not?

   B. Determine what patterns in the data are illuminated (or perhaps obscured) in the different graphical displays. Of the graphs you used, which one best illustrated the wait time pattern for Old Faithful? Would you refine your prediction strategy? If so, why and how? If not, why not?

   C. Use your prediction strategy to estimate all of the eruptions for the fourth 24-hour period, and compare your estimates to the actual eruption times. Calculate the differences between your estimates and the actual times. What is the maximum difference? Why are there patterns in the Old Faithful data? Is there a geological explanation?

   D. Create a report that describes and addresses your prediction strategy, includes your graphical displays, and explains how your graphical displays support your strategy.

2. Discuss the data you have collected, your report, and what you have learned with your mentor.

Resources

T. Scott Bryan. Geysers: What They Are and How They Work, 2nd ed. Mountain Press Publishing Company, 2005.

William J. Fritz. Roadside Geology of the Yellowstone Country. Mountain Press Publishing Company, 1985.

A Paradox of Counting: Voting Methods and Fair Decisions

This activity can be done individually or with a group of two to six people, and requires cooperation from about 20 to 30 individuals.

The scenario: Your unit wants to plan a superactivity for next summer but cannot agree on what that activity should be. There are four options under consideration, and your unit decides to vote. Your task is to collect ballots and tabulate results using several different voting methods.

This is not a binding decision on your unit! This is an exercise, but one that will be more meaningful if you use real-life possibilities.

Part 1: Ballot Setup, Gathering, and Tabulating

1. Decide on four superactivities that your unit would genuinely be interested in doing next summer. Aim for four genuine options, none of which is likely to receive a majority of the votes. Discuss these options with your mentor before doing the following:
   A. Create ballots on which each voter can list his/her first, second, third, and fourth choices from among the four prospective superactivities.

   B. Find 20 to 30 unit members, prospective guests for the superactivity, unit leaders, parents, and so on, to complete one ballot each. Each voter should vote sincerely, without trying to strategize.

C. Do some research and learn how to tabulate winners using each of the following four voting methods:
    1. Plurality method
    2. Borda count method
    3. Plurality-with-elimination method (sometimes called the instant runoff method)
    4. Pair-wise comparison method (sometimes called Copeland's method)

Part 2: Analysis and Report

1. As you tabulate the results using each voting method, evaluate each method and discuss the following with your mentor.
    A. What do you notice? How fair is each method?
    B. How would the results be affected if two or three voters had cast strategic ballots (instead of sincere ballots), in an effort to "not waste their votes"?
    C. Which of the four voting methods do you believe is the right voting method for this decision in your unit? Why?
    D. Consider how we elect the president of the United States of America.
        1. What voting method do we use?
        2. What are its advantages and disadvantages?
        3. Do you believe each voting citizen in the United States has an equal say in the vote tabulation?
        4. Is it possible for citizens to cast strategic votes and influence the outcome of a presidential election?
2. Create a report that summarizes the results from the various voting methods, outlines your analysis, and comments on voting methods for the U.S. presidency. Share your report with your mentor.

Resources

Donald G. Saari. *Chaotic Elections! A Mathematician Looks at Voting* (for youth with stronger mathematics backgrounds). American Mathematical Society, 2001.

William Poundstone. *Gaming the Vote: Why Elections Aren't Fair (and What We Can Do About It)*. Hill and Wang, 2008.