Standards-Aligned CaveSim Programs for Utah Elementary Schools

Prepared by Dave Jackson, CaveSim creator and lead educator. Contact Dave: dave@cavesim.com

Right: Awestruck at a program in Los Alamos, NM, 2017

Teacher quotes:

"Science Days was a rousing success and everyone is raving about how good your stations were. The cave, obviously, but I have also heard especially good things about the bats and echolocation games being perfect for the younger kids and I saw the bigger ones enjoying it as well. I've had a number of teachers say they want you back." **— Julie Haverluk, Academy International Elementary School, Colorado Springs**

"CaveSim was amazing. I had students come up to me the next day, give me a big hug and say 'Thank you Ms. Jones for having the cave at our school. It was so fun.' The students were able to understand cave formations, organisms and cave safety. You and the other cave experts were fantastic. You were able to share important content related to earth science and life science. Each part of the presentation was aligned to our science standards. They particularly loved climbing through the cave and the 'tower'. Mike was great. Thanks for all that you do. We would love to see you back next year." **— Patricia Jones, teacher, Houston Elementary, Austin ISD**

Document revision August 16, 2023

Table of Contents:

Summary	**2**
Schools around the country that have done and loved our programs	**2**
Standards Alignment and Program Details	**3**
Labs	**10**
Pricing and FAQ	**15**
Safety and special needs	**15**
Challenge by Choice	**16**
Classroom management	**16**

Summary

Thank you for your interest in CaveSim! The centerpiece of our programs is our mobile CaveSim system, which we'll bring to your school in a 26' trailer. The cave is filled with formations, critters, and ancient artifacts (all artificial), and students get a computerized score based on how carefully they avoid these objects as they explore. We'll also bring you an entire program of Utah Core Standards[1]-aligned hands-on lessons/activities with the mobile cave. Our elementary program meets the latest 2023 Utah standards, and covers many subjects including science, math, engineering, PE and art.

Programs are led by CaveSim inventor, educator, and MIT-trained engineer Dave Jackson. Dave and his wife Tracy are both cavers, and have been doing CaveSim since 2010 for over 70,000 students. Our lessons are designed by Tracy, who has a Masters of Teaching from Colorado College, and brought to you by Dave and other highly skilled CaveSim staff.

In addition to learning a wide range of classroom subjects, students also learn that they can do what Dave and Tracy have done: take what they've learned in school and use it to follow their passions to make the world just a little bit better. We look forward to bringing CaveSim to your school to engage your students in a whole new way, and we're excited about working with you.

Schools around the country that have done and loved our programs

CA: College Connections Academy; **OK:** Grove lower/upper ES & HS, Centennial, John Ross, & Frontier ES; **TX:** Andrews, Baranoff, Barrington, Blanton, Brentwood, Barton Hills, Cowan, Creighton, Hill, Houston, Frost, Baccus, Metz, Lakeway, Sanchez, & Wooldridge ES, Austin, Eastside, & McCallum HS, Dahlstrom MS, Brawner Intermediate, Gus Garcia YMLA, Ann Richards YWLA; **CO:** Palmer Lake, Manitou Spgs, Ute Pass, Patriot, Aragon, Abrams, Avery Parsons, Gold Camp, Academy Intl., Longfellow, Peoria, Cresson, Arrowwood, Ridgway, Las Animas, Queen Palmer, Eisenhower, Cedar Ridge, Buena Vista, Ryan, & Foothills ES, Fulton Academy, Aspen Creek K-8, Legacy Academy, Falcon, University, & Carson MS, Atlas Prep, Lake George Charter Sch., Good Shepherd Sch., CSS, Univ. Sch. of C.Spgs, BFA, Mtn. Song Community Sch; **GA:** Hillside Montessori, Barnwell & Youngs Grove ES; **KY:** Barren County Intermediate Center, Allen County MS; **TN:** WCA; **MS:** JA

---

[1] www.schools.utah.gov/curr/science, www.schools.utah.gov/curr/elaelementary?mid=1124&tid=1, www.schools.utah.gov/curr/mathematics/core?mid=4514&tid=1, https://www.schools.utah.gov/curr/pe?mid=909&tid=1, https://www.schools.utah.gov/curr/finearts?mid=4609&tid=1

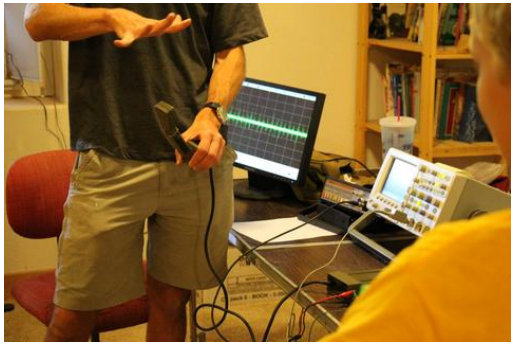
Standards Alignment and Program Details

Standard components are included in the cost of the program. Programs are typically conducted by having students work with us at a series of different stations/lessons, as follows:

