An Investigative Look at Florida's Sinkholes

by Mike Cimino and Laura French

Focus on Inquiry

The students will create a model to investigate the factors that affect sinkhole formation and apply concepts of weathering and erosion to explain the processes occurring in my model.

Lesson Content Overview

Students will:

- Differentiate between erosion, physical weathering, and chemical weathering.
- Create a model of a sinkhole.
- Investigate factors that affect sinkhole formation.
- Present an argument supported by evidence collected from their model.

Duration	Setting	Grouping	PTI Inquiry Subskills
120 minutes (3-4 classes)	Classroom	Groups of 2-3 students	1.2, 6.2, 7.1, 7.2

Lesson Components	Estimated Time	Inquiry Subskills Used	Technology Used	Level of Student Engagement	Brief Description
Engage	10 minutes	1.2	computer and projector	2	Video showing consequences of sinkhole formation. Cbsnews.com/news/sinkholes-thehole-truth/
Explore	40 minutes			3	Creation of model testing one of three factors that may affect sinkhole formation.
Explain	30 minutes			3	Evaluate data collected through model and write justification of evidence.
Expand	10 minutes			2	Examine other groups factors tested and compare data to own group. Analyze and review data on USGS Map.
Evaluate	30 minutes	6.2, 7.1, 7.2		3	Presenting their arguments to class on factors that affect sinkhole formation. Answer pregenerated questions.

Level of Student Engagement

1	Low	Listen to lecture, observe the teacher, individual reading, teacher demonstration, teacher-centered instruction
2	Moderate	Raise questions, lecture with discussion, record data, make predictions, technology interaction with assistance
3	High	Hands-on activity or inquiry; critique others, draw conclusions, make connections, problem-solve, student-centered

Next Generation Science Standards – Inquiry

NGSS Practice 2: Developing and Using Models
NGSS Practice 3: Planning and Carrying Out Investigations
NGSS Practice 4: Analyzing and Interpreting Data
NGSS Practice 6: Constructing explanations
NGSS Practice 7: Engaging in arguments from evidence
NGSS Practice 8: Obtaining, Evaluating and Communicating Information

Next Generation Science Standards – Earth Science
MS.ESS2 2.Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.
Florida Science Standards – Nature of Science
SC.6.N.1.1 Define a problem from the sixth grade curriculum, use appropriate reference materials to support scientific understanding, plan and carry out scientific investigation of various types, such as systematic observations or experiments, identify variables, collect and organize data, interpret data in charts, tables, and graphics, analyze information, make predictions, and defend conclusions.
Florida Science Standards – Earth Science
SC.6.E.6.2 Recognize that there are a variety of different landforms on Earth's surface such as coastlines, dunes, rivers, mountains, glaciers, deltas, and lakes and relate these landforms as they apply to Florida. SC.6.E.6.1 Describe and give examples of ways in which Earth's surface is built up and torn down by physical and chemical weathering, erosion, and deposition.

Materials and Advance Preparation Materials List

Class set:

- 2.5 lb. of sand per class period
- Access to sand and water
- Coffee Pot to heat water

Group materials:

- 5 Styrofoam bowls per group
- Stick of clay per group
- 5 Alka-Seltzer tablets per group
- 250mL beaker per group
- 100mL graduated cylinder
- Triple beam or electronic balance
- Stopwatch

Blackline Masters

- Blackline Master #1: How to construct your sinkhole model
- Blackline Master #2: Student Rubric
- Blackline Master #3: USGS Map
- Blackline Master #4: Student Lab Report
- Blackline Master #5: Check for Understanding
- Blackline Master #6: Check for Understanding Answer Key.

Advance Preparation

1. Teachers will need to purchase lab materials, and set up lab groups.

Lesson Information

Learning Objectives

1. The students will be able to use the model they created in this lesson to correctly describe when erosion and weathering is occurring.
2. The students will be able to correctly state, based on their data, that a larger amount of rainfall, acidification of ground water and depth of the limestone layer all play a role in the formation of sinkholes.

Prior Knowledge Needed by the Students

- A basic understanding of weathering and erosion.
- Landforms in Florida and their basic characteristics.

