Teacher Overview

"Core Idea ESS2 **Earth's Systems:** *How and why is Earth constantly changing? Earth's surface is a complex and dynamic set of interconnected systems—principally the geosphere, hydrosphere, atmosphere, and biosphere—that interact over a wide range of temporal and spatial scales. All of Earth's processes are the result of energy flowing and matter cycling within and among these systems."*

From: A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas (https://www.nap.edu/read/13165/chapter/11)

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Mountains are globally ubiquitous, locally unique, iconic interconnected environmental and human communities that provide ecosystem services to over half of the world's population. These services are broadly defined as benefits that nature provides to humans (such as clean water, food, recreation, spiritual renewal, etc.). It is therefore highly important to future generations to understand the system dynamics of mountains and explore alternative future trajectories in the different contexts of mountain systems worldwide.

Part of the results of the work of The Mountain Sentinels Collaborative Network is the creation of Story Maps[1] linked to specific sites that can be utilized by teachers and students to increase their understanding of why mountains have critical value to all who make planet Earth their home.

This Teacher Overview in the Mountain Sentinel Story Map Guide gives you a follow-up to the Introduction, World Map (pinpointed locations and links) and Story Map Links & Overview portions. Student Materials focus on middle school (Grades 6-8), and can be modified for Intermediate Elementary and High School Grades 9-10. HS Grades 11-12 may be more capable of doing their own extensions. Following ideas around modes of learning, applicable Standards and content assessment techniques, there are suggestions for extensions to serve advanced students and modifications for those with learning challenges.

For many students, the Story Maps will be a dramatic introduction to the mountainous regions of Earth. Much of the content of earth science textbooks that are utilized in middle schools focus on the generalized survey topics of geology (including landforms, rocks and minerals, plate tectonics, volcanoes, earthquakes), oceanography and atmosphere (including weather, climate), and astronomy (including solar system and universe). While case studies that involve specific regions are encouraged to personalize these topics as well as provide opportunities for critical analysis, geographical studies that integrate multiple areas of content (cross-system and cross-cultural) are generally left to social studies classes and high school texts. The use of Story Maps geared to your science, social studies and language arts classrooms will expand student understanding of the interwoven relationships between mountain region residents (people, animals, plants and more) and their environment, and the outsized influence these regions play on the world stage.

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[1]Story Maps are online "stories" that combine text, photographs, interactive maps, and other multi-media content.

Mountain regions are majestic and mysterious, and have a unique set of multidimensional issues and problems; they are biophysically and culturally complex. That being said, they provide a great opportunity for students to study the ecological interconnectedness of humans as part of their environment. Many of the Middle School Standards required by teachers in science, reading, writing and in some cases mathematics can be addressed utilizing Story Map content. Students can learn about the geography, plants and animals of Tibet, while at the same time becoming familiar with the people that inhabit that region with their unique history, languages, land-use practices and political conflicts. They can study the types of forests in the U.S. West and the influence of volcanic activity and role of wildfires over time, concurrently utilizing graphs, text and diagrams to learn about the effects of changes in farm irrigation and forestry practices due to increased urban pressure and climate change.

Depending on factors such as allowable time available in required curriculum, personal interest of the teacher or student group, or ability of students to utilize parts or whole Story Maps for study, they can be a useful tool in modes such as:
   1) Units of study in earth, life and environmental sciences, cultural focuses in social studies or an integration of both areas of learning,
   2) Supplemental materials or special assignments for the same as above,
   3) Choice personal interest readings for vocabulary expansion,
   4) Skill development (eg. map reading and feature identification, presentation skills), and
   5) Interpretation of critical issues.

The format of a Story Map lends itself to multiple levels of understanding. The visuals are stunning in their grandeur, while at the same time illustrating the complexity of the landscape and regions displayed. They vary from closeups in singular habitats or mountains to entire regions. Sometimes the focus is on the biota, sometimes the geography, and sometimes the people who inhabit and work in and upon the land. All Story Maps follow the same structure, with the same sections, so that aspects (e.g. endangered species) can be compared across the Story Maps from around the world. Story Map content includes pictures, text, videos, charts and graphs. These scale and format variations facilitate addressing individual and localized concerns all the way up to larger scale issues, with opportunities to develop a variety of student skills while tapping into different levels of Bloom's Taxonomy.

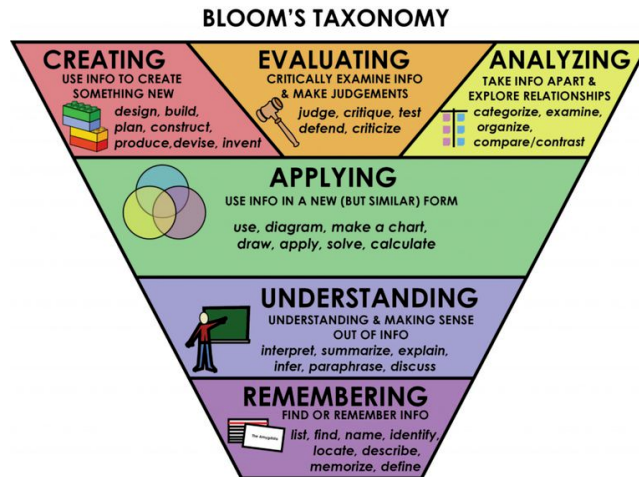[1]Story Maps are online "stories" that combine text, photographs, interactive maps, and other multi-media content.

