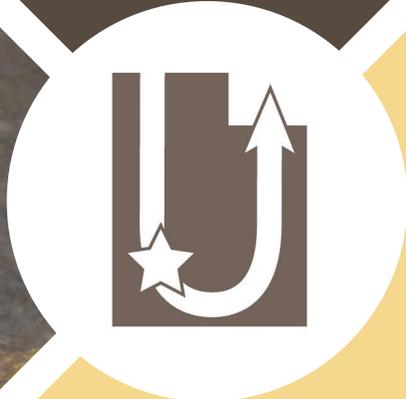


EXPLAINING THE UNEVEN DISTRIBUTION OF THE EARTH'S **NATURAL RESOURCES**



TEACHERS HANDOUT

Utah SEEd Standard 8.4.1
Next Generation Science Standard: MS-ESS3-1
Grade and Topic: 6th-grade Integrated Science
Middle School Physical Science



Explaining the Uneven Distribution of the Earth's Natural Resources

Curriculum developed as a collaboration between the Utah FORGE project and the University of Utah College of Education, supported by the Department of Energy. This curriculum is aligned with national NGSS standards as well as the Utah SEEd standards. The curriculum provides support for diverse learners in diverse environments.

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Overview

Most of the resources that humans depend on come from the Earth. We depend on metal and mineral resources. We depend on clean water. We depend on energy resources. We depend on a variety of plants and animals who also need resources. However, these resources are not evenly distributed. The geological processes that shape the Earth are responsible for the way the resources are distributed. An example of this uneven distribution of resources as a result of geological processes can be seen in the site location for the Utah FORGE enhanced geothermal energy project. The site is located in Beaver County, Utah, near Milford; the geothermal resources here are a result of the geological processes that formed the basin and range topology of the area.

In this lesson, students working in small groups of 3-5, will explore the distribution of geological and geothermal resources in Utah, and learn about the geologic processes that shaped these areas. The students will use this as evidence to develop explanations of how these resources came to be unevenly distributed.

Grade and Topic:

8th-grade Integrated Science

Middle School Earth Science

Standards:

This lesson aligns with the following state and national standards

Utah SEEd Standard 8.4.1 -- Construct a scientific explanation based on evidence that shows that the uneven distribution of Earth's mineral, energy, and groundwater resources is caused by geological processes. Examples of uneven distribution of resources could include Utah's unique geologic history that led to the formation and irregular distribution of natural resources like copper, gold, natural gas, oil shale, silver, or uranium. (ESS3.A)

Next Generation Science Standard: MS-ESS3-1. -- Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes. [Clarification Statement: Emphasis is on how these resources are limited and typically non-renewable, and how their distributions are significantly changing as a result of removal by humans. Examples of uneven distributions of resources as a result of past processes include but are not limited to petroleum (locations of the burial of organic marine sediments and subsequent geologic traps), metal ores (locations of past volcanic and hydrothermal activity associated with subduction zones), and soil (locations of active weathering and/or deposition of rock).]

Overall Objectives for Student Learning:

- Students will explore and interpret data regarding the locations of geological resources in Utah.
- Students will investigate the differences between the three geological regions of the State: Basin and Range, Rocky Mountains, and Colorado Plateau, and how these regions formed.
- Students will use evidence from their explorations and investigations to construct an explanation of the geological processes that resulted in the uneven distribution of resources.
- Students will present their results and explanations to the class.

Prior Knowledge:

This lesson would fit in a unit on geological processes or in a unit on human interactions with natural resources. It is assumed that the students are familiar with the structure of the Earth and plate tectonics. In addition to explaining crustal movements, plate tectonics provides insight into how and where earthquakes and volcanoes occur and how and where different types of rocks form.

Timeline:

This should take approximately three 90-min block class periods or six 45-min class periods.

Materials:

See each section for the relevant material list

Support for Students with Disabilities

Students with Disabilities and at-risk learners benefit from specifically designed instruction that gives meaningful access to the general education curriculum (Individuals with Disabilities Education Act (IDEA), 2004). To ensure access to the core curriculum, evidence-based practices, including instructional scaffolding (Kim et al., 2018; Larkin, 2002) and explicit instruction (Archer & Hughes, 2010; Hughes et al., 2017), should be considered when developing lessons to meet individual student's learning needs. This document includes suggestions for teachers to individualize instruction when planning and implementing this lesson plan within each relevant section.

Preparation:

Before beginning

- Read the entire lesson sequence.
- Print out readings, maps and student handouts. Some of the pages are intended to be used throughout the lesson. It is recommended to laminate these pages.

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- Decide what modifications to make, if any.
- Decide how to organize small class groups (students select their own groups, the teacher assigns groups, the teacher assigns groups with input from students, etc.).
- Decide the format of the presentations for the Elaborate and Evaluate sections.

Day 1

- Prepare slides for the Engage teacher presentation with the anchoring phenomenon and vocabulary words for class discussion.
- Prepare materials for the anchoring phenomenon.
 - Consider providing the link to the GeoSights page to the students either by book-marking, through e-mail, or via a shared google docs or similar.
- Prepare instructions and materials for the Explore stations, set up stations.
 - Consider providing the link to the Utah Mineral Resources and Rock and Mineral Collecting page to the students either by book-marking, through e-mail, or via a shared google docs or similar.
- Prepare student handouts for the Engage and Explore sections.