Background Information

Sinkholes are a common feature of Florida's landscape. They are only one of many kinds of karst landforms, including caves, disappearing streams, springs, and underground drainage systems. Karst refers to a type of terrain produced by erosional processes associated with the chemical weathering and break down of limestone, which is one of the most common carbonate rocks in Florida. The breaking down of carbonate rocks begins when they are exposed to acidic water. Most rainwater is slightly acidic and usually becomes more acidic as it moves through decaying plant debris.

Limestone in Florida is porous, meaning it has a lot of tiny holes within it. This allows acidic water to penetrate through the rocks layers, dissolving some limestone and carrying it away in solution. Over long periods of time, this erosional process has created extensive underground voids and drainage systems in much of the carbonate rocks throughout the state. Collapse of overlying sediments into the underground areas produces sinkholes.

When groundwater discharges from an underground drainage system, it is a spring, such as Wakulla Springs, Silver Springs, or Rainbow Springs. Sinkholes can occur in the beds of streams, sometimes taking all of the stream's flow, creating a disappearing stream. Dry caves are parts of karst drainage systems that are above the water table, such as Marianna Caverns located on the Florida Panhandle.

Lesson Procedure

Engage

1. Students will watch a video: Cbsnews.com/news/sinkholes-the-hole-truth/ (Only play first 3 minutes)
   - *Make sure to fast forward past the advertisements and display the video "whole screen" so that the web page advertisements located on the right-hand side and underneath the video will not be seen. In addition, please be on the lookout for "pop-up" ads while the video is playing.*
2. Display the following questions and have students answer them with shoulder partners or in their science notebooks. This should be followed-up with a whole group discussion.
   - Why does the news reporter refer to Florida as "Swiss cheese"?
     - *Possible student response: Florida is considered "Swiss cheese" because the limestone layer underground is full of holes like Swiss cheese.*
   - What factors lead to the ground creating a sinkhole?
     - *Possible student response: Florida's bedrock, mostly limestone, lies below layers of soil sand and clay. That bedrock is porous and over time can erode and become unstable, forming what geologists call "karst."*
3. Students will record three things they learned from the video on their student lab sheet.

Explore

1. Students need to determine what they want to test from the three options below:
   a. If the amount of soil causes sinkholes to form.
   If you choose thickness of soil, the only thing you may change is the amount of soil.
   b. If the amount of water causes sinkholes to form.
   If you chose amount of water, the only thing you may change is the amount of water.
   c. If the pH (acidity) of water causes sinkholes to form.
   If you chose pH, the only thing you may change is the pH of the water you are using.

Important Note for the educator: To simulate the effect pH has on sinkhole formation, use different temperatures of warm water. Using an acid such as vinegar will result in the formation of carbonic acid, causing the antacid tablet (representing the limestone layer) to break down slower, which is the opposite of the desired results. In actuality, limestone chemically reacts to weak acids, which happens gradually over time with rainwater. Rainwater has a pH of around 5.6, and it becomes acidic as it comes in contact with carbon dioxide in the atmosphere and the soil including living and decaying plant matter, creating a mild carbonic acid. As this acid propagates through the ground, it breaks down the limestone layer, which in turn causes sinkhole formation over time. When discussing this with your students, you need to put it into terminology they will understand, especially since this is a sixth grade Florida standard. In class, indicate that the warm water represents rainwater that has come into contact with the carbon dioxide in our atmosphere and the soil for prolonged periods of time and has acidified, whereas room temperature water will represent water that has not come into contact with the soil for a prolonged period and in turn, is not as acidic. If you would like to simulate an industrialized zone which has had prolonged periods of acid rain, we would use the warmest possible water. This would simulate more acidic groundwater than the other two scenarios. *Please be sure the students do not confuse the "temperature of the water with pH." The different temperature water represents different pH levels of water in our model. Do NOT reference temperature at all when referring to the pH.*

Please exercise caution, making sure the water is not too hot for the students.

Before students enter the classroom:

- Create three different types of "acidic water." Make slightly acidic, acidic, and very acidic using different temperatures of water. Do NOT reference the temperature. Label the beakers containing the hot water using the following names: slightly acidic, acidic, and very acidic. When students ask about the temperature, simply tell them we are not using temperature, simply go off what the label says.