CaveSim program element: Horizontal Cave Exploration	Corresponding Utah Core Standards	Photos of past CaveSim programs
In CaveSim mobile cave (60' of passage with multiple levels in a 24' trailer), students explore in small groups (while wearing helmets with headlamps) and:	Standard 1.3.2 Use a model to show the effect of light on objects. Emphasize that objects can be seen when light is available to illuminate them or if they give off their own light. (PS4.B)	 *Thrilled to explore CaveSim in Glenwood Springs, CO, 2018. Photo by Chelsea Self, Post Independent.*
• Try to avoid bumping into artificial cave formations. Students learn that oil & water do not mix, & that touching formations can cover them with skin oil, which stops formations from growing. Students learn that cave formations take a long time to form.	Science Standard 2.1.2 Construct an explanation about changes in Earth's surface that happen quickly or slowly. Emphasize the contrast between fast and slow changes	
• Look for cave biota (critters, all artificial), and discuss the cave ecosystem after they exit the cave. CaveSim staff teaches about the cave food web, including the amazing lampshade spider, which eats fungus gnats, which eat fungus, which eat deceased bats, etc.	Science Standard 3.2.1 Develop and use models to describe changes that organisms go through during their life cycles. Emphasize that organisms have unique and diverse life cycles but follow a pattern of birth, growth, reproduction, and death.	
• Learn about how cave passage forms. Staff teach about bacteria that use enzymes to eat limestone (breaking chemical bonds to get energy). We can also discuss the formation of sinkholes, and the benefits / dangers that they afford humans. Demo available upon request: dissolution of carbonate rocks using weak acid. Discussion of how humans use cave-based resources (e.g., limestone, guano)	Science Standard 3.2.5 Engage in argument from evidence that in a particular habitat (system) some organisms can survive well, some survive less well, and some cannot survive at all. Emphasize that organisms and habitats form systems in which the parts depend upon each other.	
• CaveSim staff explain how aqueous cave formations (helictites, soda straws, gypsum) form. Topics covered: water flow is usually downhill due to gravity; sometimes water flows against gravity due to capillary action (examples: water climbing up a towel, water flow inside cave formations); water is capable of mechanically weathering limestone to produce caves, and water with acidic pH is capable of chemically weathering limestone to produce caves. Students expand vocabulary with "capillary action."	Science Standard 2.1.1 Develop and use models illustrating the patterns of landforms and water on Earth.	 *Elementary students in Cascade, CO explore the mobile cave.*
• Look for modern equipment in the cave, including rescue cache and vertical caving rope ladder (etrier). Students learn that the etrier (rope ladder) is named after the French word for stirrup. Students expand vocabulary with the word "cache," which is a homophone	ELA Standard 3.R.9: Determine or clarify the meaning of unknown and multiplemeaning words and phrases choosing flexibly from a range of strategies…. Use sentence-level context as a clue to the meaning of a word or phrase.	
• Look for artifacts and rock art. Discuss the importance of artifacts to native people and to archaeologists and anthropologists. Hear a real story about a CaveSim staff member's experience with artifacts while exploring caves in Mexico. Students discuss why we don't take native artifacts or damage native art. Differences between graffiti and art are discussed. • Available upon request: prior to entering the cave, students are asked to make cave paintings with black paint on butcher paper. Students are encouraged to reflect on their paintings and write a few sentences about what story their picture tells. During exploration of the mobile cave, students are given extra time in the cave to make sketches of the cave paintings that they find. After they exit the cave, students are given time to write a few sentences on their sketch to tell a story about what they saw in the cave paintings. As a group, students are invited to share the stories that they wrote.	Fine Arts Standard K.V.CR.1: Engage in self-directed exploration and imaginative play with art materials, and engage collaboratively in creative art-making in response to an artistic problem. Fine Arts Standard K.V.R.1: Recognize art, identify its uses within one's personal environment, and describe what an image represents.	
Space required: the 24' trailer is typically kept outside. See www.cavesim.com/site-logistics for more details. In inclement weather, we may close the trailer and do indoor activities.		