Day 2

- Set up Explore stations.
- Prepare slides for the Explain teacher presentation and class discussion.
- Prepare instructions and materials for the Explain stations, set up stations.
- Prepare student handouts for the Explain section.
 - Consider providing the link to the readings and video pages to the students either by book-marking, through e-mail, or via a shared google docs or similar.

Day 3

- Set up Explain stations.
- Prepare instructions for creating posters/presentations.
- Prepare materials for creating posters/presentations, whether as physical posters or as electronic presentations for the Elaborate section.

Day 4

- Upload student presentations.
- Prepare slides with students' expectations for being a good presenter and for being an active listener.
- Prepare slides with appropriate student responses.

Engage: Where are the Resources? (30-40 min)

Student Objectives:

Students will use an interactive map to explore places in Utah with interesting geology.

Students will connect to relevant background knowledge and define essential vocabulary.

Overview:

This part of the lesson is intended to motivate students to seek the answer to the question, Where are the geological resources located in Utah? They will explore an interactive map of interesting geological sites in Utah.

Materials Needed:

Introduction:

Computer with internet access

Projector

Map of Utah, for example:

<https://atlas.utah.gov/>

GeoSights Exploration:

Computers with internet access

GeoSights map

<https://geology.utah.gov/apps/geosights/index.htm>

Student Handout – GeoSights Exploration

Introduction (10 min)

To motivate this exploration, the teacher will explain to the students that they have been asked to help create an augmented reality game where the players need to find resources. The game would be something like a cross between Pokemon Go!, Minecraft, and geocaching. The game designers want the locations of the augmented reality caches to be located at some of the sites in Utah with interesting geology. The students will explore the Utah GeoSights page to find possible sites to locate the augmented reality resources.

Suggested Teacher Script

[Teachers should modify the following story as relevant to their lives and classrooms.]

Our class has been asked to help build a video game. This game will be what they call an augmented reality game. Has anyone ever heard that term? [check for nods, or blank looks] In an augmented reality game you actually go outside, with your electronic device, and look for things. It's a bit like a treasure hunt (or geocaching) but you are finding virtual objects instead of real objects. Raise your hand if you have ever played Pokemon Go!? Or seen people playing Pokemon Go!? This is an example of an augmented reality game.

Okay, so in this game, the players will need to find resources to build other things that they need. Raise your hand if you have played a game where you need to find resources in order to make other stuff. Can you give me an example of a game like that?

[Call on students to share examples. Minecraft is the obvious one, you mine things in order to craft other things. Many games require the players to find resources: Subnautica, Don't Starve, Starview Valley, Slime Rancher, etc.]

Our class is going to help the developers figure out where to place the resources for the game. Since this is an augmented reality game, they want the resources in the game to be located in places where these resources actually exist.

[Display a map of Utah on the projector. A suggested map is located at <https://atlas.utah.gov/>]

Okay, here is the world map for our game. It looks like it's gonna be a pretty amazing world. It has stuff like mountains and lakes and deserts and red rocks and salt flats. It will be pretty cool to explore this world looking for the resources we need in the game.

This world has 3 distinct geological regions, Basin and Range [outline this region on the map] Rocky Mountains [outline this region], and Colorado Plateau [outline this region]. There is also a transitional region between the Basin and Range and the Colorado Plateau [outline this strip]. From this, where do we live? [accept answers] Perfect! Yes we live in _____ region. Has anyone vacationed in _____ region? What about _____ region? [Ask students to share their observations about the regions.]

To begin, we are going to "visit" some of the possible locations the developers are considering as caches to locate the virtual resources. If the game developers are going to place virtual resources for players to find, they should be in places that are interesting to visit. Also, you may have visited some of these sites yourself, or seen similar landscapes. As we do this, think about the types of landscapes you've seen in these various regions.

Key Terms:

Geological resources – Resources that can be extracted from the Earth's crust. There are three main types of geological resources:

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Energy resources such as oil, coal, and uranium,

Metal resources such as iron, copper, and gold,

Non-metal resources such as gems, limestone, and sand.

Geothermal resources – Heat from the earth that can be used for direct heating or to generate electricity.

Base metals – metals mined as commodities, such as iron, copper, and lead

Energy mineral – minerals mined for energy use, such as uranium and vanadium

Precious metal – metals with high economic value, such as gold and silver

Basin and Range – A geological province in the inland west and southwest portion of the United States and Mexico. This region is characterized by parallel mountain ranges and valleys.

Rocky Mountains – A geological province in the inland west and northwest part of the United States and Canada. This region is broken into 4 provinces based on landscape. Utah is part of the Middle Rocky Mountains, which is characterized by folded mountains.

Colorado Plateau – A geological province in the 4-corners area of the United States. This region is characterized by ancient volcanic mountains, plateaus and buttes, and deeply carved canyons.

GeoSights Exploration (15-20 min)

For this part of the lesson, students will explore the interactive GeoSights map located at <https://geology.utah.gov/apps/geosights/index.htm>. The students can do this individually or in pairs.

The students will explore various locations on the interactive map, and write down locations they think would be good resource cache sites for the augmented video game they are helping develop. As the students explore the interactive map, the teacher will walk around the class, checking on the students' progress, highlighting important information, and asking probing questions.