2. Students fill out their lab sheet by developing a hypothesis, identifying the testing variable and the outcome variable.
3. Demonstrate the control as a class, or have the students complete the control using 100g of sand and 100mL of water. Have students record the data on their lab sheet. The typical amount of time it takes for the sinkhole to form is between 1 minute 30 seconds and 2 minutes 30 seconds. If you get a group that achieves 8 minutes for a control they had one of the following errors:
    a. Their hole is too small.
    b. They used too much clay, covering the Alka-Seltzer tablet.
    c. The crushed the sand down.
4. Students create their model following the directions on Blackline Master #1. Hand the, **"How to Construct Your Sinkhole Model" worksheet** to the students at this time so they can create their initial model.
5. Students will experiment with their model, measuring the amount of time it takes for the sinkhole to form.
    a. Students will complete a series of experiments testing different levels of the independent (test) variable. The group only changes one variable and keeps all others constant which is the control amounts. For example, if testing *a. the thickness or (depth) of the limestone layer and its effect on sinkhole formation,* the student would want to test different amount of sand. For example, if our control is 100g of sand and 100mL of water, we may want to experiment with 50g of sand and 100mL of water.

How to Construct Your Sinkhole Model

Step 1: Gather the following materials; Styrofoam bowl, large pen/marker, 200 mL beaker, clay, sand and Alka-Seltzer. 	**Step 2:** Using your large marker/pen, poke a hole in the center of the bowl, *slightly* smaller than the Alka-Seltzer tablet. The hole should be roughly the size of a nickel. 	**Step 3:** Place the Alka-Seltzer tablet on top of the hole, fully covering the hole. If you see any part of the hole, your hole is too large. 
Step 4: Take a **small amount** of clay and roll it into a straight line. Use the smallest amount of clay possible! 	**Step 5:** Place the clay around the outside of the tablet. This should be as tight as possible so no water will go underneath the tablet. Leave as much of the tablet exposed as possible. **DO NOT COVER THE TOP OF THE TABLET- *THIS WILL LEAD TO POOR RESULTS!*** 	**Step 6:** Place your Styrofoam bowl on top of the beaker. 
Step 7: Place your sand/soil into the Styrofoam bowl. Make the sand a smooth surface, but do not compact it (do not push the sand down) 	**Step 8:** Pour your water/solution into the Styrofoam bowl. Record your observations. 	**Step 9:** Remember, after each test you will need a new Alka-Seltzer tablet, clay and new soil/sand.

Explain

1. Students will reflect on their data by answering the following questions:
    a. Is there a pattern with either the amount of soil, amount of water or pH of the water used?
        - *Possible student response: responses will vary based on student data.*
    b. What was the longest amount of time it took for the sinkhole to appear? Was there a reason for this?
        - *Possible student response: responses will vary based on student data.*
    c. What was the shortest amount of time it took for the sinkhole to appear? Was there a reason for this?
        - *Possible student response: responses will vary based on student data.*
2. Students will answer questions connecting the science content to their model:
    a. At what point did your model demonstrate chemical weathering?
        - *Possible student response: when bubbles appear in the water, chemical weathering is occurring.*
    b. Did your model demonstrate physical weathering? If so, when?
        - *Possible student response: this model does not really demonstrate physical weathering.*
    c. Did your model demonstrate erosion? If so, when?
        - *Possible student response: the water carrying the sand into the beaker (through the hole) could be an example of erosion because the water is taking the sand to a new location..*
    d. How do you know a sinkhole occurred?
        - *Possible student response: I know a sinkhole occurred because there was a dip and then an opening in the middle of my bowl. It allowed the sand to sink down into lower layers of the "earth."*
3. Students will read the additional information and answer the questions below:
    a. What is a karst? How are karsts related to sinkholes?
        - *Possible student response: karsts are a type of terrain produced by erosional processes associated with the chemical weathering and break down of limestone. A sinkhole is a type of Karst.*
    b. What are some of the causes of sinkholes?
        - *Possible student response: Sinkholes can be caused by too much rain, increased pH of the rain, too much weight on the land above, a weakening of the limestone layer.*
    c. Why are sinkholes common in Florida?
        - *Possible student response: Sinkholes are common in Florida because we have a large amount of limestone under the soil and a large aquifer system.*
    d. In your model, you are using an Alka-Seltzer tablet. Over time, the tablet dissolved and broke down. What layer of rock does the Alka-Seltzer tablet represent?
        - *Possible student response: The Alka-Seltzer tablet represents the limestone layer.*
    e. What similarities are there between the sinkhole described in the reading and the one you created with your model?
        - *Possible student response: Answers will vary, but students may suggest the limestone layer, the amount of sand/water used, the type of topography, etc.*
4. Students will create a Claim/Evidence/Justification Poster explaining their reasoning behind the formation of sinkholes.

