Big Idea/ Topic
Landscape Change and Distribution

Standards Alignment

<table>
<thead>
<tr>
<th>SES3. Obtain, evaluate, and communicate information to explore the actions of water, wind, ice, and gravity as they relate to landscape change.</th>
</tr>
</thead>
<tbody>
<tr>
<td>c. Construct an explanation that relates the past and present actions of ice, wind, and water to landform distribution and landscape change.</td>
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</tbody>
</table>

Connection to other content areas:

<table>
<thead>
<tr>
<th>ELAGSE11-12R17 Integrate and evaluate multiple sources of information presented indifferent media or formats (e.g., visually, quantitatively) as well as in words in order to address a question or solve a problem.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELAGSE11-12R11 Cite strong and thorough textual evidence to support analysis of what the text says explicitly as well as inferences drawn from the text, including determining where the text leaves matters uncertain.</td>
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<tr>
<td>ELAGSE11-12W1 b. Develop claim(s) and counterclaims fairly and thoroughly, supplying the most relevant evidence for each while pointing out the strengths and limitations of both in a manner that anticipates the audience’s knowledge level, concerns, values, and possible biases.</td>
</tr>
<tr>
<td>ELAGSE11-12SL2 Integrate multiple sources of information presented in diverse formats and media (e.g., visually, quantitatively, orally) in order to make informed decisions and solve problems, evaluating the credibility and accuracy of each source and noting any discrepancies among the data.</td>
</tr>
</tbody>
</table>
Instructional Design

In this lesson students will obtain, evaluate, and communicate information about weathering and erosion. We will be following The 5E Model (Engage, Explore, Explain, Elaborate, Evaluate) for this lesson plan. A major aspect of The 5E Model is that students are allowed to develop their own understanding of a phenomenon through engagement and exploration before terms are presented. This allows students more opportunities to “discover” the concepts on their own to reach a deeper understanding and connection to the content.

In addition, our Georgia Standards of Excellence in Science have three dimensions, the disciplinary core ideas, science and engineering practices (SEPs), and crosscutting concepts (CCCs). More information about each SEP and CCC can be found in the following documents: Science and Engineering Practices for GSE Science and Crosscutting Concepts for GSE Science. The focus SEP for this lesson is Constructing Explanations and the focus CCC is Stability and Change. To support students with using the SEP and CCC, consider using graphic organizers for Constructing Scientific Explanations and Stability and Change. The organizers are found on thewonderofscience.com and can accessed there and edited.

Engage/Phenomenon: Every year, thousands of tourists visit the northeastern part of Georgia for the many scenic landforms and landscapes that occur in this part of the state, including many vistas and waterfalls. A map of Chattahoochee National Forest is included to give you an idea of the area of the state we are referring to. Also see the attached images of some of these vistas and waterfalls. Have you ever been to any one of these sites? Why are there so many vista and waterfall land formations in this part of the state?

Explore: Students can set up a simulation to explore the actions of water on landscape change. Possible answers to the questions on the Activity #1 sheet.

Once they have completed the simulation, students should investigate the following maps of Georgia: Physical Map of Southeast, and Geology of Georgia Digital Data. As they investigate these maps, have them research the different types of rocks found in each area of the state. During their research they should make note of the characteristics of each rock type. Websites listed below have great background information for this research.

Unplugged: The instructor can print copies of the information from the websites.

Plugged: For more background information on rock types and the geologic regions of Georgia, go to Georgia Encyclopedia

The Georgia Public Broadcasting (GPB) Georgia Digital textbook has great background information related to the topics in this lesson:

- Go to Georgia Studies
- Click on the “Launch” button and it will load Unit 1.
- Click on the Table of Contents icon (three dots and flat lines) in the upper left corner.
- Click on Chapter 2: The Physical Geography of Georgia.

Explain: In this section, we will introduce the concepts and the terms used to develop explanations for the phenomenon we have just observed. This is important to the 5E model that explanation follows experience. To continue with the lesson, students are assumed to already know the basics of weathering and erosion. To begin, a note sheet on “Stream Capture that made the Blue Ridge Scenery” has been provided with a key.

There are three figures (A, B, and C) that go with the note sheet to help visualize the proposed theory for the formation of Tallulah Gorge. Additional links are provided in the “Plugged” section for more background information.
Unplugged: The instructor can print a copy of the information from the websites housed below in the plugged section.