Image downloaded from https://www.toppr.com/bytes/blooms-taxonomy/; Source Identified as Press Books.

The content can often be assessed through methods that focus on Remembering, Understanding and Applying with students at lower middle school grade levels or by those that require more scaffolding for understanding (ELL, students with IEP's and 504 Plans). For more advanced students and grade levels, there are multiple opportunities to Create, Evaluate and Analyze. That being said, all levels of Bloom's Taxonomy can be utilized for every grade and ability level with differentiation of lessons.

Differentiated learning opportunities are important for varied rates and levels of children, because every individual learns differently, quality classroom and learning experiences are more important than quantity, and the content importance does not supersede that of the student. Story Maps can be used in this way by changing the pacing and sophistication, depth, complexity and personalization of the assignments. More choices made by learners to delve into the material with these variations, with guidance in appropriate complexity, will enable teachers to "tier" the lesson content to reach the same goals by all.

The principles of Universal Design for Learning might be considered for all levels of learners when creating lessons that utilize Mountain Sentinel Story Maps. Using these can help utilize the Why, What and How aspects of brain development by presenting content in predictable ways that can stimulate student interest and motivation to learn, while allowing for a variety of ways they can utilize and respond to that learning. This could include accommodations such as text, speech, video and audio modifications of the Story Maps so students of all abilities can interact with the content using multiple senses, based on their individual learning mode preferences. (See...http://udlguidelines.cast.org/?utm_medium=web&utm_campaign=none&utm_source=cast-about-udl)

Story Map content understanding can be achieved through various methods. These include:
1. Question and Answer Sessions

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2. Quick Assessment Techniques; commonly known ones include 3-2-1 Format, Focused Listing, Muddiest Point, One Minute Paper, Think-Pair-Share, Jigsaw, Concept Mapping, and Memory Matrix.
3. Short Answer and Essay Assignments
4. Short Fiction Stories (with content based on facts)
5. Diary Entries of a Traveler (with content based on facts)
6. Presentations on Selected Topics (Prezis, Power Points, etc.)
7. Role-Playing Debates ("Town Hall")
8. Work Samples (for particular school district requirements)
9. Critiques of the Maps Themselves
10. Group Projects
11. Individual Projects
12. Traditional Quizzes and Tests

It is essential that the use of any tool be appropriate to student rate and level. For example, if you want to get a standard and diverse 6th grade classroom to organize their thoughts after reading through a Story Map and identify sources of confusion for them, you could utilize the 3-2-1 Format activity. The students would create a document that shows **3 Ideas, 2 Uses or Examples, and 1 Question or Unresolved Issue**. A focus of this activity could be on the entire Story Map, or one portion. For example, a science teacher might use the "Landforms and Geography" section to ask students to compare and contrast those in the Tibetan region of the world with that of mountains in their own state or country, using this 3-2-1 method. Initially, this would focus on the Remembering and Understanding portions of Bloom's Taxonomy, and could be extended with an Application and Analysis activity in a tiered followup lesson. This initial activity would also promote reflection and metacognition, and discussion of these assignment products in class would encourage review of the material. If there are ELL (English Language Learner) students in that classroom, you could use a template with sections and illustrating pictures for the student to choose from to represent the ideas, uses and questions. LD students could be offered a template with similar pictures and accompanying general sentences and questions that contain blanks for completion (scaffolding). And always, there should be an example that illustrates towards what goal students should be focusing their efforts.

Learning-challenged students (LD) should be given the opportunity to ask questions in shortened content portions, with more opportunities to share, lengthened wait times for complete answers, and extensive scaffolding of content. Fill-in-the-blank questions, mind maps and partially completed flow-charts can be designed to allow assessment of content.

On the higher end of middle school rate and level, advanced 8th grade students might be interested in a specific aspect of one Story Map region such as "rare & endangered species" present there and how they are affected by the physical hazards exacerbated by climate change, or a comparison of the same focus between two or more regions of interest. For example, if the individual student or group wants to compare and contrast problems related to how climate change affects birds of prey in

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mountainous regions around the world, they could work on a presentation format (vismi, canva, haiku deck, power point, prezi, keynote, flash, other) that utilizes content from several Story Maps.
CCSS.ELA-Literacy.SL.8.5: Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.
Science & Engineering Practices: Ecosystems are dynamic in nature; their characteristics can vary over time. Disruptions to any physical or biological component of an ecosystem can lead to shifts in all its populations (LS2.C)