Integration (5-10 minutes)

After the students have completed their explorations, the teacher should lead a full class discussion on the GeoSights exploration. The teacher should ask students to share information about the sites they visited, reminding them that they are looking for cache sites for the resources they are going to locate. This should allow the teacher to transition to exploring geological and geothermal resources.

Suggestions for Specifically Designed Instruction In Engaging Students in the Lesson

- A. Post expectations and directions in a form that is visual, explicit, and easy to access throughout the lesson.
- B. Explicitly Teach Content Vocabulary (Kennedy et al., 2017).

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- a. Teach and practice vocabulary included in the lesson plan that is included in key terms.
 - b. Teach no more than 3-5 per lesson.
 - c. Key terms and definitions that have been previously taught in previous lessons should be visibly accessible to students.
- C. Post and display instruction for expectations for student response.
-

Transitioning (10 min)

Student Expectations:

After exploring the GeoSights map, the students will transition to exploring the distribution of resources for 3 types of geological and geothermal resources: energy resources (uranium, geothermal, coal hydrocarbons), metal resources, both base metals (iron, copper, lead, zinc) and precious metals (gold, silver), and gem/other unusual resources (topaz, sunstone, fossils, wonderstone).

At each station, they will be asked to explore one or more maps with the locations of the resources. They will be asked to identify where on the map the resources are located and answer questions about the distribution of these resources.

Rotating Roles:

At each station, there are several tasks for the students to complete: reading the background information, having a discussion on the locations of the resources, recording notes for the discussion, and answering questions about the readings and maps.

Roles are assigned at each station such that the leadership is shared amongst the group members. Teachers should assign the rotating roles of Group Leader and Discussion Leader (see below for the job descriptions). Students are encouraged to volunteer for the roles of reader and scribe.

Depending on the classroom and learner needs, the teacher can assign these roles to students in the group or instruct students to choose these roles themselves. When assigning roles or instructing students to choose roles, this should be done such that they rotate roles between stations. Each student should have the opportunity to be the group leader and discussion leader. The roles of reader and scribe do not need to rotate through all group members (some students might like writing notes or reading to the group, others might not, but the teacher should make sure that one student is not dominating the group.) The teacher should decide if the students will submit the questions as a group or individually.

Example of how to assign rotating roles: On a slide, list the names of the students in each group. Label the students in each group A, B, C, and D. At station 1, Student A will be the group leader and Student B will be the discussion leader. At station 2, Student A will rotate to a group member, Student B will rotate to the group leader, and Student C will become the discussion leader. At station 3,

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Student B will rotate to a group member, Student C will rotate to the group leader, and Student D will become the discussion leader.

Talk Moves: Contributing to a group discussion can be intimidating for many types of learners. Sentence stems are one way to help students formulate their ideas. Included in the student instructions are some sentence stems, labeled “talk moves” to help students with facilitating and contributing to the group discussions.

Suggested Teacher Script

So, the next thing we need to do is to figure out where our resources are located. We have been asked to look for geological and geothermal resources. We are going to be looking for energy resources, so stuff like oil and gas, but also coal, uranium, and geothermal. We are going to be looking for different metals, both regular metals like iron and copper, and also precious metals like gold and silver. We are also going to be looking for gems and other cool rocks.

We will be spending the next couple of class periods working on this exploration in small groups. At each station, you will be asked to read some information and explore maps of how these resources are distributed in Utah. You will be asked to discuss things in your group.

Because talking in groups can sometimes be intimidating, you will be provided with some talk moves to help you figure out how to say what you want to say. When you are having group discussions, everyone needs to contribute, and when you are not talking, you need to be active listeners. The talk moves can help you both with contributing and with active listening.

There are several roles for the group members, the roles will rotate as you go through the stations. We will discuss how to know which role you have at which station.

Group Leader: Your task is to make sure that your group stays on task. Keep track of the time spent on each item, and make sure that your group is progressing. You also need to help choose the roles of reader and scribe. These are volunteer positions, but you need to make sure that everyone who wants to read gets to read, and that everyone who wants to be the scribe gets the opportunity. If necessary, the group leader or discussion leader could be the reader. It is better if the scribe is a group member.

Discussion Leader: Your task is to lead the discussion. Use the talk moves to make sure that each of the members in your group is able to contribute to the discussion and have their voice heard. If necessary, you could also volunteer to be the reader. You cannot be the scribe and also lead the discussion.

Group Member: Your task is to contribute to the discussion. Use the talk moves to express your ideas and check your understanding of your group members' ideas.

- **Reader:** If you are assigned the role of group member, you can also choose to be the reader. The reader will read the background information to the full group. This is a volunteer position. When volunteering, make sure that everyone who wants to read has the chance to read.

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- **Scribe:** The scribe is also a volunteer position. The scribe's job is to take notes on the group discussions. Your teacher will let you know if you need to submit your notes, or if you just need to keep them as references. As with the reader, when volunteering for this position, make sure that everyone who wants to be the scribe gets the chance. You might also be asked to write the group answers for the questions if your teacher tells you to submit one set of answers for each group.

[Give instructions on forming groups and rotating leadership roles. Also, instruct students on what they need to submit for this assignment (as a group or individually).]

Once students have formed their groups and understand the expectations, they will begin the explorations.