CaveSim program element: Vertical Caving	Corresponding Utah Core Standards	Photos of past CaveSim programs
On CaveSim portable 12' A-frame w/ crash pads:		
• While wearing helmets, students use a Bosun's chair, ropes, and pulleys to learn about mechanical advantage afforded by 1:1 and 5:1 pulley systems, and learn that work is unchanged when a mechanical advantage is introduced. Students work together to lift a fellow student up the tower using the different systems. Students use their understanding of fractions to determine that the 5:1 pulley system reduces the required lifting force by a factor of 5. In the pulley experiments, CaveSim staff emphasize the importance of changing just one variable at a time. Students learn about balanced and unbalanced forces by lifting a fellow student, and by lifting themselves in the Bosun's chair.	Science Standard 3.3.1 Plan and carry out investigations that provide evidence of the effects of balanced and unbalanced forces on the motion of an object. Emphasize investigations where only one variable is tested at a time. Science Standard 3.3.2 Analyze and interpret data from observations and measurements of an object's motion to identify patterns in its motion that can be used to predict future motion. Science Standard K.3.1 Plan and conduct an investigation to compare the effects of different strengths or different directions of forces on the motion of an object. Emphasize forces as a push and pull on an object. The idea of strength should be kept separate from the idea of direction.	 *Above, a student uses mechanical advantage to lift herself up the A-frame.* *Below, students in Montana work together under direct supervision from staff to lift a fellow student .* 
• CaveSim staff use harnesses and mechanical ascenders to ascend the A-frame. CaveSim staff discuss the ascender mechanics, as well as equipment safety and the important differences between caving and rock climbing equipment. Students learn the words "ascend," "descend," "vertical", and "horizontal." CaveSim staff demonstrate the role that gravity plays in both the ascending and descending processes (making ascending more difficult for the explorer). Students learn about current events in vertical caving, including ongoing efforts in Mexico to find the world's deepest cave. Students learn that some of the cavers who help with CaveSim have been over 6000' underground.	Science Standard 3.3.3 Construct an explanation that the gravitational force exerted by Earth causes objects to be directed downward, toward the center of the spherical Earth. Emphasize that "downward" is a local description depending on one's position on Earth.	
• With the help of students, CaveSim staff demonstrate the power of friction to rapidly destroy Nylon rope. Before the demonstration, students are encouraged to develop hypotheses about what will happen when two ropes are rubbed together, and then develop hypotheses about which rope will break first. After the two ropes are rubbed together rapidly and the larger rope breaks, students are encouraged to try to figure out why the larger rope broke. CaveSim staff explain the outcome by introducing the concept of "concentrated" (because of the way the experiment is done, the heat is *concentrated* in just one spot on the larger rope, and spread out on the smaller rope, hence the melting of the larger rope). Staff also demonstrate that metal rappel racks do not get damaged in the same way as the Nylon rope.	Science Standard 2.3.1 Plan and carry out an investigation to classify different kinds of materials based on patterns in their observable properties. Examples could include sorting materials based on similar properties such as strength, color, flexibility, hardness, texture, or whether the materials are solids or liquids. (PS1.A) Science Standard 2.3.2 Construct an explanation showing how the properties of materials influence their intended use and function. Examples could include using wood as a building material because it is lightweight and strong or the use of concrete, steel, or cotton due to their unique properties. (PS1.A)	
Space required: typically outdoors on flat ground. May also be placed indoors where ceiling height is >12'6". Footprint is 8' x 9'.		

