CaveSim Programs for Kentucky Elementary Schools

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

Teacher quotes:

“This is an incredible experience. My students absolutely enjoyed the CaveSim experience and learned so much! Thank you CaveSim!” **— Lori Hines, 3rd grade teacher, Grove Lower Elementary, Grove, OK**

“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.’ Students were able to understand cave formations, organisms and cave safety. The 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. Thanks for all that you do. We would love to see you back next year.” **— Pat Jones, teacher, Houston Elementary, Austin,TX**

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Summary

Thank you for your interest in CaveSim! The centerpiece of our program is our mobile cave, which we bring to schools from Colorado in a 26' trailer. The cave is filled with cave formations, critters, and artifacts (all artificial). Students get a computerized score based on how carefully they avoid stalactites and other objects as they explore. CaveSim is much more than exploring a mobile cave. We address Kentucky Academic Standards[1] with hands-on lessons and experiences. Programs cover subjects including science, math, engineering, PE, and art.

Programs are led by inventor, educator, and MIT-trained engineer Dave Jackson. Dave and his wife Tracy are both real cavers, and have been doing CaveSim programs around the country for 11 years. Lessons are designed by Tracy, who has a Masters of Art in Teaching.

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 and our staff look forward to bringing CaveSim to your school to engage your students in a whole new way.

Schools that have done and loved our programs

KY: Barren County Intermediate Center, Allen County Middle School; **OK:** Grove Lower ES, Upper ES, and HS, Centennial ES, John Ross ES, Frontier ES; **TX:** Austin HS, McCallum HS, Andrews ES, Baranoff ES, Barrington ES, Blanton ES, Brentwood ES, Cowan ES, Hill ES, Houston ES, Wooldridge ES, Frost ES, Dahlstrom MS, Brawner Intermediate, Baccus ES, Lake Travis, Lakeway ES, Sanchez ES, Metz ES; **CO:** Peoria ES, Fulton Academy, Ryan ES, Aspen Creek K-8, Avery Parsons ES, Gold Camp ES, Academy International ES, Buena Vista ES, Cresson ES, Arrowwood ES, Legacy Academy, Falcon MS, Carson MS, Patriot ES, Aragon ES, Abrams ES, Atlas Prep, Palmer Lake ES, Ute Pass ES, Manitou Springs ES, Lake George Charter School, Ridgway ES, Las Animas ES, Queen Palmer ES, Eisenhower ES, Good Shepherd School, Cedar Ridge ES, Ben Franklin Academy, The Colorado Springs School, The University School of Colorado Springs, Longfellow ES, Mountain Song Community School, University Schools (middle school); **GA:** Hillside Montessori, Barnwell ES, Youngs Grove ES.

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[1] https://kystandards.org/home/ky-acad-standards/

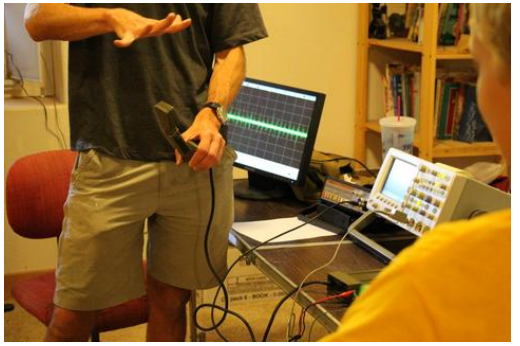
Program Components (with standards alignment)

All the components below are included in the cost of the program. Your schedule will determine how much we can cover. Students typically rotate through four different stations/lessons. Color key: Science, ELA, Math, Social Studies

