Standards-Aligned CaveSim Programs for Alabama Middle Schools

Thank you for your interest in CaveSim! The centerpiece of our program is our mobile cave. Housed in a 26’ trailer, the cave contains 60’ of passage filled with formations, cave biota, and ancient artifacts (all artificial), and students get a computerized score based on how carefully they avoid these objects as they explore.

Our programs are about much more than just fun. Students learn valuable content in life science, physical science, earth science, PE and even art. To accomplish all this, students rotate through stations. Students learn physical science first-hand on a 12' vertical caving tower. They learn about microorganisms and other life science lessons via hands-on bat-related activities. Lessons with cave rescue phones and visualization equipment teach students about properties of waves. Carbide lamp demos illustrate exothermic reactions, conservation of mass, and other chemistry concepts. In short, we provide an experience that is so thrilling and interesting that students readily absorb valuable educational content without realizing that they’re learning.

With engineering skills learned at MIT, I created the entire cave, including the electronics and software that give students feedback about their careful-caving skills. As a result, students learn that real people can create amazing things by excelling in school and following their passions. My staff and I are excited to help your students see the value of education in a whole new way.

— Dave Jackson, owner and inventor, CaveSim LLC.

Teacher quotes:

“We loved having you guys, and I am so excited to keep this program going. I've heard fantastic things from each site and I know they will want to continue it in the future.” **— Deitra Biely, 7th-8th grade science teacher, Grove Middle School, Grove, OK**

“Your staff was terrific.” **— Annette Humphrey, Middle School Science, Good Shepherd School, Denver**

“The kids learned a lot and had a good time. It was definitely worthwhile.” **— Amos White, MS Division Lead, The Colorado Springs School**

“The day went very well and the outcomes were beneficial to our seminar.” **— Blisse Beardsley, Middle School Math Teacher, CSS**

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Middle schools whose students have benefitted from our programs

Colorado:

Boulder Valley School District: Aspen Creek K-8
Falcon D49: Falcon Middle School
Fountain Fort Carson D8: Carson Middle School
Harrison D2: Atlas Preparatory School
Manitou Springs School D14: Manitou Springs MS
parochial schools: Good Shepherd School, Denver
private schools: Ben Franklin Academy; The Colorado Springs School; The University School of Colorado Springs
Weld County School District 6: University Schools

Kentucky:

Allen County: Allen County Intermediate Center
Barren County: Barren County Middle School

Oklahoma:

Grove: Grove Middle School

Texas:

Hays CISD: Dahlstrom Middle School

Learning physical science on the 12' CaveSim vertical caving tower

Standard Program Components (with Alabama standards[1] alignment)

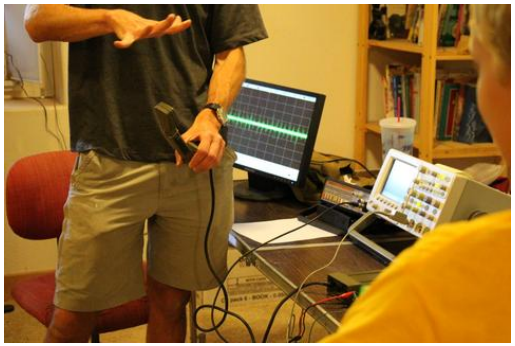
Standard components are included in the cost of the program. Students rotate through a series of different stations/lessons.

Exploration of CaveSim & Associated Lessons	Corresponding ALEX Standards	Photos of programs
Students look for cave life (artificial) inside the mobile cave. We discuss the cave ecosystems. Students compare cave- and surface-dwelling organisms and the impact that in-cave and surface resources have on the size & characteristics of organisms.	Grade 6 Earth & Space Science standard 7) Use models to construct explanations of the various biogeochemical cycles of Earth (e.g., water, carbon, nitrogen) and the flow of energy that drives these processes.	 *A student explores CaveSim in 2018.*
Students look for artifacts & rock art, and discuss the importance of artifacts to native people, archaeologists, and anthropologists.		
Students learn from CaveSim staff about the impact of skin oil on stalactites, stalagmites, and other speleothems. The polar nature of the water molecule & the non-polar nature of skin oil are discussed as a way to explain why touching destroys cave formations.		
Students discuss how cave tunnels form. Students learn about the role microorganisms (extremophile bacteria) play in metabolizing limestone w/ enzymes. Staff explain how aqueous cave formations form. Fluid dynamics & the role of extremophiles are discussed.	Grade 7 Life Science standard 5) Examine the cycling of matter between abiotic and biotic parts of ecosystems to explain the flow of energy and the conservation of matter. a. Obtain, evaluate, and communicate information about how food is broken down through chemical reactions to create new molecules that support growth and/or release energy as it moves through an organism.	
Study the impact of diluted acid on various rock types to learn about which rock types are conducive to cave development. Discuss how carbonate rocks form (i.e., fossilization of remnants of lime-based and carbonate life forms). Students learn about how cave-based rock strata tell us about geologic history.	Grade 6 Earth & Space Science standard 5) Use evidence to explain how different geologic processes shape Earth's history over widely varying scales of space and time (e.g., chemical and physical erosion; tectonic plate processes; volcanic eruptions; meteor impacts; regional geographical features, including Alabama fault lines, Rickwood Caverns, and Wetumpka Impact Crater). Grade 6 Earth & Space Science standard 6) Provide evidence from data of the distribution of fossils and rocks, continental shapes, and seafloor structures to explain past plate motions.	