Plugged:

Influence of Structure

The following video is using an example of glacial melting changing a river’s path on a much shorter time scale; however, it is basically the same process that would happen with the erosion of rock on a much longer time scale.

- When a River Goes Missing, It's Kind of a Big Deal... (3:34 video)

Elaborate:

This is the part of the lesson where students should be able to apply what they have learned to new situations to gain a deeper understanding of the concepts. To achieve this goal, students will first focus on the CCC of “Stability and Change”. Have the students complete the attached graphic organizer for “Stability and Change” in relation to how the past and present actions of water have impacted landform distribution and landscape change.

The focus SEP of this standard is “construct an explanation”. See the Science and Engineering Practices for GSE Science for an explanation of this practice and the skills students should be able to perform. Focus on the yellow highlighted sections of the skills. A graphic organizer is also included to help students construct their explanation for this task.

A very important part of constructing scientific explanations includes making claims, supported by evidence, followed by reasoning or justification of how the evidence supports the claim. See the attached sheets for further explanation and a rubric.

Student task: Construct a written explanation of how the past and present actions of water relate to landform distribution and landscape change in northeast Georgia. Please review the attached rubric before writing to make sure you address all the bullet points that relate to constructing scientific explanations. Students use the rubric to do a self-evaluation and peer-evaluations in addition to the teacher’s evaluation of their explanation. Then students should revise their explanation based on their self-evaluation and the feedback that they received in the peer evaluation.

Evaluate:

Have students evaluate the following scenarios. Students should construct an explanation about how ice, wind or water would cause changes in the land for each scenario. The teacher should ask students to provide a justification of their explanation using information that they have gained throughout the lesson.

Once students have had the opportunity to evaluate the scenarios and construct various explanations then the class should discuss their explanations and reasoning. This allows students to see others’ ideas and gain new perspectives. Then students may want to revise their explanations to include new information.
Evidence of Student Success

Student mastery is assessed throughout this unit using formative and summative components. Student discussion, explanations and products should reflect the understanding indicated in the Evaluate section above. Each activity in the segment functions as an assessment opportunity as well to plan targeted support or provide extension items. Formative options using the self-evaluation checklist and the activities at various points during the segment.

Student Learning Supports

The vision for science education in the state of Georgia is as follows: All Students, over multiple years of school, actively engage in science and engineering practices and apply crosscutting concepts to deepen their understanding of the core ideas in these fields.

The learning experiences provided for students should engage them with fundamental questions about the world and with how scientists have investigated and found answers to those questions.

This lesson includes the disciplinary core ideas, science and engineering practices and crosscutting concepts to actively engage students in exploring science concepts with real world topics. As part of the vision we must support the inclusion of all students in science learning. Some general ideas to consider when designing things to support students that struggle are as follows:

- Be sure that students can access the information that you they are learning. Make sure that you can answer the following questions:
  - Do students have what they need to get the information? This is about them having the book or internet access to get to the information.
  - Once students obtain the information, are students able to determine what information is important? This is about the students having materials on the appropriate grade level and that is in a format that students can understand.
  - Is the material presented in multiple ways that allows all students to interact with information in a way that works for them? Such as video, audio, and articles.
  - Consider read aloud as a potential option for students that have reading deficits as an option to assist students in accessing the material. This could be done using video, read aloud or via phone.
- Students may need ideas about where to find information. Providing students with information about what a reliable source is and even where to find reliable sources may be beneficial for students.
- Some students may find it difficult to complete the entire lesson workload. Some students may benefit from a reduced workload (note: this should be used only when absolutely necessary). Be sure that the information that is removed will not negatively impact the student's understanding of the disciplinary core idea.
- Consider how students show their knowledge. Students need multiple ways and opportunities to show their knowledge. Things to consider:
  - Recording video or audio
  - Drawing
  - Writing
  - Typed
- Verbal
  - Provide students with a way to ask questions in a forum that does not cause anxiety. Frequently students do not want to ask questions in front of their peers because they are afraid of what their peers may think of them. So, be sure to provide students a way to ask questions that is private or anonymous.
  - Consider materials that students need to complete the assignments.
    - Do students have needed materials?
    - What are some alternative materials that students may have available to them?
  - Have a clear and consistent set of guidelines for providing consistent feedback to all students.
  - Utilize graphic organizers such as those from the Wonderofscience.com
  - Use high leverage and evidence-based practices to reach all students.