CaveSim program element: Horizontal Caving	Pertinent Kentucky Academic Standards	Photos of past CaveSim programs
In the CaveSim mobile cave (contains 60' of passage with multiple levels in a 24' trailer), students explore in small groups and:		 *Thrilled to be exploring CaveSim in Glenwood Springs, CO, 2018. Photo by Chelsea Self, Post Independent.*
• Try to avoid bumping into cave formations. Students learn that oil and water do not mix, and that touching formations can cover them with skin oil, which stops the formations from growing.	ESS1.C: The History of Planet Earth: Some events happen very quickly; others occur very slowly, over a time period much longer than one can observe. (2-ESS1-1)	
• 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.	LS2.A: Interdependent Relationships in Ecosystems: The food of almost any kind of animal can be traced back to plants. Organisms are related in food webs in which some animals eat plants for food and other animals eat the animals that eat plants. Some organisms, such as fungi and bacteria, break down dead organisms (both plants or plants parts and animals) and therefore operate as "decomposers." Decomposition eventually restores (recycles) some materials back to the soil. Organisms can survive only in environments in which their particular needs are met…. (5-LS2-1)	
• Learn about how cave tunnels form. CaveSim staff talk about special bacteria that use enzymes to eat limestone (breaking chemical bonds to get energy).	LS2.B: Cycles of Matter and Energy Transfer in Ecosystems Matter cycles between the air and soil and among plants, animals, and microbes as these organisms live and die. Organisms obtain gases, and water, from the environment, and release waste matter (gas, liquid, or solid) back into the environment. (5-LS2-1) ESS2.E: Biogeology Living things affect the physical characteristics of their regions. (4-ESS2-1)	
• Discussion of how humans use cave-based resources (e.g., limestone, guano)	2.E.MI.1 Describe how examples of capital, human, and natural resources are related to goods and services.	 *Elementary students in Cascade, CO explore the mobile cave.*
• Staff explain aqueous speleothems. Topics: 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). Vocabulary: "capillary action."	L.5.4.d. Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases, including those that signal contrast, addition and other logical relationships.	
• Look for man-made equipment in the cave, including rescue cache and vertical caving rope ladder. Students learn that the etrier (rope ladder) is named after the French word for stirrup. Students expand vocabulary with the word "cache."	L.3.4 Determine or clarify the meaning of unknown and multiple-meaning words and phrases based on grade 3 reading and content, choosing flexibly from an array of strategies. a. 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 scientists. Learn about a CaveSim staff member's experience with artifacts in caves in Mexico. Students discuss why we don't take artifacts.	K.G.HE.1 Identify ways humans interact with their environment.	
• Art program: before entering the cave, students make cave paintings on paper. Students reflect on their art and write sentences about what story their art tells. While exploring the mobile cave, students make sketches of the cave paintings they find. After they exit the cave, students write a story about what they saw in the cave paintings. Students are invited to share the stories that they wrote.		

CaveSim program element: Vertical Caving	Pertinent Kentucky 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. Forces, including the gravitational force, are discussed.	PS2.A: Forces and Motion: Pushes and pulls can have different strengths and directions. (KPS2-1),(K-PS2-2); Pushing or pulling on an object can change the speed or direction of its motion and can start or stop it. (K-PS2-1),(K-PS2-2) PS3.C: Relationship Between Energy and Forces: A bigger push or pull makes things speed up or slow down more quickly. 5.NF.B.7 Apply and extend previous understandings of division to divide unit fractions by whole numbers and whole numbers by unit fractions. (5-PS1-1) 4.MD.A.2 Use the four operations to solve word problems involving distances, intervals of time, liquid volumes, masses of objects, and money, including problems involving simple fractions or decimals...(4-ESS2-1),(4-ESS2-2) PS2.A: Forces and Motion: Each force acts on one particular object and has both strength and a direction. An object at rest typically has multiple forces acting on it, but they add to give zero net force on the object. Forces that do not sum to zero can cause changes in the object's speed or direction of motion. (3-PS2- 1); The patterns of an object's motion in various situations can be observed and measured; when that past motion exhibits a regular pattern, future motion can be predicted from it. (Boundary: Technical terms, such as magnitude, velocity, momentum, and vector quantity, are not introduced at this level, but the concept that some quantities need both size and direction to be described is developed.) (3-PS2-2)	 *Above, a student in Colorado uses mechanical advantage to lift herself up the A-frame.* *Below, students and staff in Montana work together to lift a fellow student .* 
• CaveSim staff use harnesses and mechanical ascenders to climb rope. Staff discuss ascender mechanics, equipment safety, and differences between caving and rock climbing equipment. Students learn the words "ascend," "descend," "vertical", and "horizontal." Students learn about ongoing efforts to find the world's deepest cave. Students learn that some of the cavers who help with CaveSim have been over 6000' underground.	PS2.B: Types of Interactions: The gravitational force of Earth acting on an object near Earth's surface pulls that object toward the planet's center. (5-PS2-1)	
• With the help of students, staff demonstrate the power of friction to rapidly destroy Nylon rope. Before the demo, students develop hypotheses about what will happen when two ropes are rubbed together, and about which rope will break first. After the two ropes are rubbed together rapidly and the larger rope breaks, students try to figure out why the larger rope broke. 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 *distributed* on the smaller rope, hence the melting of the larger rope). • With the help of students, staff demonstrate the power of friction to allow a person to ascend a rope using the Prusik knot. Students learn to tie the Prusik, the Alpine Butterfly, the Lark's Head, and/or other knots.	PS3.C: Relationship Between Energy and Forces When objects collide, the contact forces transfer energy so as to change the objects' motions. (4-PS3-3) K.CC.A Know number names and the count sequence. (K-ESS2-1) L.5.4.d. Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases, including those that signal contrast, addition and other logical relationships.	
Space required: typically outdoors on flat ground. May also be placed indoors where ceiling height is >12'6". Footprint is 7' x 11'.		