[1] For Alabama standards alignment information, we have referred to https://alex.state.al.us/browseSC.php

Vertical Caving on the 12' Vertical Caving Tower	Corresponding ALEX Standards	Photos of CaveSim programs
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.		 *Above, a Grove, OK student uses mechanical advantage to lift herself up the A-frame. Below, Grove students & CaveSim staff destroy a rope in 20 seconds using another rope.* 
Students use buckets of water interconnected by ropes run through pulleys to investigate Newton's first, second, and third laws.	Grade 8 Physical Science standard 8) Use Newton's first law to demonstrate and explain that an object is either at rest or moves at a constant velocity unless acted upon by an external force (e.g., model car on a table remaining at rest until pushed). Grade 8 Physical Science standard 9) Use Newton's second law to demonstrate and explain how changes in an object's motion depend on the sum of the external forces on the object and the mass of the object (e.g., billiard balls moving when hit with a cue stick).	
Students use the tower to drop water buckets onto a wooden board. Students observe that the board gets destroyed, and then they work in groups to design and test a system to protect the board from getting broken.	Grade 8 Physical Science standard 10) Use Newton's third law to design a model to demonstrate and explain the resulting motion of two colliding objects (e.g., two cars bumping into each other, a hammer hitting a nail).	
Students use harnesses & mechanical ascenders to climb rope. Staff discuss ascender mechanics, equipment safety, & important differences between caving and rock climbing equipment.	Physical Education 6-2.1) Demonstrate a basic knowledge of the rules and regulations for a variety of games and activities. 6-2.3) Identify appropriate safety behaviors related to a variety of games and activities.	
Students engage in a discussion about vertical caving safety, and forces and vectors are discussed in the context of the 12' A-frame.		
W/ help of students, staff demonstrate the power of friction to rapidly destroy Nylon rope, as well as the power of friction to allow a person to ascend a rope using the Prusik knot.		

Carbide Demonstrations	Corresponding ALEX Standards	Photos of CaveSim programs
Staff put carbide & ice in a pan; ice melts; water reacts w/ carbide to form acetylene. Students study state/ temperature changes associated w/ the exothermic carbide/water reaction. Positive feedback is discussed.	Grade 8 Physical Science standard 4) Design and conduct an experiment to determine changes in particle motion, temperature, and state of a pure substance when thermal energy is added to or removed from a system.	 *Carbide lamp demonstration by CaveSim staff in Grove, OK.*
Staff put carbide & water in a lamp to form acetylene. The acetylene burns to make light & heat, but the lamp body also becomes hot b/c carbide/water reaction is exothermic. Reaction rate is controlled by the rate of dripping in the lamp. Limiting reactants & reflector properties are discussed.	Grade 8 Physical Science standard 5) Observe and analyze characteristic properties of substances (e.g., odor, density, solubility, flammability, melting point, boiling point) before and after the substances combine to determine if a chemical reaction has occurred. Grade 8 Physical Science standard 7) Design, construct, and test a device (e.g., glow stick, hand warmer, hot or cold pack, thermal wrap) that either releases or absorbs thermal energy by chemical reactions (e.g., dissolving ammonium chloride or calcium chloride in water) and modify the device as needed based on criteria (e.g., amount/concentration, time, temperature).	 *Example of the lamps we use.*
Students learn that carbide is synthesized from coal & lime in arc ovens. Societal impact is discussed.	Grade 8 Physical Science standard 3) Construct explanations based on evidence from investigations to differentiate among compounds, mixtures, and solutions. a. Collect and analyze information to illustrate how synthetic materials (e.g., medicine, food additives, alternative fuels, plastics) are derived from natural resources and how they impact society.	
CaveSim staff mix carbide and water in a sealed container to demonstrate conservation of mass and energy. The container is placed on a gram balance, and the mass is recorded before & after the reaction. Students observe that the mass changes only after the resultant acetylene gas is released from the container. Students draw models of the reactants and products of the reaction. Students learn about the components of carbide, which is a man-made fuel created with naturally occurring ingredients.	Grade 8 Physical Science standard 6) Create a model, diagram, or digital simulation to describe conservation of mass in a chemical reaction and explain the resulting differences between products and reactants.	