CaveSim program element: Carbide Demonstrations	Corresponding Utah Core Standards	Photos of past CaveSim programs
To illustrate chemistry and physics concepts, CaveSim staff bring working carbide lamps and carbide to programs. Demonstrations can include: • CaveSim staff light a working carbide lamp by placing carbide and water in the lamp to produce a small (and safe) quantity of flammable gas. The resultant gas (acetylene) burns to produce light and heat, but the lamp body also becomes warm because of the exothermic reaction between the carbide and water. Students can touch the lamp body to get a better understanding of the concept of an exothermic reaction. Students also learn about pressure as they see the intensity of the flame drop as the pressure in the lamp drops over time. Older students gain an understanding of the concept of reflectors by observing the behavior of the reflector on the lamps. New vocabulary explained by CaveSim staff: “exothermic,” with connection drawn to “exoskeleton.”	Science Standard 5.2.1 Develop and use a model to describe that matter is made of particles on a scale that is too small to be seen. Science Standard 4.3.2 Develop and use a model to describe how visible light waves reflected from objects enter the eye causing objects to be seen. Emphasize the reflection and movement of light.	 *Above, carbide lamp demonstration by CaveSim staff.*
• CaveSim staff use a specially-designed carbide lamp to demonstrate conservation of matter. The lamp is sealed, allowing staff to mix carbide and water without the resultant acetylene gas escaping. Staff use a digital scale to demonstrate that matter is conserved despite the chemical reaction.	Science Standard 5.2.4 Use mathematics and computational thinking to provide evidence that regardless of the type of change that occurs when heating, cooling, or combining substances, the total weight of matter is conserved.	
• CaveSim staff place carbide and ice in an open pan. As the ice melts, the water reacts with the carbide, producing the aforementioned acetylene gas. CaveSim staff discuss states of matter (solid ice turns to liquid water as it’s heated by the carbide, and then to vapor as it boils). For older students, the concept of limiting reactants is introduced. By watching the exciting reaction occur, students gain a more intuitive understanding of the concept of a chemical reaction. New vocabulary taught by CaveSim staff: “reaction”, “reactant.”	Science Standard 5.2.3 Plan and carry out investigations to determine the effect of combining two or more substances. Emphasize whether a new substance is or is not created by the formation of a new substance with different properties. Examples could include combining vinegar and baking soda or rusting an iron nail in water. (PS1.B) Science Standard 2.3.4 Obtain, evaluate, and communicate information about changes in matter caused by heating or cooling. Emphasize that some changes can be reversed and some cannot. Examples of reversible changes could include freezing water or melting crayons. Examples of irreversible changes could include cooking an egg or burning wood. (PS1.B)	*Below, a stock photo of the lamps we use.* 
• Science experiment safety is emphasized (e.g., firmly close containers when not in use). • Fire safety is emphasized, with an emphasis on who is allowed to make a fire (a responsible adult), what must be present (a method of extinguishing the fire), where the fire should be made (in a safe container away from other fuel sources). Space required: typically conducted outdoors, but cannot be done in the rain. May be done indoors in an appropriate lab setting where a small quantity of smoke may be safely produced without setting off alarms or creating hazardous conditions. The smoke produced in this activity is equivalent to the smoke produced by extinguishing about a dozen birthday candles.		

CaveSim program element: Cave Rescue Phones	Corresponding Utah Core Standards	Photos of past CaveSim programs
Hands-on lessons about basic circuits using a pair of wired cave rescue phones. Activities include:		
• We bring two cave rescue phones to our programs. The phones are connected by wire, which allows us to discuss basic circuits, and demonstrate that a circuit requires at least one complete loop to function. Students can disconnect and reconnect wires for hands-on learning about conductors and insulators. Students talk with each other over the phones. CaveSim staff discuss the relationship between wire length, electrical resistance, electrical energy dissipation in the wire, and phone volume. Electrical circuits involving the earth as one of the conductors are discussed, as are the role of magnets in the functioning of the phones.	Science Standard 3.3.4 Ask questions to plan and carry out an investigation to determine cause and effect relationships of electric or magnetic interactions between two objects not in contact with each other. Science Standard 3.3.5 Design a solution to a problem in which a device functions by using scientific ideas about magnets.	
• CaveSim staff use waterproof speakers, waveform generators, and oscilloscopes to demonstrate that sound is a form of mechanical energy, and that sound waves can produce standing waves in a container of water.	Science Standard 4.3.1 Develop and use a model to describe the regular patterns of waves. Emphasize patterns in terms of amplitude and wavelength. Examples of models could include diagrams, analogies, and physical models such as water or rope. (PS4.A) Science Standard 1.3.1 Plan and carry out an investigation to show the cause and effect relationship between sound and vibrating matter. Emphasize that vibrating matter can make sound and that sound can make matter vibrate. (PS4.A)	*Two friends enjoy talking on the cave rescue phones during a 2013 CaveSim program.*
• Available upon request: Demonstrations with an oscilloscope (see https://whatis.techtarget.com/definition/oscilloscope) by CaveSim owner Dave Jackson, who has designed high speed computer chips for oscilloscopes. The oscilloscope produces a graphical representation of voltage on the cave rescue phone wire vs. time, which allows students to visualize their vocal energy on a screen. We discuss graph axes, and the relationship between time-based and frequency based graphs. Resonances/oscillation of electrical and sound signals are also discussed. This activity is typically done for middle/high school, but can be adapted to older elementary students.		 *A CaveSim staff person teaches students about electricity and magnetism using cave rescue telephones and electronic test equipment (oscilloscopes).*
Space required: typically outdoors for convenience, but can also be done in any classroom or indoor setting. Oscilloscope demo must be done indoors if it is raining. The oscilloscope has a VGA output, which can be projected to a smartboard, projector, or computer monitor for better viewing by students.		