Some ideas for supporting this lesson specifically would be to make sure to consider the following:

- The teacher should consider providing students with questions in a format that they could refer back to as they work.
- The teacher should consider providing directions for the simulation in multiple formats to help students understand what they should be doing. These formats could include written directions, video directions or audio directions.
- The teacher should consider images and videos to help students get information about how different factors on earth effect landforms and landscape.
- The teacher should consider reviewing weathering and erosion.
- The teacher may want to consider asking students discussing examples of weathering and erosion.
- The teacher might want to discuss with students what causes changes to landforms as you work through the lesson.
- The teacher may want to discuss the simulation after completion. The discussion could focus on how the simulation shows the different ways that ice, water, and wind can impact landscapes and landforms.
- Ask students to discuss what stability is and talk though some examples of stability to help students understand what they are looking for in the lesson.
- The teacher should consider the format of any task and provide students with choices of multiple formats to show their knowledge. These formats could include written, audio recording or video recording.

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Engaging Families

Additional resources to support this segment can be found at GPB: Georgia Home Classroom
Chattahoochee National Forest in northeast Georgia

Source: https://www.fs.usda.gov/main/conf/maps-pubs
Images of vistas and waterfalls in northeast Georgia

Source for Images: Dr. Bill Witherspoon, georgiarocks.us

Black Rock Mountain State Park

Amicalola Falls

Tallulah Gorge
Attachment #3: Images of vistas and waterfalls in northeast Georgia (cont.)

Source for Images: Dr. Bill Witherspoon, georgiarocks.us

Images from left to right: Toccoa Falls, Tallulah Falls, Raven Cliffs

Images from left to right: Anna Ruby Falls, Amicalola Falls
Activity #1: Actions of Water on Landscape Change

Materials:
Flat-bottom plastic containers of various sizes and shapes
Play sand and/or soil from the yard (optional)
Modeling clay or modeling dough
Water

Procedure:
1. Select two or three flat-bottom plastic containers that can hold water and be placed in a freezer.
2. In each empty container, take the modeling clay or playdough and make thin layer (1/4 inch thick) to cover the entire bottom of the container.
3. On top of the bottom layer, construct a few “landforms” with additional clay or dough. These might include mountains, rivers, islands, canyons, etc. These landforms should not exceed the height of your container.
4. At this point, you can add a layer of sand/soil to your plastic containers with landforms. You can decide how much to add and where to completely or partially cover your landforms.
5. Now add enough water to fill the plastic containers to the top. The landforms and sand/soil should be completely submerged. You can add some food coloring to the water at this point to make the melting water more visible later.
6. Place the container(s) in a freezer overnight or long enough for the water to completely freeze.
7. Once the water has completely frozen, carefully remove the frozen contents from the plastic containers and place them on a large, flat surface with the clay/dough layer on the bottom.
8. Carefully observe the frozen contents as they melt. This could take a few hours so decide to make your observations every 30-60 minutes until they completely melt if possible.
9. During your observations of the melting process, try to take pictures along the way to generate a time-lapse image.

Questions:
1. How did the water change your “landforms” as it was melting?
2. In this simulation, what do the water, clay/dough, melting time, and sand (if used) represent?
3. How does this simulation model the past and present actions of water to landform distribution and landscape change?
4. How would you change the simulation to better represent landscape change?
Physical Map of Southeast

Image source: www.arcgis.com
Geology of Georgia

Source: https://commons.wikimedia.org/wiki/File:Geologic_Map_of_Georgia.png
Note sheet: Stream Capture That Made the Blue Ridge Scenery

VISTAS:
1. 
2. 
3. 

WATERFALLS:
1. 
2. 
3. 
4. 
5. 

_______________________________: A narrow zone, sometimes a cliff, that is several miles long and separates two areas of different elevation. 
________________________ vs. ________________rock types drive land features in much of Georgia, but Blue Ridge & Piedmont rocks are all ________________and pattern is more complex.

_______________________________: The event in which a stream, usually through headward erosion, cuts into the valley of another stream, causing the upper part of the other stream to become its tributary.

Tallulah Gorge: how can gradual erosion produce dramatic scenery?