Claim: Answers the guiding question: "What factors contribute to sinkhole formation."	
Evidence: • Students place all data below (quantitative and qualitative) - this can be data from your table. • Create a graph of the amount of time it took for your sinkhole to occur. • Include mathematical connection such as max/min/mean when providing data. • Include any other observations including qualitative and quantitative data that you find important to explaining your claim.	**Justification**: • Is a well-written paragraph reflecting on the group's model, data and research? • All evidenced is tied to and supports student's "claim." • Must be in paragraph form. • Uses data from the evidence section to support the group's claim. • Must *use* key vocabulary terms including: ➢ erosion ➢ weathering ➢ sinkhole

Expand

1. There were 3 factors that were tested, and each group was only permitted to test one. These included the effect of amount of water on sinkhole formation, the depth of the limestone layer/amount of sand on sinkhole formation, and the acidification of ground water on sinkhole formation. The teacher will lead a class discussion of data on how these 3 interactions each could possibly cause a sinkhole to form.
    a. For the group that tested amount/pH/amount of sand of water, "Do your results support the idea of sinkhole formation?" (Propose this question 3 different ways, so each group can respond).
        - *Student responses will vary depending on variable tested and results.*
    b. Why do you believe we used sand in our model instead of topsoil? Would we use a different soil type if this model represented Nebraska?
        - *Florida's "soil" is mostly sand with very little topsoil. We would use a different type of soil if we modeled Nebraska because the composition of the soil in Nebraska is much different than that of Florida.*
    c. What factors were important to keep constant during your experimentation?
        - *The amount that the tablet was covered, the type of liquid (water), the type of tablet, the bowl size and shape, the person and method of timing should have all been kept constant.*
2. The students will analyze the USGS map of Florida, which indicates the amount and depth of the limestone layer and determine the area's susceptibility to the formation of sinkholes.
3. Class discussion of what Floridians should do if their area is prone to the formation of sinkholes.
4. The map is included on page 9 of this document, also here is a link to USGS Map of Florida http://publicfiles.dep.state.fl.us/FGS/FGS_Publications/MS/MS110SinkholeType/sinkholetype3.pdf
5. The USGS Map is quite large. You may want to display the map up on the overhead to drive discussion.

Questions to consider for class discussion:

1. On the USGS Map, which areas are most susceptible to sinkhole formation? Why might these areas be more prone to sinkholes?
    - *The blue and pink areas are most prone to sinkholes. These might be more prone to sinkholes because they have the most limestone or the limestone may be closest to the surface of the ground (not much topsoil).*
2. Find Sumter County on the Florida map. What would you expect to discover about the limestone layer if you were to dig deep into the Earth there?

- *I would expect to find that the limestone layer is buried very deep or is not as porous as the other limestone because this area does not have many sinkhole areas.*

3. If you were to build on an area that is prone to sinkhole formation, what precautions should the developer consider before beginning development of the land?
    - *The builder might want to consider the amount of sinkholes in the immediate area. They might want to use ultrasound technology to get a better picture of the rock layers below their build site. They might want to use lighter grade materials and spread the building out over the maximum surface area as not to put too much weight or pressure in one area.*
4. Create a definition for a sinkhole incorporating the terms weathering and erosion.
    - *A sinkhole is an area where extended chemical weathering has caused the layers of rock underground to erode, allowing for topsoil and rock to cave into the Earth.*
5. Do you believe the peninsula landform of Florida contributes to sinkhole formation? Discuss.
    - *Because Florida is a peninsula, it is surrounded by water. This typically makes for a much wetter climate resulting in large amounts of rain. The rainwater absorbs into the earth, speeding up the erosion and chemical weathering processes happening underground. Also, being surrounded by water means a higher water table which can contribute to greater erosion underground.*