CaveSim program element: Bat games and lessons	Corresponding Utah Core Standards	Photos of past CaveSim programs
Bat skeleton and guano demonstrations and lessons: • Discussion of similarities and differences between bat wing structure and human hands. Discussion of the similarities and differences between various bat species, including bats found in Utah. • Demonstration of bat tail structure and usage of the tail in steering, balance, and in catching insects. Discussion about the different tail structures of different species of bats. • Discussion of different types/sizes of bats, and the role that they play in helping humans. Real-life lesson about bat eradication by farmers and the impact on their crops. • Photographic and/or video demonstration of the ongoing White Nose Syndrome (WNS) epidemic that has killed nearly 6 million bats in the last ~10 years. For older grades, lessons about the WNS fungus (Pseudogymnoascus destrucans) and how it eats (metabolizes) bats alive. • Discussions about history and the role that caves played in the civil war (as sources of saltpeter for the production of gunpowder). Space required: typically done by the trailer to engage students as they wait to explore. Can also be done anywhere inside.	Science Standard 5.3.3 Develop and use a model to describe the movement of matter among plants, animals, decomposers, and the environment. Science Standard 4.1.1 Construct an explanation from evidence that plants and animals have internal and external structures that function to support survival, growth, behavior, and reproduction. Emphasize how structures support an organism's survival in its environment and how internal and external structures of plants and animals vary within the same and across multiple Utah environments. Science Standard 3.2.2 Analyze and interpret data to identify patterns of traits that plants and animals have inherited from parents. Science Standard 3.2.3 Construct an explanation that the environment can affect the traits of an organism. Science Standard 2.2.1 Obtain, evaluate, and communicate information about patterns of living things (plants and animals, including humans) in different habitats. Emphasize the diversity of living things in land and water habitats.	 *CaveSim program lead Dave Jackson teaches kids about bat biology in Glenwood Springs, CO. Photo by Chelsea Self, Post Independent.*
Bat echolocation game #1: Two at a time, students take turns roleplaying a bat and a moth. The bat (blindfolded) tries to locate and tag the moth using only the "bats" voice and their hearing. The other students form a circle to contain the two students playing the bat and moth. Students learn about echolocation (including the root of the word), and about the reasons that bats must consume so many insects (e.g., high metabolic rate). Students also gain personal confidence. Space required: may be played indoors or outdoors. If outdoors, a safe surface must be used (to allow a blindfolded student to move in a small circle of other students without tripping on uneven ground.	Science Standard 5.3.2 Obtain, evaluate, and communicate information that animals obtain energy and matter from the food they eat for body repair, growth, and motion and to maintain body warmth. ELA Standard 5.R.3: Demonstrate mastery of age-appropriate phonics skills. a. Read and spell all letter-sound correspondences, syllabication patterns, morphology (e.g., roots and affixes), and etymology to accurately read unfamiliar multisyllabic words in context and out of context.	
Bat echolocation game #2: Students work individually to use sound to navigate their environment. Students are asked to close their eyes and move slowly toward a wall while making a "Shhh" sound. Students are asked to stop when they detect a change in the sound that they hear, and a discussion about how bats and humans process sound differently follows the exercise.	Science Standard 4.1.2 Develop and use a model of a system to describe how animals receive different types of information from their environment through their senses, process the information in their brain, and respond to the information. Emphasize how animals are able to use their perceptions and memories to guide their actions. Standard 2.2.2 Plan and carry out an investigation of the structure and function of plant and animal parts in different habitats. Emphasize how different plants and animals have different structures to survive in their habitat.	
Bat Migration Challenge game: Working individually or in groups (depending on grade level), students act out the lives of bats as they encounter daily challenges and opportunities. Students learn about the ways in which humans can act to help or harm bats, including how humans can design bat-friendly cave gates.	Science Standard 5.3.4 Evaluate design solutions whose primary function is to conserve Earth's environments and resources.	

CaveSim program element: Geology	Corresponding Utah Core Standards	Photos of past CaveSim programs
Cave Formation: Students learn about how caves and cave formations grow		 *CaveSim program lead Dave Jackson teaches kids about limestone solubility in weak acid during a demo in Austin, TX. Photo by Austin Parks & Rec staff.*
• Learn about how cave passage forms. CaveSim staff talk about special bacteria that use enzymes to eat limestone (breaking chemical bonds to get energy). We also have a presentation that discusses the formation of sinkholes, and the role that erosion plays in the formation of such karst features. As a group, we discuss how sinkholes can impact humans, and what can be done to mitigate the effect of sinkholes. Demos available upon request: (1) dissolution of carbonate rocks using weak acid, (2) sinkhole in a flower pot (we use a hose to produce a sinkhole in a large container of sand). Discussion of how humans use cave-based resources (e.g., limestone, guano)	Science Standard 5.1.3: Ask questions to plan and carry out investigations that provide evidence for the effects of weathering and the rate of erosion on the geosphere. Standard 5.1.4 Develop a model to describe interactions between Earth's systems including the geosphere, biosphere, hydrosphere, and/or atmosphere. Science Standard 5.1.5 : Design solutions to reduce the effects of naturally occurring events that impact humans.	
• Using geologic maps, CaveSim staff explain Utah geology, and illustrate geologic patterns found in the local area, as well as patterns found within caves (e.g., bedding planes).	Science Standard 5.1.1: Analyze and interpret data to describe patterns of Earth's features.	