Suggestions for Specifically Designed Instruction in Transition

- A. Explicitly teach and post directions and expectations in a format that is easily accessible for students to access throughout the lesson.
 - a. Small-Group Learning Objective at stations
 - i. Explore 3 different types of geological/geothermal resources
 - ii. Determine that these resources are not evenly distributed across Utah
 - b. Directions for Group Station Activity
 - i. Read background information
 - ii. Explore a map with the resources
 - iii. Discuss how the resources are distributed
- B. Teach and practice the expectations when working in a group with designated roles.
 - a. Explicitly Teach the Roles in the Group
 - b. Explain and direct procedures in changing roles
 - c. Consider assigning Students with Disabilities a consistent role throughout the rotations.
- C. Suggestions for ensuring smooth transitions and procedures while working in small groups
 - a. Explain and allow students to practice talk moves before working within their group.
 - b. Describe and allow students to practice the actions of active listening before working in groups.
 - c. Post and be explicit with time. Use a timer and give a 5-minute warning. Explain procedures if students finish the task early or do not complete the tasks at each station.
 - d. Be clear and consistent on the format of note-taking, how work should be turned in, and expectations for mastery.

Explore: Distribution of Natural Resources in Utah (75-90 min)

Student Objectives:

Students will explore the location of energy, metal, and gem/unusual rock resources in Utah.

Students will observe that the resources are not evenly distributed.

Students will find patterns in the distribution of the resources in Utah.

Overview:

In this part of the lesson students working in small groups of 3-5 will explore interactive maps of the distribution of resources across Utah. The focus is on observing that geological resources are not evenly distributed. This will lead to a wonderment: Why are they unevenly distributed?

The students will explore 3 different stations to determine how different geological resources are distributed in Utah. Students should spend approximately 25-30 minutes at each station. For a block schedule, students will be able to explore 1 station on the first day. For a traditional schedule, students may not be able to explore stations until the second day.

The teacher should set up the stations in advance. While the students are following the instructions at each station, the teacher will walk around the class, dropping into the various discussions, highlighting productive ideas, and asking probing questions. The teacher should signal the time to finish the current activity and transition to the next.

Suggestions for Specifically Designed Instruction In Small Groups

- A. Allow students to see the questions to be answered before starting the station.
- B. Give the Students with Disabilities the reading prior to the activity.
- C. Highlight the main ideas and essential information in the text before the station activity.
- D. Provide graphic or advanced organizers to scaffold student learning and classify information.
- E. Provide an advanced organizer using a cloze procedure to note important information and main ideas.
- F. Reduce cognitive demand by assigning students to gather specific information rather than all information simultaneously.
- G. Follow all accommodations and modifications listed on the IEP.

Station 1: Energy Resources (25-30 min)

At this station, the students will view 5 maps that show the location of geothermal, hydrocarbon, and uranium resources. Each map includes information about the distribution of these resources. The

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students will read the map, make observations about the location of resources on the map, and look for patterns.

Materials Needed:

Laminated pages – Distribution of Natural Resources in Utah–Group roles, Distribution of Natural Resources in Utah–Talk Moves, Station 1: Energy Resources directions, Utah Energy Landscapes Maps: Geothermal, Coal, Crude Oil and Petroleum Products, Natural Gas, and Uranium

Student handouts – Station 1: Energy Resources

Instructions:

In each group, one student volunteer will read the printed information aloud to the rest of the group. There will be 3 stations, and readings at each station. Make sure that everyone who wants to read gets the opportunity to read.

Next, the students should spend ~5 min examining the maps without talking. While doing this, they are encouraged to think about these questions: What are the maps showing? How do you read the maps? Is there anything about the maps you do not understand? What patterns do you see? What information do you think is important or interesting? They may also want to write notes about their thinking.

Next, they will take 5-10 minutes to discuss the things they noticed about the maps. One student should volunteer as scribe to record key ideas from the discussion. Just like with the readings, make sure that everyone who wants to be the scribe gets the opportunity to do so.

Finally, individually or as a group, they will answer some questions about how these resources are distributed in Utah, and draw the major locations of the resources on the map provided.

Specific details can be found in the student handouts for Station 1.

Station 2: Metal Resources (25-30 min)

At this station, the students will use both printed and online interactive maps to determine the locations of both base and precious metals in Utah. The students will make observations about the location of resources on the map, and look for patterns.

Materials Needed:

Computer with internet access

https://geology.utah.gov/apps/blm_mineral/

Laminated pages – Distribution of Natural Resources in Utah–Group roles, Distribution of Natural Resources in Utah–Talk Moves, Station 2: Metal Resources directions, Utah Mining Districts Map, Utah Mining Districts Introduction

Student handouts – Station 2: Metal Resources

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Instructions:

In each group, one student volunteer will read the printed information aloud to the rest of the group. There will be 3 stations, and readings at each station. Make sure that everyone who wants to read gets the opportunity to read.

Next, the students should spend ~5 min examining the maps without talking. While doing this, they are encouraged to think about these questions: What are the maps showing? How do you read the maps? Is there anything about the maps you do not understand? What patterns do you see? What information do you think is important or interesting? They may also want to write notes about their thinking.

They will also have the opportunity to explore the interactive map located at https://geology.utah.gov/apps/blm_mineral/. Here they can find out more in-depth information about each of the mining districts on the printed map. They should spend 5-10 minutes on this.