Evaluate

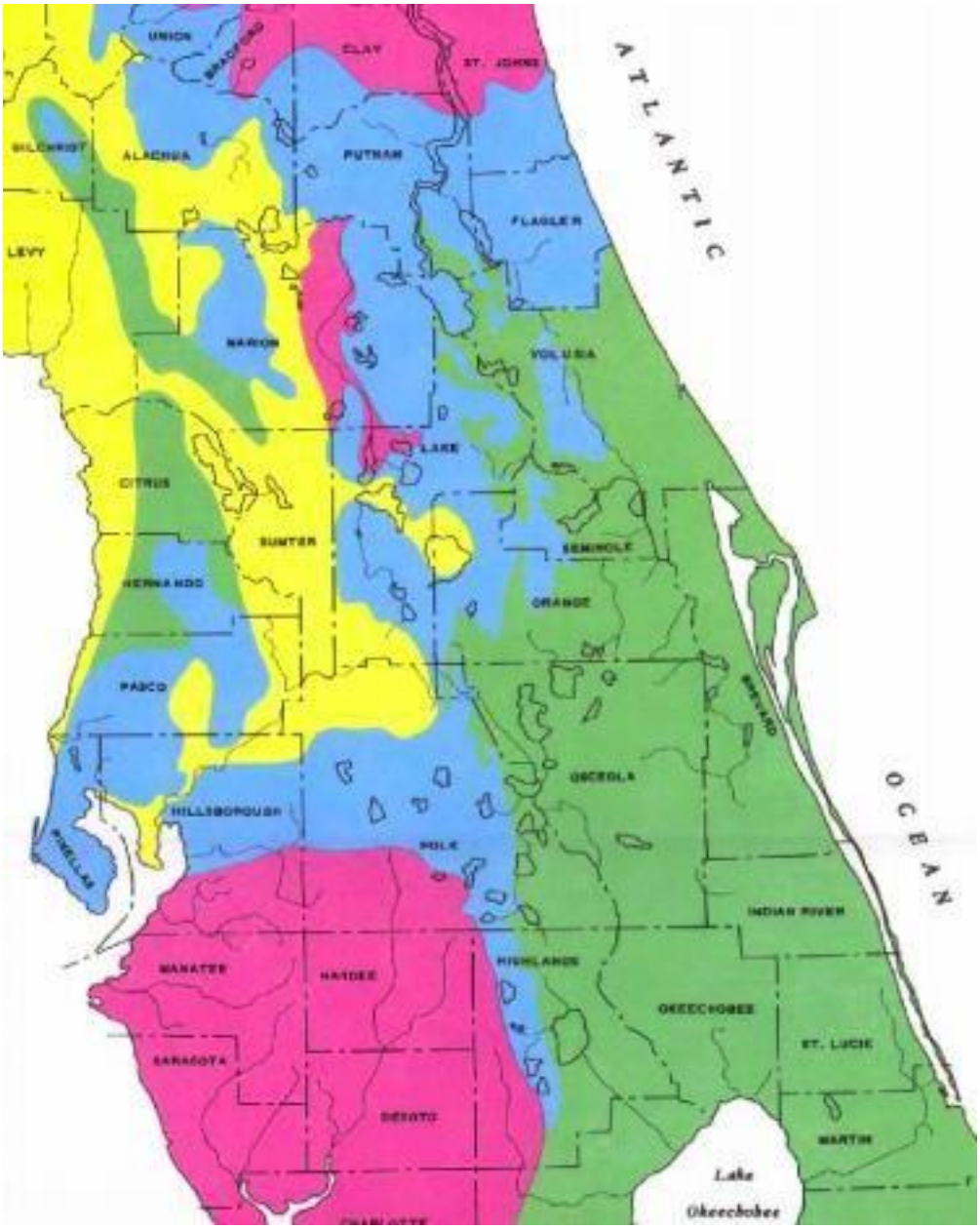
FORMAL EVALUTION: Students will present their CEJ (Claim/Evidence/Justification) Model and be evaluated based on the rubric on the next page. After all groups have presented and the class has reflected on the data the students will complete the Check for Understanding Exit Slip. This can easily be evaluated by teacher.