CaveSim program element: Squeezebox and Math	Corresponding Utah Core Standards	Photos of past CaveSim programs
We bring an adjustable-height wooden box through which students can crawl to safely test their ability to navigate tight spaces. Students use a tape measure to quantify how tight a space they can move through. Students are asked questions like, "If the box was 10 inches tall, and I made it shorter by 2 inches, how tall is the box now?" For older students, this inquiry includes subtraction of fractional numbers (e.g., "What is 8¾ inches minus ½ inch?") Space required: typically set up near the stretcher (see above). Any indoor or outdoor setting is fine.	Math Standard K.MP.5 Use appropriate tools strategically. Consider the tools that are available when solving a mathematical problem, whether in a real-world or mathematical context. Choose tools that are relevant and useful to the problem at hand, such as physical objects, drawings, diagrams, physical tools, technologies, or mathematical tools such as estimation or a particular strategy or algorithm. Math Standard 1.OA.6 Add and subtract within 20. Math Standard 5.NF.1 Add and subtract fractions with unlike denominators (including mixed numbers) by replacing given fractions with equivalent fractions in such a way as to produce an equivalent sum or difference of fractions with like denominators. Physical Education Standard K.1.5 Form wide, narrow, curled, and twisted body shapes.	 *Students at a 2018 Austin, TX program use a tape measure to quantify their squeezebox skills.*

CaveSim program element: Rescue Stretcher	Corresponding Utah Core Standards	Photos of past CaveSim programs
We bring a cave rescue stretcher (Sked) to our programs. Students take turns getting into the stretcher. With the direct supervision of CaveSim staff, the student in the stretcher is carried through and around obstacles by fellow students, as well as passed from student to student. Students learn teamwork, communication, and leadership. Space required: any indoor or outdoor setting. May be done in classrooms or even hallways.	Physical Education Standard K.4.1 Follow directions in a group setting (e.g., safe behaviors, following rules, taking turns) and recognize responsible behavior while following instruction with teacher prompts and minimal reminders. Physical Education Standard K.4.2 Share equipment and space with others. Physical Education Standard 1.2.1 Move in personal space and general space while participating in activity or dance. Physical Education Standard 2.4.2 Work collaboratively in pairs and small groups.	 *With direct supervision from CaveSim staff, a team of kids gets ready to lift and carry a friend in the stretcher.*

The value of education: As an inventor and educator, Dave encourages students to study hard, find their passion, and understand that education is very important in life. During each program, Dave uses his personal story (including getting multiple degrees from MIT) to teach students that education leads to great success and adventure.

Keynote presentation in Lake George, CO.

Labs

Standard programs (above) can be enhanced by adding our labs. Labs provide an in-depth educational experience in a specific subject, like biology or engineering. We never use kits because our goal is to teach students that engineering and science projects are accessible to them without the use of pre-prepared materials. We emphasize conservation by using post-consumer recyclable materials in our engineering labs. Labs require extra funding for materials and staff time. Contact us for pricing.

Fruit Bat Lab: Students work in small groups to design a "bat tongue" with the goal of extracting "nectar" (jellybeans) from a "flower" (plastic tube). Dry-erase markers are used to demonstrate the transfer of pollen from the flower to the pollinating bat.

Recommended time: 30-45 minutes. Recommended class size: Up to 25 students. Recommended grade level: 2nd grade and up.
Standard(s) addressed: Science Standard 2.2.3 Develop and use a model that mimics the function of an animal dispersing seeds or pollinating plants.

Helmet Engineering Lab: In our version of the classic egg-drop experiment, students design and prototype "helmets" for eggs. Working in groups, students use basic materials like straws, bags, bottles, popsicle sticks, tape, and hot glue to create an enclosure for a plastic egg

(filled with small rocks). The students test their "helmet" designs from a low height, and re-design as needed if the plastic egg cracks. Students are then given a real egg, which they insert into their design in place of the plastic egg. CaveSim staff then drop the students' helmet designs from the top of the CaveSim tower. Students check their projects after each drop to see if their egg has survived the 12 foot fall. Students learn fundamental engineering principles, as well as the importance of perseverance.