Cave Rescue Phones / Waterproof Speakers	Corresponding ALEX Standards	Photos of CaveSim programs
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/reconnect wires to study circuits. 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. The differences between analog & digital information transmission are also discussed.	Grade 8 Physical Science standard 19) Integrate qualitative information to explain that common communication devices (e.g., cellular telephones, radios, remote controls, Wi-Fi components, global positioning systems [GPS], wireless technology components) use electromagnetic waves to encode and transmit information. Grade 8 Physical Science standard 18) Use models to demonstrate how light and sound waves differ in how they are absorbed, reflected, and transmitted through different types of media.	 *Students in Grove, OK enjoy using the cave rescue phones.*  *A CaveSim staff person teaches students about electricity and magnetism using cave rescue telephones and electronic test equipment (oscilloscopes).*
Demos with waterproof speakers, which we use to show that sound is a wave that can move matter, and that electrical energy can be converted to mechanical (sound) energy (and vice versa). Students learn how we made the speakers to learn that they can make cool things with simple materials.	Grade 8 Physical Science standard 11) Plan and carry out investigations to evaluate how various factors... affect the strength of electric and magnetic forces.	
Demonstrations w/ oscilloscopes (see https://whatis.techtarget.com/definition/oscilloscope) by CaveSim owner Dave Jackson, who has designed high speed computer chips for o'scopes. The o'scope 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 & frequency based graphs. Resonances/oscillation of electrical and sound signals & the Fourier transform are discussed. Students use their voices and the phones to demonstrate relationship b/w frequency & wavelength.	Grade 8 Physical Science standard 17) Create and manipulate a model of a simple wave to predict and describe the relationships between wave properties (e.g., frequency, amplitude, wavelength) and energy. a. Analyze and interpret data to illustrate an electromagnetic spectrum.	
Students use the aforementioned cave rescue phones to conduct electromagnetism experiments with analog meters, simple generators, and the aforementioned oscilloscope.	Grade 8 Physical Science standard 12) Construct an argument from evidence explaining that fields exist between objects exerting forces on each other (e.g., interactions of magnets, electrically charged strips of tape, electrically charged pith balls, gravitational pull of the moon creating tides) even when the objects are not in contact.	

Bat Biology & Epidemiology Lessons/Activities	Corresponding ALEX Standards	Photos of CaveSim programs
<u>Bat skeleton and guano</u> demonstrations and lessons: ● Discussion of similarities/differences b/w bat wing morphology and human hand morphology. Discussion of evolutionary pressures that may have created the similarities/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. ● Discussions about history & the role caves played in the civil war (sources of saltpeter for the production of gunpowder).	Grade 7 Life Science standard 4) Construct models and representations of organ systems (e.g., circulatory, digestive, respiratory, muscular, skeletal, nervous) to demonstrate how multiple interacting organs and systems work together to accomplish specific functions. Grade 7 Life Science standard 6) Analyze and interpret data to provide evidence regarding how resource availability impacts individual organisms as well as populations of organisms within an ecosystem. Grade 7 Life Science standard 10) Use evidence and scientific reasoning to explain how characteristic animal behaviors... affect the probability of successful reproduction of both animals and plants.	 *CaveSim program lead Dave Jackson teaches bat biology in Oklahoma.*
● Photo/video demos of the ongoing White Nose Syndrome (WNS) epidemic that has killed >6 million bats in the last ~10 years. Lesson about WNS fungus (Pseudogymnoascus destrucans) which metabolizes live bats. ● Discussion of bats' colonial behaviors, and the advantages and disadvantages of such behaviors.	Grade 7 Life Science standard 8) Construct an explanation to predict patterns of interactions in different ecosystems in terms of the relationships between and among organisms (e.g., competition, predation, mutualism, commensalism, parasitism).	 *Students in Oklahoma roleplay bats spreading WNS fungus by using a UV fluorescent dye.*
<u>Bat epidemiology activity</u>: As mentioned above, millions of bats are dying in the US from WNS. Students learn about the spread of WNS, and about overarching epidemiological concepts, through a hands-on game. Students use UV fluorescent dye in test tubes and transfer the dye among the class. CaveSim staff use a blacklight to monitor the spread of the "disease" (i.e., dye) among the "bat" (i.e., student) population. Students play the game in rounds, with the number of bat-bat interactions being equal to the round number. Students make a graph of interaction count vs. disease prevalence. Stochastic (i.e., random) processes are discussed. Students discuss various ways in which the disease might be stopped, and the pros/cons of each.	Grade 7 Life Science standard 7) Use empirical evidence from patterns and data to demonstrate how changes to physical or biological components of an ecosystem (e.g., deforestation, succession, drought, fire, disease, human activities, invasive species) can lead to shifts in populations. Grade 7 Life Science standard 9) Engage in argument to defend the effectiveness of a design solution that maintains biodiversity and ecosystem services (e.g., using scientific, economic, and social considerations regarding purifying water, recycling nutrients, preventing soil erosion).	