Blackline Master #2

Student Scoring Rubric

	Score of 1	Score of 2	Score of 3	Score of 4
Evidence / Data	*An attempt of including graphs and data, however there is data missing. Graphs/Data not easy to follow and are **missing 2 or more of the following**:* *___Label x and y axis* *___Use of appropriate units* *___Correct Title* *___Data table not properly labeled mat may have been used* *___Wrong graph type (bar/line)*	*An attempt of including graphs/data, however some data may be missing. Graphs are sloppy and may be **missing one of the following**:* *___Label x and y axis* *___Use of appropriate units* *___Correct Title* *___Data table not properly labeled*	*Student used graphs and data tables that are easy to follow.* *All graphs are properly labeled with NO errors including axis labeled with correct units, title and data headings on tables.* *All data is represented with **nothing missing.***	*Student used **multiple** data tables and graphs with properly labeled axes.* *Data is represented in **multiple ways**.* *Graphs all have a title, key and are very easy to follow.* *Student's graphs are mathematically competent.* *Data is analyzed mathematically (Slope, mean, max/min etc.) - this will vary based on math level.*
Science Concepts and Justification	*The student did not use all of the required vocabulary weathering, erosion and sinkholes in the report, however an attempt was made.* *Justification is poorly written and may not match the data.* *Claim is not supported by the data.* *Student did not make connections between the science content and lab.*	*Most of the vocabulary is used, but one word may be missing.* *The vocabulary may be explained at a definition level, and does not "flow" in the justification.* *Justification may not have fully supported the claim, or the student was missing key data points.* *An attempt was made at connecting the science process with the content.*	*The student used and incorporated all of the key vocabulary correctly into the justification including weathering, erosion and sinkholes.* *The justification fully supported the claim and defended the claim with the data the group collected.* *Student connected science process with data to support their claim.*	*The student used and incorporated all of the key vocabulary correctly into the justification including weathering, erosion and sinkholes.* *Use of words was not simply a definition, but provided a deeper understanding connecting the lab and content.* *Justification fully supported the claim.* *Student qualitatively + quantitatively analyzed all sources of data.* *Student provided **comprehensive reasoning** connecting the data, vocabulary and experimental process.*

USGS Map



Key:

Yellow: Fewest Sinkholes
Green: Sinkholes are generally few and far between and develop gradually. Typically small in size
Blue: Sinkholes most abundant. Develop randomly.
Pink: Sinkholes are few, but are very large when developed.

WRAP UP.

Bring the lesson to a conclusion by focusing on the data and conclusions reached by each group. Also give feedback to groups and allow groups to give feedback to one another.

Supplementary Resources

Teachers

Sinkholes Winter Park, Florida
http://www.thelivingmoon.com/45jack_files/03files/Endangered_Earth_Sinkhole_Florida.html

Students

McDougall-Littell, Exploring Earth: How Do Rocks Undergo Change? Interactive Rock Cycle Animation http://www.washington.edu/uwired/outreach/teched/projects/web/rockteam/WebSite/rockcycle.htm.htm *A visual simulation that shows the rock cycle in the context of a convergent plate boundary.*

CITATION OF SOURCES.

Background Information and images adapted from:

Endangered Earth Sinkholes Winter Park, Florida. (n.d.). Retrieved May 18, 2015, from http://www.thelivingmoon.com/45jack_files/03files/Endangered_Earth_Sinkhole_Florida.html

FGS - Sinkholes in Florida. (n.d.). Retrieved May 18, 2015, from http://www.dep.state.fl.us/geology/geologictopics/sinkhole.htm

(n.d.). Retrieved May 19, 2015, from http://publicfiles.dep.state.fl.us/FGS/FGS_Publications/MS/MS110SinkholeType/sinkholetype3.pdf

__✓__ Yes, I cited all materials and resources used in this lesson.

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Lesson author signature

Blackline Master #4

Name _____ **Date** _____ **Period** _____

Student Lab Sheet: An Investigative Look at Florida's Sinkholes

The Investigation: It is believed that the amount of rainfall, pH of groundwater and the depth of the limestone layer *could* lead to the formation of sinkholes. In this investigation, you will hypothesize which of these three have the greatest effect on the formation of sinkholes, carryout your experiment with a scientific model, and conclude using your collected data along with comparing it to your classmates' data.

List three interesting ideas/facts you know about sinkholes. This can be from the intro video or from your prior knowledge.