Next, they will take 5-10 minutes to discuss the things they noticed about the maps. One student should volunteer as scribe to record key ideas from the discussion. Just like with the readings, make sure that everyone who wants to be the scribe gets the opportunity to do so.

Finally, individually or as a group, they will answer some questions about how these resources are distributed in Utah, and draw the major locations of the resources on the map provided.

Specific details can be found in the student handouts for Station 2.

Station 3: Gems and Unusual Rock Resources (25-30 min)

At this station, the students will use an online interactive map to determine the locations of places in Utah where you can collect unusual rocks and gemstones. The students will make observations about the location of these rocks and minerals on the map, and look for patterns.

Materials Needed:

Computer with internet access

https://geology.utah.gov/apps/rock_collecting/index.html

Laminated pages – Distribution of Natural Resources in Utah–Group roles, Distribution of Natural Resources in Utah–Talk Moves, Station 3: Gem and Unusual Rock Resources directions

Student handouts – Station 3: Gem and Unusual Rock Resources

Instructions:

In each group, the students will spend 5-10 min exploring and reading the information on the interactive map. While doing this, they are encouraged to think about these questions: What are the maps showing? How do you read the maps? Is there anything about the maps you do not understand? What patterns do you see? What information do you think is important or interesting?

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They are also asked to select their top 5 unusual rocks or minerals to include on the final map. They may want to write notes about their thinking.

Next, they will take 5-10 minutes to discuss the things they noticed about the maps. One student should volunteer as scribe to record key ideas from the discussion. Just like with the readings, make sure that everyone who wants to be the scribe gets the opportunity to do so.

Finally, individually or as a group, they will answer some questions about how these resources are distributed in Utah, and draw the locations of the unusual rocks and minerals that the group members would like to include on the map provided.

Specific details can be found in the student handouts for Station 3.

Explain: Geological Provinces (40-50 min)

Student Objectives:

Students will gather evidence on the geological regions in Utah in order to explain why the geological and geothermal resources are unevenly distributed.

Students will use this evidence to construct an explanation of how the geological processes that shaped Utah caused the uneven distribution of resources in the state.

Overview:

Now that the students have observed the uneven distribution of resources in Utah, they need to begin seeking the answer to the question *Why are the resources unevenly distributed?* To do this, the students will read about both the geology of the geological regions in Utah, and about specific resources from their prior investigation. The students will use the readings to gather evidence which they will then bring to their small groups in order to construct an explanation through scaffolded discussions.

Materials Needed:

Introduction:

Computer with internet access

Projector

Map of Utah, for example:

<https://opendata.gis.utah.gov/maps/utah::utah-address-points-base-map-wmts/explore?location=39.400765%2C-111.607500%2C-1.00>

Geological Provinces Jigsaw:

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Computers with internet access

Laminated pages – Distribution of Natural Resources in Utah–Group roles, Distribution of Natural Resources in Utah–Talk Moves, Geological Provinces Jigsaw directions, Selected readings from “*The Teacher-Friendly Guide to the Earth Science of the Southwestern US*”

Student handouts – Geological Provinces Jigsaw–Basin and Range, Geological Provinces Jigsaw–Colorado Plateau, Geological Provinces Jigsaw–Rocky Mountains, Geological Provinces Jigsaw–Putting it Together

Web pages:

Basin and Range:

<https://geology.utah.gov/popular/general-geology/utah-landforms/physiographic-provinces/>

<https://geology.utah.gov/map-pub/survey-notes/glad-you-asked/how-was-utahs-topography-formed/>

<https://www.nps.gov/articles/basinrange.htm>

<http://geology.teacherfriendlyguide.org/index.php/topography-w/topography-region1-w>

https://www.iris.edu/hq/inclass/animation/basin_range_structural_evolution

https://www.iris.edu/hq/inclass/animation/basin_range_deformation_erosion_sedimentation

https://www.iris.edu/hq/inclass/animation/basin_range_volcanoes

Colorado Plateau:

<https://geology.utah.gov/popular/general-geology/utah-landforms/physiographic-provinces/>

<https://geology.utah.gov/map-pub/survey-notes/glad-you-asked/how-was-utahs-topography-formed/>

<https://www.nps.gov/articles/coloradoplateaus.htm>

<http://geology.teacherfriendlyguide.org/index.php/77-southwestern/topography-sw/600-topography-region1-sw>

<https://www.youtube.com/watch?v=RVMKzxtJAto> (watch the first 2 minutes)

<https://www.youtube.com/watch?v=6oTUZDBpbio>

Rocky Mountains:

<https://geology.utah.gov/popular/general-geology/utah-landforms/physiographic-provinces/>

<https://geology.utah.gov/map-pub/survey-notes/glad-you-asked/how-was-utahs-topography-formed/>

<https://www.nps.gov/articles/rockies.htm>

Explaining the Uneven Distribution of the Earth's Natural Resources

<http://geology.teacherfriendlyguide.org/index.php/topography-nc/topography-region3-nc> (read the section on the Middle Rocky Mountains)

<https://www.youtube.com/watch?v=tJk9cFz152s>

Introduction (5-10 min)

The teacher will introduce the next section by asking the students to verbally share the results of their explanations. Specifically, were the resources evenly distributed? Each group should share one observation about the locations of the resources they explored. The teacher could assign each group one resource to report on, or the teacher could ask the students to choose a resource to report on. Either way, the goal is to lead to the wonderment, why are the resources unevenly distributed?

