CaveSim Programs for Alabama Elementary Schools

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

Above, awestruck at a program in Los Alamos, NM, 2017

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

Alabama program quote: “We loved having you here!” **— Hollie Baranick, Tours & Special Projects Manager, Ruby Falls**

Alabama program quote: “I had a great time volunteering for CaveSim.... The high school vice principal… brought some summer students over to do CaveSim. This was a bunch of African-American kids who might never step foot inside a cave without this introduction.” Kim Fleischmann, Huntsville

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Summary

Thank you for your interest in CaveSim! The centerpiece of our programs is our mobile CaveSim system, which we'll bring to your school from Colorado in a 24' trailer. The cave is filled with formations, critters, and ancient artifacts (all artificial), and students get a computerized score based on how carefully they avoid the stalactites and other objects as they explore.

We'll also bring you an entire set of ALEX[1]-aligned hands-on lessons and activities with the mobile cave. Our elementary programs are tailored specifically to elementary standards, and cover a wide range of subjects including science, math, engineering, PE and art.

Our programs are led by CaveSim inventor, educator, and engineer Dave Jackson. Dave and his wife Tracy are both cavers who've been doing CaveSim programs for 11 years. Lessons are designed by Tracy, who has a Masters of Art in Teaching from Colorado College.

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

Schools 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

[1] Alabama Learning Exchange (ALEX) educational standards, https://www.alsde.edu/sec/sct/COS/2015%20FINAL%20Science%20COS%2010-1-15.pdf

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.

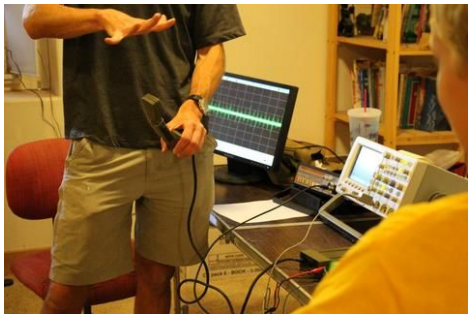
Standard Program Components (with ALEX standards alignment)

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

CaveSim program element: Horizontal Cave Exploration	Corresponding standards	Photos of past CaveSim programs
In CaveSim mobile cave (contains 60' of passage with multiple levels in a 24' trailer). While wearing helmets, students explore the cave 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 artificial 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. Students also investigate a model cave to learn about why it is important for us to take care of groundwater.	Sci K. 6) Identify and plan possible solutions to lessen the human impact on the local environment. Sci 2. 1) Conduct an investigation to describe and classify various substances according to physical properties….	
• 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. Students look for roots growing down into the cave.	Sci K.4) Gather evidence to support how plants & animals provide for their needs by altering their environment. Sci 3.11) Construct an argument from evidence to explain the likelihood of an organism's ability to survive when compared to the resources in a certain habitat…. Sci 5.11) Create a model to illustrate the transfer of matter among producers; consumers, including scavengers and decomposers; and the environment.	
• Learn about how cave passage forms. CaveSim staff talk about special bacteria that use enzymes to eat limestone (breaking chemical bonds to get energy). We can also discuss the formation of sinkholes (common in Alabama), and the benefits / dangers that they afford humans. Demo: dissolution of carbonate rocks using weak acid.	Sci 3.5) Obtain & combine information to describe that organisms are classified as living things, rather than nonliving things, based on their ability to obtain & use resources, grow, reproduce…. Sci 5. 4) Investigate whether the mixing of two or more substances results in new substances….	 *Elementary students in Cascade, CO explore the mobile cave.*
• CaveSim staff explain how aqueous cave formations (helictites, soda straws, gypsum) form. Topics covered: water flow is usually downhill due to gravity; water can flow against gravity due to capillary action (examples: water climbing up a towel, water flow inside cave formations). Students grow vocabulary with "capillary action." • Geology demos with fossils, the three major rock types, and rock-identifying tests. • Look for equipment in the cave (rescue cache & rope ladder). Students learn that etrier (rope ladder) is French for "stirrup." Students expand vocab w/ the word "cache."	Sci 3. 9) Analyze and interpret data from fossils (e.g., type, size, distribution) to provide evidence of organisms and the environments in which they lived long ago. Sci 5. 5) Construct explanations from observations to determine how the density of an object affects whether the object sinks or floats when placed in a liquid	
• Look for artifacts & art, and discuss the importance to native people & archaeologists. Hear a real story about a CaveSim staffer's experience w/ artifacts while caving. Students discuss why we don't take artifacts or damage art. • Upon request: before entering the cave, students make cave paintings on paper, and write a few sentences about what story their picture tells. While exploring the mobile cave, students sketch the cave paintings they find. After exiting, students write a story about what they saw in the cave paintings. As a group, students share their stories.		
Space required: the 24' trailer is typically kept outside. See www.cavesim.com/site-logistics for more details. In inclement weather, we may close the trailer and do indoor activities.		

