

# CaveSim Programs for Minnesota Elementary Schools

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## 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 24' trailer. The cave is filled with formations, critters, and artifacts. 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 Common-Core and NextGen Science Standards<sup>1</sup> with hands-on lessons. K-5 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 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



**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; **KY:** Barren County Intermediate Center, Allen County MS.

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<sup>1</sup> [www.corestandards.org/wp-content/uploads/ELA\\_Standards1.pdf](http://www.corestandards.org/wp-content/uploads/ELA_Standards1.pdf); [www.nextgenscience.org/](http://www.nextgenscience.org/); [www.corestandards.org/wp-content/uploads/Math\\_Standards1.pdf](http://www.corestandards.org/wp-content/uploads/Math_Standards1.pdf)



## 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: **NextGen Science**, **CommonCore ELA**, **CommonCore Math**



CaveSim program element: Horizontal Caving	Pertinent Standards	Photos of past CaveSim programs
<p>In the CaveSim mobile cave (contains 60' of passage with multiple levels in a 24' trailer), students explore in small groups and:</p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• 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.</li> <li>• Learn about how cave tunnels form. CaveSim staff talk about special bacteria that use enzymes to eat limestone (breaking chemical bonds to get energy).</li> <li>• Discussion of how humans use cave-based resources (e.g., limestone, guano)</li> <li>• 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."</li> <li>• 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."</li> <li>• 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.</li> <li>• 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.</li> </ul>		 <p><i>Thrilled to be exploring CaveSim in Glenwood Springs, CO, 2018. Photo by Chelsea Self, Post Independent.</i></p>  <p><i>Elementary students in Cascade, CO explore the mobile cave.</i></p>




CaveSim program element: Vertical Caving	Pertinent Standards	Photos of past CaveSim programs
<p>On CaveSim portable 12' A-frame w/ crash pads:</p> <ul style="list-style-type: none"> <li>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.</li> <li>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." 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.</li> <li>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 <i>concentrated</i> in just one spot on the larger rope, and spread out on the smaller rope, hence the melting of the larger rope).</li> <li>With the help of students, CaveSim staff demonstrate the power of friction to allow a person to ascend a rope using the Prusik knot. Depending on available time, students learn to tie the Prusik, the Alpine Butterfly, the Lark's Head, and/or other knots.</li> </ul>		 <p><i>Above, a student in Colorado uses mechanical advantage to lift herself up the A-frame.</i></p> <p><i>Below, students and staff in Montana work together to lift a fellow student .</i></p> 
<p><u>Space required:</u> typically outdoors on flat ground. May also be placed indoors where ceiling height is &gt;12'6". Footprint is 7' x 11'.</p>		

CaveSim program element: Carbide Demonstrations	Pertinent Standards	Photos of past CaveSim programs
<p>To illustrate chemistry and physics concepts, CaveSim staff bring working carbide lamps and carbide to programs. Demonstrations include:</p> <ul style="list-style-type: none"> <li>• 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. 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."</li> <li>• 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."</li> <li>• CaveSim staff demonstrate conservation of mass (matter) using carbide, water, Buchner funnel, and an electronic balance. The carbide/water reaction is allowed to occur, by 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.</li> <li>• Science experiment safety is emphasized (e.g., firmly close containers when not in use).</li> <li>• 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).</li> </ul>		 <p>Above, carbide lamp demonstration by CaveSim staff at a program in Colorado.</p> <p>Below, stock photo of the lamps we use.</p> 
<p><u>Space required:</u> 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.</p>		



CaveSim program element: Cave Rescue Phones	Pertinent Standards	Photos of past CaveSim programs
<p>Hands-on lessons about basic circuits using a pair of wired cave rescue phones. Activities include:</p>		
<ul style="list-style-type: none"> <li>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.</li> </ul>		
<ul style="list-style-type: none"> <li>Upon request: Hands-on activities with electromagnets, permanent magnets, analog meters, and other equipment to allow students to learn about electromagnetic forces.</li> </ul>		
<ul style="list-style-type: none"> <li>Available upon request: Demonstrations with an oscilloscope (see <a href="https://whatis.techtarget.com/definition/oscilloscope">https://whatis.techtarget.com/definition/oscilloscope</a>) 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.</li> </ul>		
<p><u>Space required:</u> typically outdoors for convenience, but can also be done in any classroom or indoor setting. Oscilloscope demo must be done indoors if raining. The oscilloscope has a VGA output, which can be projected to a smartboard, projector, or computer monitor for better viewing by students.</p>		 <p><i>A CaveSim staff person teaches students about electricity and magnetism using cave rescue telephones and electronic test equipment (oscilloscopes).</i></p>