CaveSim program element	Corresponding ALEX Standards	Photos of CaveSim programs
Cave rescue stretcher: we bring an adult-sized 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.	Physical Education 6-4.5) Cooperate with a small group of classmates during a variety of physical activities.	 *Austin High School student and football player gets ready to ride (successfully!) in the Skedco stretcher.*
Squeezebox: 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 taught to be encouraging and supportive of classmates.	Physical Education 6-3.2) Participate in a variety of moderate to vigorous activities. Physical Education 6-2.2) Identify appropriate sporting behavior and etiquette related to a variety of games and activities.	 *Students at a 2018 Austin program use a tape measure to quantify their squeezebox skills.*

Special Program Components (aka labs)

Our standard programs (described above) can be enhanced with the addition of our labs. Our labs provide a very in-depth educational experience in a specific subject, such as 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 environmental conservation by including post-consumer recyclable materials in our engineering labs. Labs require:

- Classroom space
- Limited group size and sufficient time. Typically one class will spend 60 to 120 minutes on a lab (without doing other activities in that time), which can be scheduled over a two-day period.
- Extra funding for lab materials and staff time.

CaveSim program element: Biology Lab	Corresponding ALEX Standards	Photos of past CaveSim programs
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, including the impact of external stimuli. <u>Subjects covered:</u> Experiment design, scientific method, and biology concepts, including prokaryotic/eukaryotic, kingdoms of life, nuclei, and membranes.	Grade 7 Life Science standard 1) Engage in argument from evidence to support claims of the cell theory. Grade 7 Life Science standard 2) Gather and synthesize information to explain how prokaryotic and eukaryotic cells differ in structure and function, including the methods of asexual and sexual reproduction. Grade 7 Life Science standard 3) Construct an explanation of the function (e.g., mitochondria releasing energy during cellular respiration) of specific cell structures (i.e., nucleus, cell membrane, cell wall, ribosomes, mitochondria, chloroplasts, and vacuoles) for maintaining a stable environment.	 *Students at a two-day high school program in Oklahoma get ready to inoculate their Petri dishes.*

CaveSim program element: Engineering Lab	Corresponding ALEX Standards	Photos of CaveSim programs
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.		 *Middle school students work on their circuit designs..*

CaveSim program element: Karst Lab	Corresponding ALEX Standards	Photos of past CaveSim programs
Students make their own karst topography using basic household materials. Students add water to their models and watch as sinkholes form in real time. We discuss hydrology, geology, basic chemistry, landforms, states of matter, and the limitations of the small-scale model.	Grade 6 Earth & Space Science standard 4) Construct explanations from geologic evidence (e.g., change or extinction of particular living organisms; field evidence or representations, including models of geologic cross-sections; sedimentary layering) to identify patterns of Earth's major historical events (e.g., formation of mountain chains and ocean basins, significant volcanic eruptions, fossilization, folding, faulting, igneous intrusion, erosion). Grade 6 Earth & Space Science standard 8) Plan and carry out investigations that demonstrate the chemical and physical processes that form rocks and cycle Earth's materials (e.g., processes of crystallization, heating and cooling, weathering, deformation,	 *Students work on topography models*

	and sedimentation). Grade 6 Earth & Space Science standard 10) Use research-based evidence to propose a scientific explanation regarding how the distribution of Earth's resources such as minerals, fossil fuels, and groundwater are the result of ongoing geoscience processes (e.g., past volcanic and hydrothermal activity, burial of organic sediments, active weathering of rock).	

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 $1658/day. 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.

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 have done as many as six days in one school district.

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 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.