As the groups share, the teacher could draw major areas on a projected map. The suggested map for this section, <https://opendata.gis.utah.gov/maps/utah::utah-address-points-base-map-wmts/explore?location=39.400765%2C-111.607500%2C-1.00> is a greyscale topological map.

After each group has had a chance to share, the teacher could ask students to make observations about the locations of the resources. The teacher should highlight productive ideas and “wonder” why the resources are located in different regions of Utah. The teacher might make observations such as “I notice that the geothermal resources are located in the western part of the state, in the Basin and Range region. I wonder why that is?” or “I notice that the uranium resources are located in the southeast part of the state in the Colorado Plateau region, I wonder what is happening there?”

After this brief sharing of information, the teacher should tell the students that it looks like they need to find out more information. They are going to need to collect more data on the geological regions in Utah, and the resources found in each region, so that they can explain, with evidence, what causes this uneven distribution of resources. They will be asked to share their answer to this final question with the class.

Suggestions for Specifically Designed Instruction for Teacher-Led Class

Discussion

- A. Provide clear directions for student expectations during the lecture, including behavior and academic expectations.
 - a. Explicitly teach and review specific content vocabulary.
 - b. Provide an advanced organizer for students to take notes.
- B. Provide students with higher needs a completed copy of teacher notes to decrease cognitive load
- C. Use a Cloze or graphic organizer to classify information.
- D. Follow all accommodations and modifications listed on the IEP

Geological Provinces Jigsaw (30-40 min)

In a jigsaw assignment, each member of a group will investigate part of the problem, then report their findings to the rest of the group. After each member reports their findings, the group will answer the discussion questions together.

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The teacher will assign each student a province to research. For each province, there are recommended online readings. The students should look for answers to these questions. What is the topology of this province? How did this province form? What geological/geothermal resources are found here? The students should spend 15-20 minutes on this. The teacher should indicate when it is time for students to transition from individual research to group work.

After the students have finished their research, they will take turns sharing their results with their group members. They will then spend 5-10 minutes discussing their findings.

Finally, individually or as a group, they will answer questions about the relationship between the geology of a region and the resources located there. The end result will be an explanation of how the geological processes that shaped Utah caused the uneven distribution of resources in the state. This should also take 5-10 minutes.

Suggestions for Specifically Designed Instruction for Online Research

- A. Post and provide the directions and expectations for the students.
 - a. Using the links provided, research the geology of your assigned province.
 - b. Answer the questions on the handout.
 - c. Share your findings with your group members.
 - d. Discuss with your group members what evidence do you have that connects the geological process to the geological/geothermal resources you found there?
- B. Bookmark the website that is used or link in a google document or email.
- C. Clear expectations for time and post and display a classroom timer.
- D. Consider allowing students to work in pairs or with a peer.
- E. Consider response types (e.g., verbal, written, paired).
- F. Demonstrate/model expectations.
- G. Extended guided practice with a teacher, paraprofessional, or peer.
- H. Read aloud the information found on the website.
- I. Follow all accommodations and modifications listed on the IEP.

Elaborate: Revisit Anchoring Phenomenon (30-45 min)

Student Objectives:

Students will create a presentation to share with the class that includes:

A map of the locations for the resources they have previously explored.

Explanations of the geology that caused the distribution of the resources.

Evidence that supports their explanations.

Overview:

In this part of the lesson, the students will create a presentation that synthesizes all the pieces that the students have discovered in this lesson: GeoSights locations to use as cache sites for the augmented reality game, which (virtual) resource(s) should be found at each Geo Site, the geology of the 3 provinces of Utah, and the explanations about how the geology caused the resources to be unevenly distributed.

The teacher will decide which type of presentation the students should create, and how they should share their presentations. The teacher may want the students to make a poster presentation that they set up around the classroom so that other students visit their presentations in a science fair format. The teacher may want the students to create a Powerpoint or Prezi presentation that they show to the class.

Whichever presentation type the teacher selects, the presentation should contain the following:

- A map of the selected GeoSights sites to be used as cache sites for the augmented reality game labeled with the resources that will be cached at each site.
- Descriptions of the geological processes that shaped each province.
- Explanations that the geological processes caused the distribution of resources.
- Evidence to support the explanations.

Materials Needed:

Varied, depending on presentation type

Possible materials:

Posterboard or similar

Markers

Whiteboard

Dry erase markers

Computers

Printer

Creating a Presentation (30-45 min)

The teacher will introduce this next section by revisiting the anchoring phenomenon. Remind the students that they were trying to figure out where different resources are located in Utah so that the developers of the augmented reality game could place virtual resources at these locations for the players to find. Now they are going to put all of this information together so they can share it with the game developers.

The game developers will want to know why they need to place the resources at these locations (instead of a more populated location, such as downtown Provo). They will also want to know why they can't place all the resources at the same spot and why do they need to be placed all over the

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state, with different locations for different resources. So the students will need to explain to the game developers why the resources are not evenly distributed and explain how different geological processes caused this uneven distribution.