CaveSim program element: Carbide Demonstrations	Pertinent Kentucky Academic Standards	Photos of past CaveSim programs
To illustrate chemistry and physics concepts, CaveSim staff bring working carbide lamps and carbide to programs. Demonstrations include:		
• CaveSim staff light a working carbide lamp by placing calcium 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. Older students gain an understanding of the concept of reflectors by observing the behavior of the reflector on the lamps. Students learn that calcium carbide is produced from coal and limestone. New vocabulary explained by CaveSim staff: "exothermic," with connection drawn to "exoskeleton."	PS1.B: Chemical Reactions When two or more different substances are mixed, a new substance with different properties may be formed. (5-PS1-4) PS4.B: Electromagnetic Radiation An object can be seen when light reflected from its surface enters the eyes. (4-PS4-2) ESS3.A: Natural Resources Energy and fuels that humans use are derived from natural sources, and their use affects the environment in multiple ways. Some resources are renewable over time, and others are not. (4-ESS3-1) L.3.4.c. Use a known root word as a clue to the meaning of an unknown word with the same root.	 *Above, carbide lamp demonstration by CaveSim staff at a program in Colorado.*
• 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."	PS3.D: Energy in Chemical Processes and Everyday Life The expression "produce energy" typically refers to the conversion of stored energy into a desired form for practical use. (4-PS3-4) PS1.B: Chemical Reactions: Heating or cooling a substance may cause changes that can be observed. Sometimes these changes are reversible, and sometimes they are not. (2-PS1- 4)	
• CaveSim staff demonstrate conservation of mass (matter) using carbide, water, Buchner funnel, and an electronic balance. The carbide/water reaction is allowed to occur, but the resultant acetylene gas is not allowed to escape. The mass reported by the balance remains unchanged until the gas is released through a nozzle and burned.	PS1.A: Structure and Properties of Matter: Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon; the effects of air on larger particles or objects. (5-PS1-1) The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2)	*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	Pertinent Kentucky Standards	Photos of past CaveSim programs
Hands-on lessons about basic circuits using a pair of wired cave rescue phones. Activities include:		  *Two friends enjoy talking on the cave rescue phones during a 2013 CaveSim program in Colorado.*
• 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.	PS4.C: Information Technologies and Instrumentation: People also use a variety of devices to communicate (send and receive information) over long distances. (1-PS4-4) PS4.C: Information Technologies and Instrumentation: Digitized information transmitted over long distances without significant degradation. High-tech devices, such as computers or cell phones, can receive and decode information— convert it from digitized form to voice—and vice versa. (4-PS4-3)	
• Upon request: Hands-on activities with electromagnets, permanent magnets, analog meters, and other equipment to allow students to learn about electromagnetic forces.	PS2.B: Types of Interactions: Objects in contact exert forces on each other. (3- PS2-1) Electric and magnetic forces between a pair of objects do not require that the objects be in contact. The sizes of the forces in each situation depend on the properties of the objects and their distances apart and, for forces between two magnets, on their orientation relative to each other. (3-PS2-3),(3-PS2-4)	 *A CaveSim staff person teaches students about electricity and magnetism using cave rescue telephones and electronic test equipment (oscilloscopes).*
• 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 using demos with waterproof speakers in water.	PS4.A: Wave Properties: Waves, which are regular patterns of motion, can be made in water by disturbing the surface. When waves move across the surface of deep water, the water goes up and down in place; there is no net motion in the direction of the wave except when the water meets a beach. (Note: This grade band endpoint was moved from K–2). (4-PS4-1) Waves of the same type can differ in amplitude (height of the wave) and wavelength (spacing between wave peaks). (4-PS4-1) PS3.B: Conservation of Energy and Energy Transfer: Energy is present whenever there are moving objects, sound, light, or heat. When objects collide, energy can be transferred from one object to another, thereby changing their motion. In such collisions, some energy is typically also transferred to the surrounding air; as a result, the air gets heated and sound is produced. (4-PS3-2),(4-PS3-3) Light also transfers energy from place to place. (4-PS3-2) Energy can also be transferred from place to place by electric currents, which can then be used locally to produce motion, sound, heat, or light. The currents may have been produced to begin with by transforming the energy of motion into electrical energy. (4-PS3-2),(4-PS3-4)	
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	Pertinent Kentucky 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 evolutionary pressures that may have created the similarities and differences. • Discussion of bat tail structure and usage of the tail in steering, balance, and in catching insects. • 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). • Discussion about why bats live and hunt in groups (passive information transfer) Space required: typically done by the trailer to engage students as they wait to explore. Can also be done anywhere inside.	LS1.C: Organization for Matter and Energy Flow in Organisms Food provides animals with the materials they need for body repair and growth and the energy they need to maintain body warmth and for motion. (secondary to 5-PS3-1) LS1.A: Structure and Function Plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. (4-LS1-1) LS2.C: Ecosystem Dynamics, Functioning, and Resilience: When the environment changes in ways that affect a place's physical characteristics, temperature, or availability of resources, some organisms survive and reproduce, others move to new locations, yet others move into the transformed environment, and some die. (secondary to 3-LS4-4) LS1.A: Structure and Function All organisms have external parts. Different animals use their body parts in different ways to see, hear, grasp objects, protect themselves, move from place to place, and seek, find, and take in food, water and air. Plants also have different parts (roots, stems, leaves, flowers, fruits) that help them survive and grow. (1-LS1-1)	 *CaveSim program lead Dave Jackson teaches kids about bat biology in Glenwood Springs, CO. Photo by Chelsea Self, Post Independent.*
Bat echolocation game: 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 and adaptation. 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.	LS3.A: Inheritance of Traits: Many characteristics of organisms are inherited from their parents. (3-LS3-1) Other characteristics result from individuals' interactions with the environment, which can range from diet to learning. Many characteristics involve both inheritance and environment. (3-LS3-2)	 *A student roleplaying the bat in the echolocation game during a 2012 program.*
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. Students read cards to understand how to migrate through the game. Space required: may be played indoors or outdoors.	LS2.D: Social Interactions and Group Behavior: Being part of a group helps animals obtain food, defend themselves, and cope with changes. Groups may serve different functions and vary dramatically in size. (Note: Moved from K–2) (3-LS2-1)	
White Nose Syndrome epidemiology game: Working as a class, students use plastic test tubes and fluorescent dye to model the spread of the WNS fungus among a population of bats. Students learn about random processes and other basic statistics concepts. Students make a graph to demonstrate how the frequency of interaction among individual members of a population correlates to the rate of disease spread in the population.	MP.4: Model with mathematics. (5-LS1-1),(5-LS2-1) 2.MD.D.10 Draw a picture graph and a bar graph (with single-unit scale) to represent a data set with up to four categories.	