CaveSim program element: Vertical Caving	Corresponding 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.	Sci K.1) Investigate the resulting motion of objects when forces of different strengths & directions act upon them... Sci K.2) Use observations and data from investigations to determine if a design solution... solves the problem of using force to change the speed or direction of an object. Sci 3.1) Plan and carry out an experiment to determine the effects of balanced and unbalanced forces on the motion of an object using one variable at a time, including number, size, direction, speed, position, friction, or air resistance..., and communicate these findings graphically. Sci 4. 1) Use evidence to explain the relationship of the speed of an object to the energy of that object. Sci 5. 7) Design and conduct a test to modify the speed of a falling object due to gravity	 *Above, a student in Colorado uses mechanical advantage to lift herself up the A-frame.* *Below, students in Montana work together under direct supervision from staff to lift a fellow student .* 
• Students design and conduct collision experiments using ropes and weights on the tower.	Sci 4. 3) Investigate to determine changes in energy resulting from increases or decreases in speed that occur when objects collide.	
• CaveSim staff use harnesses and mechanical ascenders to climb the tower. Staff discuss ascender mechanics, equipment safety, and the 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 to find the world's deepest cave. Students learn that some of the cavers who help with CaveSim have been over 6000' underground.		
• With the help of students, CaveSim 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 then develop hypotheses 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 spread out on the smaller rope, hence the melting of the larger rope). • With the help of students, CaveSim staff demonstrate the power of friction to allow a person to ascend a rope using Prusik knots. Students learn to tie the Prusik, the Alpine Butterfly, the Lark's Head, and/or other knots.	Sci 3. 15) Evaluate a design solution….	
Space required: typically outdoors on flat ground. May also be placed indoors where ceiling height is >14'. Footprint is 8' x 9'.		

CaveSim program element: Carbide Demonstrations	Corresponding standards	Photos of past CaveSim programs
To illustrate chemistry and physics concepts, CaveSim staff bring working carbide lamps and carbide to programs. Demonstrations can include: ● CaveSim staff light a working carbide lamp by placing carbide and water in the lamp to produce a small (and safe) quantity of flammable gas. The resultant gas (acetylene) burns to produce light and heat, but the lamp body also becomes warm because of the exothermic reaction between the carbide and water. Students can touch the lamp body to get a better understanding of the concept of an exothermic reaction. 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.” ● 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.” ● CaveSim staff us a laboratory-grade carbide lamp to demonstrate conservation of mass. ● 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.	Sci 2. 4) Provide evidence that some changes in matter caused by heating or cooling can be reversed (e.g., heating or freezing of water) and some changes are irreversible…. Sci. 5. 2) Investigate matter to provide mathematical evidence, including graphs, to show that regardless of the type of reaction (e.g., new substance forming due to dissolving or mixing) or change (e.g., phase change) that occurs when heating, cooling, or mixing substances, the total weight of the matter is conserved.	 *Above, carbide lamp demonstration by CaveSim staff at a program in Colorado.* *Below, stock photo of the lamps we use.* 