1. _____

2. _____

3. _____

Develop a Hypothesis

You may choose/be assigned one of the following things to investigate with your model:

a. If the amount of sand causes sinkholes to form faster.
   - If you choose thickness of soil, the only thing you may change is the amount of soil.

b. If the amount of water causes sinkholes to form faster.
   - If you chose amount of water, the only thing you may change is the amount of water.

c. If the pH (acidity) of the water causes sinkholes to form faster.
   - If you chose pH, the only thing you may change is the *simulated* pH of the water you are using.

Why do you believe letter ____ will cause the fastest formation of sinkholes?

_____

_____

The Science Process

In each of the experiments, we are going to measure the amount of time it takes for the Alka-Seltzer tablet to break down. (The Alka-Seltzer represents the limestone layer) You will know when the tablet has fully broken down due to the appearance of a sinkhole in the container.

In your experiment, what is your independent (test) variable? _____

In your experiment, what is your outcome (dependent) variable? _____

What must be held constant, or stay the same in each of your tests? _____

_____

Procedure:

1. Create your sinkhole model using the, "*How to Construct Your Sinkhole Model*" worksheet your teacher handed out.
2. Using your model, complete a control test using 100mL of water and 100g of sand.
   a. Measure 100 g of sand on a balance and place it over the Alka-Seltzer tablet. *Do not pound the sand down; gently flatten it out on the surface so it is smooth.*
   b. Measure 100 mL of water using a graduated cylinder.
   c. **Slowly and carefully** pour the 100 mL of water onto the sand. Try not to cause any erosion while dumping your water into your model.
3. Record the amount of time, in seconds, how long it takes until the sinkhole forms from the first second you pour the water into the container**. The timer should stop when you see the hole (Alka-Seltzer tablet) in the top of the Styrofoam bowl.**
4. Once the sinkhole has formed, throw away your model in the garbage, and create a new model for your next trial. With each trial, you are to have different levels of the independent variable. For example, if you are testing the amount of sand, try 50g and 200g.
5. Complete multiple trials, making a new model each time.

Quantitative Data Collected:

We are testing the effect of _____on the amount of time it takes for our sinkhole to form. *Remember to ONLY change your independent variable, while keeping others constant!*

Trial	Control	Trial 1	Trial 2	Trial 3
Amount of Water	100mL			
Amount of Sand	100 g			
pH of water	Normal			
Time for sinkhole to form				

6. Prepare to talk about your data: ***Answer the questions below after collecting all of your data***:

   a. Based on what you tested with your model, is there a pattern with either the amount of soil, amount of water or pH of the water used?

   b. What was the longest amount of time it took for the sinkhole to appear? Was there a reason for this?

   c. What was the shortest amount of time it took for the sinkhole to appear? Was there a reason for this?

Additional Information:

Sinkholes are a common feature of Florida's landscape. They are only one of many kinds of karst landforms, including caves, disappearing streams, springs, and underground drainage systems. A karst is a generic term which refers to a landform created by erosion associated with chemical weathering and the breakdown of limestone, which is one of the most common carbonate rocks in Florida. The breaking down of carbonate rocks begins when they are exposed to acidic water. Most rainwater is slightly acidic and usually becomes more acidic as it moves through decaying plant debris.

Limestone in Florida is porous, meaning it has a lot of tiny holes within it. This allows acidic water to enter through the rocks layers, dissolving some limestone and carrying it away in solution. Over long periods of time, this erosional process has created wide underground voids and drainage systems in much of the carbonate rocks throughout the state. The collapsing of covering sediments into the underground areas produces sinkholes.

When groundwater discharges from an underground drainage system, it is a spring, such as Wakulla Springs, Silver Springs, or Rainbow Springs. Sinkholes can occur in the beds of streams, sometimes taking all of the stream's flow, creating a disappearing stream. Dry caves are parts of karst drainage systems that are above the water table, such as Marianna Caverns located on the Florida Panhandle (right).