CaveSim program element: Bat games and lessons	Pertinent Standards	Photos of past CaveSim programs
<p><b>Bat skeleton and guano</b> demonstrations and lessons:</p> <ul style="list-style-type: none"> <li>• Discussion of similarities and differences between bat wing structure and human hands. Discussion of evolutionary pressures that may have created the similarities and differences.</li> <li>• Discussion of bat tail structure and usage of the tail in steering, balance, and in catching insects.</li> <li>• 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.</li> <li>• 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, lesson about the WNS fungus (<i>Pseudogymnoascus destructans</i>) and how it eats (metabolizes) bats alive.</li> <li>• Discussions about history and the role that caves played in the civil war (as sources of saltpeter for the production of gunpowder).</li> <li>• Discussion about why bats live and hunt in groups (passive information transfer)</li> </ul> <p><u>Space required</u>: typically done by the trailer to engage students as they wait to explore. Can also be done anywhere inside.</p>		 <p><i>CaveSim program lead Dave Jackson teaches kids about bat biology in Glenwood Springs, CO. Photo by Chelsea Self, Post Independent.</i></p>
<p><b>Bat echolocation game</b>: Two at a time, students take turns roleplay 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 gain personal confidence.</p> <p><u>Space required</u>: 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).</p>		
<p><b>Bat Migration Challenge game</b>: 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.</p> <p><u>Space required</u>: may be played indoors or outdoors.</p>		<p><i>A student roleplaying the bat in the echolocation game during a 2012 program.</i></p>



CaveSim program element: Geology	Pertinent Standards	Photos of past CaveSim programs
<p>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:</p> <ul style="list-style-type: none"> <li>• 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.</li> <li>• Discussion on the formation of sinkholes, and the benefits / dangers that they afford humans.</li> <li>• 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 fossil station.</li> <li>• 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)</li> </ul>		 <p><i>CaveSim program lead Dave Jackson teaches kids about limestone solubility in weak acid during a demo in Austin, TX. Photo by Austin Parks &amp; Rec staff.</i></p>
<p><u>Space required:</u> may be taught indoors or outdoors.</p>		



CaveSim program element: Squeezebox and Math	Pertinent Standards	Photos of past CaveSim programs
<p>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.</p> <p><u>Space required</u>: typically set up near the stretcher (see above). Any indoor or outdoor setting is fine.</p>		<div data-bbox="1499 211 2003 548">A photograph showing two students at an outdoor event. One student is lying on their side inside a wooden squeezebox, while the other student is kneeling beside it, using a tape measure to measure the width of the opening. A sign on the box reads "BE BRAVE CaveSim GO CAVE".</div> <p data-bbox="1499 553 2003 605"><i>Students at a 2018 Austin PARD program use a tape measure to quantify their squeezebox skills.</i></p> <div data-bbox="1499 634 2024 982">A photograph of a young child lying on their stomach inside a wooden squeezebox. The child is smiling and looking out from the opening. The box is set up on a carpeted floor indoors.</div> <p data-bbox="1499 987 2024 1117"><i>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.</i></p>

CaveSim program element: Rescue Stretcher	Pertinent Standards	Photos of past CaveSim programs
<p>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.</p> <p><u>Space required:</u> any indoor or outdoor setting. May be done in classrooms or even hallways.</p>		 <p>With supervision from CaveSim staff, a team of kids gets ready to lift and carry a friend in the stretcher.</p>

**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.

*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:

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.



*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 minutes.

Recommended class size: Up to 30 students.

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

**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



*Above, 5th graders in Colorado 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 grades: 2nd & up

Standards addressed:



## 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 between \$1558 and \$1408/day, which typically works out to \$7 to \$10/student. Need-based discounts are available. 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](http://www.cavesim.com/waiver).

How much space is needed? Is power required? See [www.cavesim.com/pages/site-logistics](http://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](mailto: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 understand 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.