Recommended time: 60-90 minutes. Recommended class size: Up to 25 students. Recommended grade levels: 3rd grade and up

Standard(s) addressed: Standard 4.2.1 Construct an explanation to describe the cause and effect relationship between the speed of an object and the energy of that object; Standard 4.2.2 Ask questions and make observations about the changes in energy that occur when objects collide. Emphasize that energy is transferred when objects collide and may be converted to different forms of energy.

Flashlight Engineering Lab: Students create circuits using LEDs, switches, batteries, and other components to create an LED light system. They get hands-on experience with soldering (with supervision from CaveSim staff), and then design and make their own caving flashlight enclosure from recyclable materials. After creating their lights, students test their work in water to see if their lights are waterproof. Students have the chance to revise their designs if needed.

Subjects covered: Electromagnetics, product design, material science, and mechanical engineering.

Recommended time: 55 to 90 minutes. Recommended class size: Up to 25 students. Recommended grade levels: 5th grade and up



Above, students work on the Flashlight Engineering Lab

Biota Lab: Students culture cave biota in Petri dishes, and learn that single-celled organisms can demonstrate a form of intelligence. Students choose from multiple experiments, and discuss the factors that impact the outcome of their experiments (including how well their organisms survived).

Subjects covered: Experiment design, scientific method, and biology concepts.

Recommended lab time: 30 to 45 minutes, with a follow-up on a second day (with or without CaveSim staff present).

Recommended class size: Up to 30 students. Recommended grade levels: 3rd grade and up.

Standard(s) addressed: Science Standard 3.2.5 Engage in argument from evidence that in a particular habitat (system) some organisms can survive well, some survive less well, and some cannot survive at all. Emphasize that organisms and habitats form systems in which the parts depend upon each other.

High school students at a two-day program in Oklahoma get ready to inoculate their Petri dishes.

Karst Lab: Students make karst topography (cave landforms) with safe household materials. Students learn hydrology, geology, chemistry, landforms, states of matter.

Recommended lab time: 30-40 minutes.
Recommended class size: Up to 30 students.
Recommended grade levels: Spring-semester 3rd grade and up.

Formation Lab: Students make cave formations (e.g., stalactites) using safe household materials. We also do exciting demonstrations with the safe chemical sodium acetate (from reusable heat packs). Students learn hydrology, geology, basic chemistry, states of matter.

Recommended lab time: 30-40 minutes.
Recommended class size: Up to 30 students.
Recommended grade levels: 2nd grade and up.

Above, 5th graders work on the Karst Lab

Waves and Energy Lab: After watching a demo with real cave rescue phones, students make their own version using cups and string. Students conduct several experiments with their phones and record their observations. Students learn about waves, energy, and graphing.

Recommended lab time: 30-40 minutes.
Recommended class size: Up to 30 students.
Recommended grade levels: 1st grade and up.
Standard(s) addressed: Science Standard 4.2.3 Plan and carry out an investigation to gather evidence from observations that energy can be transferred from place to place by sound, light, heat, and electrical currents.
Science Standard 4.2.4 Design a device that converts energy from one form to another. Define the problem, identify criteria and constraints, develop possible solutions using models, analyze data from testing solutions, and propose modifications for optimizing a solution. Emphasize identifying the initial and final forms of energy. Examples could include solar ovens that convert light energy to heat energy or a simple alarm system that converts motion energy into sound energy. (PS3.B, PS3.D, ETS1.A, ETS1.B, ETS1.C)
Science Standard 4.3.3 Design a solution to an information transfer problem using wave patterns.
Science Standard 1.3.4 Design a device in which the structure of the device uses light or sound to solve the problem of communicating over a distance. Define the problem by asking questions and gathering information, convey designs through sketches, drawings, or physical models, and compare and test designs. Examples of devices could include a light source to send signals, paper-cup-and-string telephones, or a pattern of drum beats. (PS4.C, ETS1.A, ETS1.B, ETS1.C)

Geology Lab: Using small collections of rocks, students conduct geologic tests including hardness, solubility, density, and magnetism. Students record findings on a worksheet and compare results with classmates to gain an understanding of the three major rock types,

geologic classification, soil formation, fossil characteristics, etc. Students learn about the many ways in which humans use rocks and minerals in our everyday lives.

Recommended lab time: 30 minutes.
Recommended class size: Up to 50 students (two simultaneous classrooms).
Recommended grade levels: 2nd grade and up.
Standard(s) addressed: Science Standard 5.2.2 Ask questions to plan and carry out investigations to identify substances based on patterns of their properties. Emphasize using properties to identify substances. Examples of properties could include color, hardness, conductivity, solubility, or a response to magnetic forces. Examples of substances could include powders, metals, minerals, or liquids. (PS1.A)
Science Standard 4.1.3 Analyze and interpret data from fossils to provide evidence of the stability and change in organisms and environments from long ago.
Science Standard 4.1.4 Engage in argument from evidence based on patterns in rock layers and fossils found in those layers to support an explanation that environments have changed over time. Emphasize the relationship between fossils and past environments.