- ______________deepest canyon east of the Rockies
- __________feet deep, __________feet wide = steepest
- Tightrope walks in 1886 and 1970
- Resistant _______________ ledges
- _____________waterfalls
Why so steep? Recent?

The _____________ and _____________ River waters may once have flowed to the Gulf of Mexico (see Figure A).

The _____________River, at lower elevation, broke through a dividing ridge and captured the two rivers (see Figure B).

______________ streams erode landscapes faster

Steepness can depend on the _________________ to the ocean (see Figure C).

Conclusions:

• The best scenery = _____________

• Blue Ridge escarpment is _________________ one _________________ at a time.

• The formation of Tallulah Gorge is ______ example of this process in _____________ Georgia.

• The presence of vistas and waterfalls are examples of how _________ and _________ actions of water relate to _________________distribution and _____________ change in northeast Georgia.
KEY to Note sheet: Stream Capture That Made the Blue Ridge Scenery

VISTAS:

1. Black Rock Mountain
2. Amicalola Falls
3. Tallulah Gorge

WATERFALLS:

1. Amicalola
2. Anna Ruby
3. Raven Cliffs
4. Tallulah
5. Toccoa

(Escarpment): A narrow zone, sometimes a cliff, that is several miles long and separates two areas of different elevation.

(Strong) vs. (weak) rock types drive land features in much of Georgia, but Blue Ridge & Piedmont rocks are all (strong) and the pattern is more complex.

(Stream capture): The event in which a stream, usually through headward erosion, cuts into the valley of another stream, causing the upper part of the other stream to become its tributary.

Tallulah Gorge: how can gradual erosion produce dramatic scenery?

- (Fourth) deepest canyon east of the Rockies
- (600) feet deep, (1000) feet wide = steepest
- Tightrope walks in 1886 and 1970
- Resistant (quartzite) ledges
- (Five) waterfalls
- Why so steep? Recent?
The **Chattooga** and **Tallulah** River waters may once have flowed to the Gulf of Mexico (see Figure A).

The **Tugaloo** River, at lower elevation, broke through a dividing ridge and captured the two rivers (see Figure B).

- **(Steeper)** streams erode landscapes faster
- Steepness can depend on the **(distance)** to the ocean (see Figure C).

**Conclusions:**

- The best scenery = **(snapshot in time)**

- Blue Ridge escarpment is **(retreating)** one **(stream capture)** at a time.

- The formation of Tallulah Gorge is **(one)** example of this process in **(northeast)** Georgia.

- The presence of vistas and waterfalls are examples of how **(past)** and **(present)** actions of water relate to **(landform)** distribution and **(landscape)** change in northeast Georgia.
Figures A & B for Theorized Stream Capture by Tugaloo River

Figure A: The Chattooga and Tallulah River waters may once have flowed to the Gulf of Mexico, but headward erosion (black arrow) by the Tugaloo River changed everything.

Figure B: The Tugaloo River, at lower elevation, broke through a dividing ridge and captured both the Tallulah and Chattooga Rivers. As a result, the Tallulah Gorge was formed.
Figure C. This figure shows the shortest path from Tallulah Gorge to the ocean is via the Tugaloo River.
Graphic Organizer for Constructing Explanations

1. Brainstorm Possible Causes
2. Identify a scientific Cause
3. Describe a causal Mechanism
4. Formulate a Research Question

Effect

Converting

Mechanism

Georgia Department of Education
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Criteria for Constructing a Written Scientific Explanation
Adapted from a Framework for Scientific Explanation (McNeill & Krajcik, 2012) as presented at NSTA 2011

The explanation consists of: a claim, evidence and reasoning.

Claim:

- is written as the answer or conclusion to a specific question or problem

Evidence includes:

- scientific data from the investigation or other sources (e.g., observation, reading, archive data or other sources) to support the claim.
- data that is appropriate (scientifically relevant)
- data that is sufficient (multiple pieces) to support the claim.