Using the handouts they previously created and additional resources used throughout the lesson the students will create a presentation that includes each of the following:

- A map of the selected GeoSights sites to be used as cache sites for the augmented reality game labeled with the resources that will be cached at each site.
- Descriptions of the geological processes that shaped each province.
- Explanations that the geological processes caused the distribution of resources.
- Evidence to support the explanations.

Instructions for creating the map:

1. Create a map of the GeoSights sites that they want to use as cache sites.
 - a. The teacher could print a blank map, or print the GeoSights map and the students could label it by hand.
 - b. The students could take a screenshot of a map, such as the GeoSights map, and then edit it using a drawing program such as Illustrator, Powerpoint, or Paint.
 - c. If the students are creating this map electronically, they should also include images of the GeoSights cache sites.
2. Add the relevant resources to each cache site.
 - a. For example: if the students selected Upheaval Dome as a cache site, they could cache uranium there. If they selected the Honeycombs as a cache site, they could cache gold and silver there.
 - b. This may need to be done as an iterative process. If the students did not select any sites in the West Desert, they will not be able to cache geothermal or precious metal resources, and may need to revisit the GeoSights page to look for a location in the West Desert.
3. Requirements for cache sites:
 - a. Each cache site must have at least one resource.
 - b. Each resource in this lesson must be placed in at least one cache site.
 - i. Energy resources – geothermal, coal, petroleum, natural gas, uranium
 - ii. Metal resources –
 1. Base metals – iron, copper, lead
 2. Precious metals – gold, silver
 - iii. Gemstones and unusual rocks – as selected by students
 - c. Add or remove cache sites as needed
 - d. Add resources if desired
4. Draw and label the geological provinces in Utah on the map.

The teacher should explain to the students what form of presentation to create, and instruct the students on creating this presentation.

Suggestions for Specifically Designed Instruction for Presentation

Preparation

- A. State and post expectations for preparing a PowerPoint presentation
 - a. Expected time
 - b. Tools that may be accessed (e.g., computer, completed notes, team member) to prepare the presentation.
 - c. Independent vs. Group notes
- B. Prepare advanced organizer of presentation with fillable document and/or slides that include:
 - a. Partially completed map
 - b. Descriptions of the geological processes that shaped each province.
 - c. Explanations that the geological processes caused the distribution of resources.
 - d. Evidence to support the explanations.
- C. Post or create a representation of talk moves students may use when working in a group.
- D. Assign students with disabilities the section of the presentation they will be responsible for preparing.
- E. Narrow the presentation options (e.g., PowerPoint, Prezi, written document, oral presentation without visual representation).
- F. Match the researched information with the pertinent section of the PowerPoint.
- G. Limit the content to the information that has previously been researched and discussed.
- H. Provide models and guided practice with a gradual release of learning to the student.
- I. Provide a checklist to be completed of each task in the preparation process.
- J. Follow all accommodations and modifications listed on the IEP.

Transitioning (5 min)

Student Expectations:

Before beginning the student presentations, the teacher should set the classroom expectations. Students should listen actively during the presentations, and be prepared to contribute to the discussions following the presentations. All responses should be polite and respectful. If the teacher chooses to discuss the presentations as a full class, students should be prepared to respond to the presentations. Here are some possible responses:

- Students may agree with the presentations, and provide reasons to support the claims.
- Students may disagree with the presentations, and provide reasons for the disagreement.
- Students may ask questions about the proposals.

Evaluate (30-45 min)

Student Objectives:

Students will demonstrate that they have achieved the objectives by presenting their results and explanations to the class.

Materials Needed:

Varies, depending on the presentation type

Possible materials include

Student posters

Computer with internet access

Projector

Overview:

The teacher will determine how to do this. This could be done as full class presentations, as online presentations, or in a “poster session” format. Whichever way this is done, the students who are the “audience” should engage with the “presenters” in the ways described above.

Suggestions for Specifically Designed Instruction for Evaluation

- A. Follow grading expectations and give feedback for grading procedures.
- B. Evaluate only learning objectives of the lesson (e.g. reading, spelling, and quality of presentation skills are not a learning target in this lesson).
- C. Consider holistic scoring.
- D. Follow all guidelines in the student's IEP.

References

Archer, A. L., & Hughes, C. A. (2010). *Explicit instruction: Effective and efficient teaching*. Guilford Publications.

Atlas Utah. (n.d.). Retrieved from <https://atlas.utah.gov/>

Braden, S., Barth-Cohen, L., Gailey, S. & Young, T. (2021). Modeling magnetism with the floating paper clip: Supporting diverse learners with visual and linguistic scaffolds. *Science Scope*. 44(6).

elGeokid. (2011). *Formation of the Colorado Plateau*. YouTube. Retrieved from <https://www.youtube.com/watch?v=6oTUZDBpbio>