An extension for advanced students might be to create their own Story Map with the same focus as aforementioned presentation subjects, or involvement for community stewardship credit in an iNaturalist project focusing on field observations and/or data collection such as the active ones listed below:

iNaturalist Projects of Possible Interest:

https://www.inaturalist.org/projects/sonoma-coast-stewards-of-the-coast-redwoods

https://www.inaturalist.org/projects/southern-california-mountains-foundation-volunteers

https://www.inaturalist.org/observations?place_id=15486

https://www.inaturalist.org/projects/biota-of-the-klamath-mountain-geomorphic-province

https://www.inaturalist.org/projects/biodiversity-of-the-cuyamaca-mountains +

https://www.inaturalist.org/taxa/20777-Trogon-mexicanus +

https://www.inaturalist.org/taxa/371963-Lampropeltis-multifasciata +

https://www.inaturalist.org/taxa/41657-Tremarctos-ornatus +
https://www.inaturalist.org/taxa/70227-Cordyline-indivisa +

https://www.inaturalist.org/places/southern-blue-ridge-mountains-grass-balds

If students want to start their own citizen science project in the mountains, they can contact us at: mountainsentinels@gmail.com

Mountains are critical sentinels of climate change, as they are among the first to experience the extreme impacts of climate change. There are several explanations for why the amount of warming

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experienced at higher elevations generally surpasses that at lower elevations. For example, reduced snow and glaciers with warming cause even more temperature increase as snow and glaciers (which are bright and tend to reflect solar radiation) disappear and are replaced by surfaces (forests, tundra, bareground, etc.) that absorb more solar radiation and therefore warm even more.

At the time of the writing of this Guide, the western United States is being ravaged by wildfires. The leads of the Mountain Sentinels Network are located at Colorado State University, in the Poudre River Watershed, where the Cameron Peak Fire - only a little more than 50% contained - has just become the largest wildfire in recorded Colorado history.   Wildfires are a powerful force under natural circumstances in this region of the world, and a particularly significant hazard in areas where fire plays a major role in the natural ecological systems. Many species are adapted to "fire seasons" and some even utilize fire as a means for reproduction. However, the following factors are having serious consequences on the impact of these fires:

~ encroachment of human populations into these areas,

~ significant changes in precipitation regimes over several decades due to global climate change, and

~ farm and forest management practices that increase the likelihood of devastating fires, as well as the resources that could impact fire intensity and/or suppression.

Mountainous landscapes are particularly susceptible to wildfires under usual circumstances, but these times do not fall into that "usual" category.   Climate warming has increased the evaporative demand of the landscape at a faster rate at higher elevations, with the resulting heightened susceptibility to tree loss and wildfires, with accompanying landslides.   Human communities that rely on these ecosystems are part of the equation of disruption with forced, often dramatic changes to the landscape. Teachers have a unique opportunity to utilize Story Maps as a way to develop critical thinking in their students by examining the relationship between land management practices and ecological disaster events.

ESS3.C: Human Impacts on Earth Systems: Human activities have significantly altered the biosphere, sometimes damaging or destroying natural habitats and causing the extinction of other species. But changes to Earth's environments can have different impacts (negative and positive) for different living things. (MS-ESS3-3). Typically, as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. (MS-ESS3-3),(MS-ESS3-4)

Crosscutting Concepts: Cause and effect relationships may be used to predict phenomena in natural or designed systems. (MS-ESS3-4)

To address this in advanced class content, role-playing scripts could be developed by a group of students that compare the environmental changes that have occurred as a result of forestry practices in the localized and broader regions of one or more Story Maps, examining the systematic increase or decrease of wildfire hazard in the mountainous terrain. That could include positive or negative changes over time, depending on the interaction (or lack of) between indigenous peoples and the overseeing governments. This could be handled as a "Town Hall" activity, where more

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advanced students have researched the stakeholders for presentation content, or you could have developed scripts for students that need more support. The variation of content is up to you, as is the degree of complexity. The Town Hall discussion can generate questions and assessment activities, as well as segue to a new lesson and activities.

The Mountain Sentinel Story Maps contain the concept of "Multidimensional Paradoxes," where a combination of characteristics and issues sometimes lack clear definition and obvious optimal solutions. In other words, these paradoxes present multiple challenges to those looking to carry out sustainable practices. Mountains are resource rich, but income poor. The policies are often made by "outsiders" that do not have a personal connection to the land. A diverse range of actors are drawn to them, and they are prone to demographic shifts. And too, while remote to many people, mountains are highly vulnerable to global change. This can be seen by the reader as "wicked problems" that don't present clearly defined answers for students (or teachers, for that matter). That being said, they are an excellent motivating tool for advanced students to get creative while venturing into the realm of challenging land-use practices by adults in the public and private sector.

Depending on your student age group, subject areas, classroom student makeup and modes of teaching, you may not envision the time or energy to utilize additional resources provided to you beyond your district-mandated curriculum.   This is why Story Maps are so useful; whether you employ them as an extension of an existing lesson, optional reading, or as a focus of a set of lessons and projects that support the Standards you have chosen for your students, they can be the nexus of useful resources for your classroom.   Review the Student Materials, which can be used for assessment assignments as given or in part, individually or in multiples, or as in-class discussion points to prepare students for a larger project.   When they fit your goals, consider the Mountain Sentinel Story Map Guide as a key to sparking your students' reflection, imagination and production.

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