CaveSim program element: Geology	Pertinent Kentucky Standards	Photos of past CaveSim programs
Depending on the time available in your schedule, CaveSim staff can either do group demonstrations, or students can participate in our geology lab. Demos and labs are described below: ● Demonstration of how caves form. CaveSim staff apply weak acid to limestone, which causes the limestone to effervesce (fizz). Lesson about groundwater, why it's acidic, and how it makes caves.	ESS2.A: Earth Materials and Systems: Rainfall helps to shape the land and affects the types of living things found in a region. Water, ice, wind, living organisms, and gravity break rocks, soils, and sediments into smaller particles and move them around. (4- ESS2-1)	 *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.*
● Discussion on the formation of sinkholes, and the benefits / dangers that they afford humans.	ESS3.B: Natural Hazards A variety of natural hazards result from natural processes. Humans cannot eliminate natural hazards but can take steps to reduce their impacts. (3-ESS3- 1) (Note: This Disciplinary Core Idea is also addressed by 4-ESS3-2.)	
● Six-station geology lab. Students rotate through six stations and conduct a different rock/mineral identification experiment at each station. Identification methods include tests of hardness, magnetism, and density. Also includes a fossil station.	ESS1.C: The History of Planet Earth: Local, regional, and global patterns of rock formations reveal changes over time due to earth forces, such as earthquakes. The presence and location of certain fossil types indicate the order in which rock layers were formed. (4-ESS1-1)	
● Discussion of the uses that humans have for various rocks and minerals, including limestone (for concrete) and gypsum (a common cave mineral also found in drywall)	2.E.IC.1 Categorize different limited resources as renewable and non-renewable resources.	
Space required: may be taught indoors or outdoors.		