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- Hughes, C. A., Morris, J. R., Therrien, W. J., & Benson, S. K. (2017). Explicit instruction: Historical and contemporary contexts. *Learning Disabilities Research & Practice*, 32(3), 140-148.
- Incorporated Research Institutions for Seismology. (n.d.). *Basin & Range: Deformation, Erosion & Sedimentation*. IRIS. Retrieved from https://www.iris.edu/hq/inclass/animation/basin_range_deformation_erosion_sedimentation
- Incorporated Research Institutions for Seismology. (n.d.). *Basin & Range: Structural evolution*. IRIS. Retrieved from https://www.iris.edu/hq/inclass/animation/basin_range_structural_evolution
- Incorporated Research Institutions for Seismology. (n.d.). *Basin & Range: Volcanos*. IRIS. Retrieved from https://www.iris.edu/hq/inclass/animation/basin_range_volcanoes
- Individuals with Disabilities Education Act, 20 U.S.C. § 1400 (2004)
- Kennedy, M. J., Rodgers, W. J., Romig, J. E., Lloyd, J. W., & Brownell, M. T. (2017). Effects of a multimedia professional development package on inclusive science teachers' vocabulary instruction. *Journal of Teacher Education*, 68(2), 213-230.
- Kim, N. J., Belland, B. R., & Axelrod, D. (2018). Scaffolding for optimal challenge in K–12 problem-based learning. *The Interdisciplinary Journal of Problem-based Learning*.
- Krahulec, K. (2018). *Utah Mining Districts*. Utah Geological Survey. OFR-695. Retrieved from https://ugspub.nr.utah.gov/publications/open_file_reports/ofr-695.pdf
- Larkin, M. (2002). *Using scaffolded instruction to optimize learning*. <http://www.vtaide.com/png/ERIC/Scaffolding.htm>
- Lucas, M. D., Ross, R. M. & Swaby, A. N., (Eds.). (2015). *The teacher-friendly guide to the earth science of the northwest central US*. Paleontological Research Institution.
- Lucas, M. D., Ross, R. M. & Swaby, A. N., (Eds.). (2014). *The teacher-friendly guide to the earth science of the western US*. Paleontological Research Institution.
- Michaels, S. & O'Connor, C. (2012). *Talk science primer*. Cambridge, MA: TERC. Available at: https://inquiryproject.terc.edu/shared/pd/TalkScience_Primer.pdf
- Milligan, M. R. (2000). How was Utah's topography formed. *Survey Notes*, 32(1). Retrieved from <https://geology.utah.gov/map-pub/survey-notes/glad-you-asked/how-was-utahs-topography-formed/>
- National Geographic. (2008). *Rockies Thrust Up*. in *Naked Science: The Rockies*. YouTube. Retrieved from <https://www.youtube.com/watch?v=tjk9cFz152s>
- NGSS Lead States. (2013). *Next Generation Science Standards: For States, By States*. Washington, DC: The National Academies Press.
- Swaby, A. N., Lucas, M. D., & Ross, R. M. (Eds.). (2016). *The teacher-friendly guide to the earth science of the southeastern US*. Paleontological Research Institution.
- SWEarthScience. (2010). *The Colorado Plateau: Earth Science of Arizona and the Southwest*. YouTube. Retrieved from <https://www.youtube.com/watch?v=RVMKzxtJAto>

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- U.S. Department of the Interior. (n.d.). *Basin and Range Province (U.S. National Park Service)*. National Parks Service. Retrieved from <https://www.nps.gov/articles/basinrange.htm>
- U.S. Department of the Interior. (n.d.). *Colorado Plateaus Province (U.S. National Park Service)*. National Parks Service. Retrieved from <https://www.nps.gov/articles/coloradoplateaus.htm>
- U.S. Department of the Interior. (n.d.). *Rocky Mountain System Provinces. (U.S. National Park Service)*. National Parks Service. Retrieved from <https://www.nps.gov/articles/rockies.htm>
- Utah Geological Survey (n.d.). *GeoSights: Explore Utah's geologic sites*. Utah Geological Survey – Keeping Utah informed with geologic data. Retrieved from <https://geology.utah.gov/apps/geosights/index.htm>
- Utah Geological Survey. (n.d.). *Metals and Industrial Minerals*. Utah Mineral Resources. Retrieved from https://geology.utah.gov/apps/blm_mineral/
- Utah Geological Survey. (n.d.). *Physiographic provinces*. Utah Geological Survey. Retrieved from <https://geology.utah.gov/popular/general-geology/utah-landforms/physiographic-provinces/>
- Utah Geological Survey. (n.d.). *Rock & Mineral Collecting Sites: The Rockhounder*. Utah Geological Survey – Keeping Utah informed with geologic data. Retrieved from https://geology.utah.gov/apps/rock_collecting/index.html
- Utah State Board of Education. (2019). *Utah Science with Engineering Education (SEED) Standards*. <https://www.schools.utah.gov/File/f4cb6568-bb85-4908-a1f6-45feb98b9ebc>
- Utah State's Geographic Information Database. (n.d.). *Utah Address Points Base Map (WMTS)*. Utah SGID. Retrieved from <https://opendata.gis.utah.gov/maps/utah::utah-address-points-base-map-wmts/explore?location=39.400765%2C-111.607500%2C-1.00>
- Vanden Berg, M. D. (2020). *Utah's Energy Landscape - 5th Edition*. Utah Geological Survey. C-127. Retrieved from <https://ugspub.nr.utah.gov/publications/circular/c-127/c-127.pdf>
- Vickers, C. H. (2007). Second language socialization through team interaction among electrical and computer engineering students. *The Modern Language Journal*, 91(4), 621-640.
- Warren, B., Ballenger, C. Ogonowski, M., Rosebery, A., and Hudicourt-Barnes, J. (2001). Rethinking diversity in learning science: The logic of everyday sense-making. *Journal of Research in Science Teaching*, 38(5), 529-552.