CaveSim program element: Cave Rescue Phones	Corresponding standards	Photos of past CaveSim programs
Hands-on lessons about 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. • New for 2019/2020: Students make their own form of cave phones, using vibration to communicate over a distance. Students are encouraged to understand the analog between the mechanical waves in this activity and the electrical waves in the preceding activity. • New for 2019/2020: Students use a stainless steel drum to propagate waves through water. Students make observations about the interaction between sound and mechanical energy. Students are encouraged to make connections between this activity and the vibrations that travel between their home-made phones in the preceding activity.	Sci 1. 4) Design and construct a device that uses light or sound to send a communication signal over a distance…. Sci 3. 3) Explore objects that can be manipulated in order to determine cause-and-effect relationships (e.g., distance between objects affecting strength of a force, orientation of magnets affecting direction of a magnetic force) of electric interactions between two objects not in contact with one another (e.g., force on hair from an electrically charged balloon, electrical forces between a charged rod and pieces of paper) or magnetic interactions between two objects not in contact with one another…. Sci 4. 2) Plan and carry out investigations that explain transference of energy from place to place by sound, light, heat, and electric currents. Sci 4. 4) Design, construct, and test a device that changes energy from one form to another (e.g., electric circuits converting electrical energy into motion, light, or sound energy; a passive solar heater converting light energy into heat energy).	 *A CaveSim staff person teaches students about electricity and magnetism using cave rescue telephones and electronic test equipment.*
• Demonstrations with waterproof speakers to show that sound is a mechanical wave. • Demonstrations with an oscilloscope (see https://whatis.techtarget.com/definition/oscilloscope) by CaveSim owner Dave Jackson, who has designed high speed computer chips for oscilloscopes. The oscilloscope produces a graphical representation of voltage on the cave rescue phone wire vs. time, which allows students to visualize their vocal energy on a screen. We discuss graph axes, and the relationship between time-based and frequency based graphs. Resonances/oscillation of electrical and sound signals are also discussed. This activity is typically done for middle/high school, but can be adapted to older elementary students.	Sci 1. 1) Conduct experiments to provide evidence that vibrations of matter can create sound... and sound can make matter vibrate…. Sci 4. 6) Develop a model of waves to describe patterns in terms of amplitude and wavelength, and including that waves can cause objects to move. Sci 4. 7) Develop and use models to show multiple solutions in which patterns are used to transfer information (e.g., using a grid of 1s and 0s representing black and white to send information about a picture, using drums to send coded information through sound waves, using Morse code to send a message)	
Space required: 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.		

CaveSim program element: Bat games and lessons	Corresponding 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, lesson about the WNS fungus (Pseudogymnoascus destrucans) and how it eats (metabolizes) bats alive. ● Discussions about **Alabama history** and the role that caves played in the Civil War (as sources of saltpeter for the production of gunpowder). Space required: typically done by the trailer to engage students as they wait to explore. Can also be done anywhere inside.	Sci 2. 6) Design and construct models to simulate how animals disperse seeds or pollinate plants (e.g., animals brushing fur against seed pods and seeds falling off in other areas, birds and bees extracting nectar from flowers and transferring pollen from one plant to another). Sci 3. 8) Engage in argument from evidence to justify that traits can be influenced by the environment…. Sci 4. 9) Examine evidence to support an argument that the internal and external structures of plants (e.g., thorns, leaves, stems, roots, colored petals, xylem, phloem) and animals (e.g., heart, stomach, lung, brain, skin) function to support survival, growth, behavior, and reproduction.	 *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 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. 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.	Sci 4. 11) Investigate different ways animals receive information through the senses, process that information, and respond to it in different ways (e.g., skunks lifting tails and spraying an odor when threatened, dogs moving ears when reacting to sound, snakes coiling or striking when sensing vibrations).	
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. Space required: may be played indoors or outdoors.		

CaveSim program element: Squeezebox and Math	Corresponding 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.		 *Students at a 2018 Austin PARD program use a tape measure to quantify their squeezebox skills.*

CaveSim program element: Rescue Stretcher	Corresponding 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.		 *With supervision from CaveSim staff, kids get ready to lift and carry a friend in the stretcher.*

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

Right, Dave gives 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.

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\

Standards addressed: Sci 4.12) Construct explanations by citing evidence found in patterns of rock formations and fossils in rock layers that Earth changes over time through both slow and rapid processes; Sci 4.14) Explore information to support the claim that landforms are the result of a combination of constructive forces, including crustal deformation, volcanic eruptions, and sediment deposition as well as a result of destructive forces, including erosion and weathering.

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

Standards addressed: Sci 5.1) Plan and carry out investigations (e.g., adding air to expand a basketball, compressing air in a syringe, dissolving sugar in water, evaporating salt water) to provide evidence that matter is made of particles too small to be seen.

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 grade levels: 2nd grade and up

Pricing and FAQ

How much do programs cost? This depends on factors like travel distance, number of days, and number of students. Our average price this year 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 four 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 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.