CaveSim program element: Squeezebox and Math	Pertinent Kentucky 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. Space required: typically set up near the stretcher (see above). Any indoor or outdoor setting is fine.	5.MD.A.1: Convert among different-sized standard measurement units within a given measurement system (e.g., convert 5 cm to 0.05 m), and use these conversions in solving multi-step, real world problems. (5-LS1-1) MP.5: Use appropriate tools strategically. (5-LS1-1)	 *Students at a 2018 Austin PARD program use a tape measure to quantify their squeezebox skills.*  *A student in Colorado has fun making it through the squeezebox. Children with a wide range of ability levels can participate in our programs. The squeezebox lid easily lifts if a child is feeling uncomfortable.*

CaveSim program element: Rescue Stretcher	Pertinent Kentucky 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. Students learn teamwork, communication, and leadership. Space required: any indoor or outdoor setting. May be done in classrooms or even hallways.	K.C.PR.1 Identify examples of rules that apply in the school and community, and explain why they exist. K.C.PR.2 Describe consequences of following or not following rules.	 *With supervision from CaveSim staff, a team of kids gets ready to lift and carry a friend in the stretcher.*

Teaching the value of education: As an inventor and educator, Dave loves motivating students to study hard, find their passion, and understand that school is critically important later in life. During each program, Dave uses his personal story (including his experience getting Bachelors and Masters degrees in electrical engineering at MIT) to illustrate how education leads to great success and adventure. ETS1.A: Defining Engineering Problems: A situation that people want to change or create can be approached as a problem to be solved through engineering. Such problems may have many acceptable solutions. (secondary to KPS2- 2)

Dave Jackson giving a 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.

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. Standards: ETS1.A: Defining and Delimiting Engineering Problems: Possible solutions to a problem are limited by available materials and resources (constraints). The success of a designed solution is determined by considering the desired features of a solution (criteria). Different proposals for solutions can be compared on the basis of how well each one meets the specified criteria for success or how well each takes the constraints into account. (3-5-ETS1-1); ETS1.B: Tests are often designed to identify failure points or difficulties, which suggest the elements of the design that need to be improved. (3-5-ETS1-3); ETS1.C: Optimizing the Design Solution: Different solutions need to be tested in order to determine which of them best solves the problem, given the criteria and the constraints. (3-5-ETS1-3); ETS1.B: Developing Possible Solutions: Designs can be conveyed through sketches, drawings, or physical models. These representations are useful in communicating ideas for a problem's solutions to other people. (K-2-ETS1-2) SL.K.3 Ask and answer questions in order to seek help, get information, or clarify something that is not understood. (K-ESS3-2)

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 Engineering Lab

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

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: 4th grade and up.

Standards covered: ETS1.B: Developing Possible Solutions: Research on a problem should be carried out before beginning to design a solution. Testing a solution involves investigating how well it performs under a range of likely conditions. (3-5-ETS1-2) At whatever stage, communicating with peers about proposed solutions is an important part of the design process, and shared ideas can lead to improved designs. (3-5-ETS1-2) LS1.B: Growth and Development of Organisms: Reproduction is essential to the continued existence of every kind of organism. Plants and animals have unique and diverse life cycles. (3-LS1-1)

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

Karst Lab: Students get to make their own karst topography (cave landforms) using safe household materials. Students learn hydrology, geology, basic chemistry, landforms, states of matter.

Recommended lab time: 30-40 min. Recommended class size: Up to 30 students.

Recommended grade levels: Spring-semester 3rd grade and up

Standards Addressed: 5-ESS2-1. Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact.

5-ESS3-1. Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment. ESS3.B: Natural Hazards A variety of hazards result from natural processes (e.g., earthquakes, tsunamis, volcanic eruptions). Humans cannot eliminate the hazards but can take steps to reduce their impacts. (4-ESS3-2)

Above, Students in Colorado work on the Karst Lab

Formation Lab: Students make their own cave formations (think stalactites) using safe household materials. 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

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 grades: 2nd & up
Standards addressed: PS4.A: Wave Properties: Sound can make matter vibrate, and vibrating matter can make sound. (1-PS4- 1)

Pricing and FAQ

How much do programs cost? This depends on factors like travel distance, number of days, and number of students. Our price is typically $2000/day plus transportation, and our pricing typically works out to $10 to $14/student. 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.

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.

Does CaveSim do multi-day programs? Yes. We've done as many as four consecutive days at one school.

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 night-vision cameras which allow us to check on students as they explore. We also have five access points to allow us 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.