States of Matter and Chemical Reactions: Students watch several safe combustion demos with carbide lamps to learn about chemical and exothermic reactions, states of matter, pressure, and other physical science concepts. Students conduct several experiments with vinegar, water, and powdered laundry detergents. Students record observations on a worksheet and compare with the class. Allergy accommodation: if students have concerns about contact with laundry soap, please let us know and we will provide Latex-free gloves for those students.

Recommended lab time: 30 minutes.
Recommended class size: Up to 50 students (two simultaneous classrooms).
Recommended grade levels: 4th grade and up.

Bat Science: Students learn about a disease that is killing millions of bats, but which does not hurt humans at all. Using fluorescent dye in test tubes, students role-play bats and learn about how diseases spread among animal populations. As a group, we graph the results of the game to learn about the basics of graphing. Students also get to see an exclusive interview that CaveSim staff did with a bat rehabilitation expert.

Recommended lab time: 30 minutes.
Recommended class size: Up to 25 students.
Recommended grade levels: 4th grade and up.

Cave Art: Students use charred wood and water to make a simple, safe paint. Students then use the Bernoulli principle to blow their paint onto paper with straws. Students use their hands or stencils to make art the way that prehistoric people did.

Recommended lab time: 30 minutes. Recommended class size: Up to 25 students. Recommended grade levels: 2nd and up.

Pricing and FAQ

How much do programs cost? This depends on factors like travel distance, number of days, and number of students. Our average price is $1958/day plus transportation costs, and includes everything except labs. Discounts are sometimes available – please contact us for a quote.

Are deposits or contracts required? No. We will reserve your program date(s) once we agree on a price and you send us an email stating that you want us to visit your school at the agreed-upon price.

How are payments made? By check, made out to CaveSim LLC, as specified on the invoice that we'll email you. W9 available upon request.

Does CaveSim carry insurance? Yes. Once you commit to working with us, please let us know if you need a Certificate of Additionally Insured.

Are permission slips required? Yes. Paperless and printable versions in both English and Spanish are available: www.cavesim.com/waiver.

How much space is needed? Is power required? See www.cavesim.com/pages/site-logistics

Is this an outdoor activity? Typically yes. The cave stays inside the trailer (we don't move it into your school). Some activities can be moved inside in inclement weather (the tower can be moved indoors if you have 13+ foot ceilings in some part of your school). In light to moderate rain/snow, we put up tents to protect students and the cave.

Is the cave heated and air conditioned? Yes. Please provide access to 1 working 20A outlet in summer, and 2 outlets (15A and 20A) in winter.

How much setup and takedown time are needed? Typically 1.5 hours for setup, and 1 hour for takedown.

Does CaveSim do multi-day programs? Yes. We have done as many as six days in one school district.
How many students can participate in a day? For elementary, 150-200. For MS/HS, 100-150. Educational value and number of students are inversely related. We're excited about working with you to size your groups for the best possible educational experience.

Contact us: Email jacksondmit@cavesim.com or call 914-330-7824.

Safety and special needs

Teachers/staff can explore the cave, and students with special needs (physical or otherwise) may be assisted by school staff, students, and/or CaveSim staff. While each student is different, numerous wheelchair-bound students have explored CaveSim. Some students may have more difficulty avoiding cave formations, and our only requirement is that each student understands their goal of not touching the formations (for the safety of the system and students). Students who are unable to understand the careful-caving goal may participate in our other activities. CaveSim has cameras for checking on students as they explore. We have five access points to let participants out of the trailer if needed.

We follow the BSA's Youth Protection policy, which includes no 1:1 student/adult interaction.

Challenge by Choice

Most students love exploring CaveSim. Occasionally we have a student who is unsure, uncomfortable, or afraid. We encourage him/her to set a goal for themselves and see if they can attain that goal. We teach Challenge by Choice, and have plenty of activities for students to try.

Classroom management

We've been doing our programs since 2010, and our staff includes former classroom teachers, so we have a good handle on classroom management. Because we spent over two years creating CaveSim, we set expectations at the start of the program: we expect students to respect the equipment and everyone involved in the program. We rarely experience discipline problems, but when we do we ask students to either change their behavior or take a break from the activity until they are ready to participate properly. Our goal is to work as a team with you, so please feel free to communicate with us about any issues that you foresee.