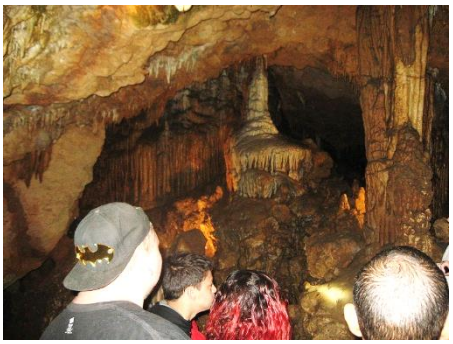

Photo Credit: https://commons.wikimedia.org/wiki/File%3ATourists_look_at_rock_formations_inside_the_caves_at_Florida_Caverns_State_Park.JPG

Use the above reading and your lab experience to answer the questions below:

1. What is a karst? How are karsts related to sinkholes?

2. What are some of the causes of sinkholes?

3. Why are sinkholes common in Florida?

4. In your model, you are using an Alka-Seltzer tablet. Over time, the tablet dissolved and broke down. What layer of rock does the Alka-Seltzer tablet represent?

5. What similarities are there between the sinkhole described in the reading and the one you created with your model?

Directions for Claim/Evidence/Justification Model of Lab Writing:

Below is an example of the claim, evidence, and justification model of lab writing. On a separate, large sheet of paper place your claim at the top of the sheet, answering the question, "What factors contribute to sinkhole formation?"

Your **claim** must be defended with **evidence** you collected during the lab. This can be any of the following:

- The amount of time it took for your sinkhole to form.
- The effect of your independent variable (depth, amount of water, pH etc.)
- Other group's information that tested a different independent variable.
- Evidence from the background information or video.
- Any other qualitative or quantitative data your feel is relevant.

Your **justification** is planned, structured writing that uses your evidence and supports your claim. You must show that you understand the science concept of sinkholes by correctly utilizing key vocabulary and explaining how your model demonstrates the concepts.

Your Poster Board:

<table>
<tr><td colspan="2">Guiding Question: "What factors contribute to sinkhole formation?"
Students Claim: Answer to the guiding question using what you learned from your model.</td></tr>
<tr><td>Evidence:
Students place all data below (quantitative and qualitative) - this can be data from your table.
Create a graph of the amount of time it took for your sinkhole to occur.
Include mathematical connection such as max/min/mean when providing data.
Include any other observations including qualitative and quantitative data that you find important to explaining your claim.
Information can be included from the reading.</td><td>Justification:
Is a well-written paragraph reflecting on the group's model, data and research?
All evidenced is tied to and supports students "claim."
Must be in paragraph form.
Uses data from the evidence section to support the group's claim.
Must use key vocabulary terms including
• erosion
• weathering
• sinkhole</td></tr>
</table>

Name _____ Date _____ Period _____

Checking for Understanding: An Investigative Look at Sinkholes

___ 1. At what point did your model demonstrate chemical weathering? (SC.6.E.6.1)

A. When the model was first constructed.
B. When the small bubbles appeared, causing the limestone layer to break down.
C. When all of the sand fell through the opening, causing a sinkhole to form.
D. When the water was poured into the sand, causing some of the sand particles to move.

___ 2. The model demonstrated erosion. (SC.6.E.6.1)
A. True B. False

Explain your answer.

___ 3. List all of the factors that can contribute to the formation of a sinkhole. (SC.6.E.6.2)

Name _____ Date _____ Period _____

Checking for Understanding: An Investigative Look at Sinkholes

___ 1. At what point did your model demonstrate chemical weathering? (SC.6.E.6.1)

A. When the model was first constructed.
B. When the small bubbles appeared, causing the limestone layer to break down.
C. When all of the sand fell through the opening, causing a sinkhole to form.
D. When the water was poured into the sand, causing some of the sand particles to move.

___ 2. The model demonstrated erosion. (SC.6.E.6.1)
A. True B. False

Explain your answer.

___ 3. List all of the factors that can contribute to the formation of a sinkhole. (SC.6.E.6.2)

ANSWER KEY: Checking for Understanding: An Investigative Look at Sinkholes

B 1. At what point did your model demonstrate chemical weathering? (SC.6.E.6.1)

A. When the model was first constructed
B. When the small bubbles appeared, causing the limestone layer to break down.
C. When all of the sand fell through the opening, causing a sinkhole to form.
D. When the water was poured into the sand, causing some of the sand particles to move.

A 2. The model demonstrated erosion (SC.6.E.6.1)
A. True B. False

Explain your answer.
When all of the sand fell through the hole created by the collapsing limestone layer, erosion occurred.

___ 3. List all of the factors that can contribute to the formation of a sinkhole. (SC.6.E.6.2)
Low levels of pH, a large storm dumping a lot of water on an area, and a limestone layer that is located closer to the surface.