Reasoning statements:

- provide logical connections between the claim and evidence.
- include scientific concepts, principles, theories and/or laws.
- include justification as to why the evidence (data) supports the claim

Claims-Evidence-Reasoning Transitional Words

<table>
<thead>
<tr>
<th>Making a Claim</th>
<th>Providing Evidence</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>A statement that answers the original question/problem.</td>
<td>The evidence I use to support _____ is _______.</td>
<td>A justification that connects the evidence to the claim. It shows why the data count as evidence using appropriate and sufficient scientific/mathematical principles.</td>
</tr>
<tr>
<td>I observed ______ when ______.</td>
<td>I believe ______ because ______.</td>
<td>As can be seen by ______, my conclusion is ______.</td>
</tr>
<tr>
<td>I noticed ______ when ______.</td>
<td>I know that ______ is ______ because ______.</td>
<td>Since ______ that means ______.</td>
</tr>
<tr>
<td>The effect of ______ on ______ is ______.</td>
<td>An example of ______ is ______.</td>
<td>In summary, ______ shows that ______.</td>
</tr>
<tr>
<td>I agree/disagree with ______.</td>
<td>For instance, ______ shows ______.</td>
<td>In conclusion, ______ displays ______.</td>
</tr>
<tr>
<td>is true/false when ______.</td>
<td>______ will sometimes/never/always be ______.</td>
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Source for table: https://www.saddlespace.org/musick/stupendousscience/cms_page/view/31992944
## Sample Rubric to Evaluate Scientific Explanation

### Base or Generic Rubric

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>Claim</th>
<th>Evidence</th>
<th>Reasoning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varies from 1 to 5</td>
<td>A statement or conclusion that answers the original question/problem.</td>
<td>Scientific data that supports the claim. The data needs to be appropriate and sufficient to support the claim</td>
<td>A justification that connects the evidence to the claim. It shows why the data counts as evidence by using appropriate and sufficient scientific principles.</td>
</tr>
<tr>
<td>0</td>
<td>Does not make a claim or makes an inaccurate claim.</td>
<td>Does not provide evidence, or only provides inappropriate evidence (Evidence that does not support claim).</td>
<td>Does not provide reasoning, or only provides inappropriate reasoning.</td>
</tr>
<tr>
<td></td>
<td>Makes an accurate but incomplete claim.</td>
<td>Provides appropriate, but insufficient evidence to support claim. May include some inappropriate evidence.</td>
<td>Provides reasoning that connects the evidence to the claim. May include some scientific principles or justifications for why the evidence supports the claim, but not sufficient.</td>
</tr>
<tr>
<td></td>
<td>Makes an accurate and complete claim.</td>
<td>Provides appropriate and sufficient evidence to support claim.</td>
<td>Provides reasoning that connects the evidence to the claim. Includes appropriate and sufficient scientific principles to explain why the evidence supports the claim.</td>
</tr>
</tbody>
</table>

This base or generic rubric (McNeill & Krajcik, 2012) is then adapted to a specific question and the number of levels depends on the question.

### FRAMEWORK FOR SCIENTIFIC EXPLANATION

McNeill & Krajcik

Presented at NSTA 2011
Scenarios

**Directions:** Evaluate the following scenarios. Answer any questions contained in the scenario and then construct an explanation of what is occurring to the landforms and landscape around the around the scenario.

1.) In Greenland glaciers are melting. The glaciers begin melting where they sit on the land. What happens to the land below the glacier, the glacier itself and the land around the glacier?

2.) Jekyll island is a barrier island off the coast of Georgia. Jekyll island is in a state of change due to the constant moving of the ocean on the coast. At the north end of the island the ocean is hitting the coast and causing sand to be washed away. The sand then follows the current in the ocean. Where does the sand go? What is the process here? What is happening to the island?

3.) Sand dunes form around beaches. What causes sand dunes? What moves sand dunes? How does the formation of sand dunes impact beaches?

4.) In areas where construction projects are taking place there is a lot of black silt fencing. What is the purpose of silt fencing? Why is the silt fencing important? What happens to the areas around the silt fencing?

**Answer Key**

1.) Students should mention that the melting water acted differently on the various materials. The frozen water mixed with sand/soil will melt faster than the pure water. Of course, the clay/dough do not change as a result of the melting water.

2.) The melting water represents the erosion of landscapes that are composed of a variety of materials that erode at different rates. The sand/soil, clay/dough, and pure water (with no sand/soil) represent these different materials. Some of them erode faster than others. The melting time represents the slow process of most landscape changes.

3.) This simulation shows how the actions of water (melting ice), erodes and changes the landscape at different rates depending on the type of material (sand/soil, clay/dough). Some of the materials erode much faster than others and this creates unique landform distributions.

4.) Answers will vary.