

Including Earth-Space Science Topics in Biology, Chemistry, & Physics

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How are you including Earth-Space Science?

- NGSS says we need to include Earth-Space Science in high school.
- How is that happening in your district?
- If not by a separate Earth-Space course, the topics need to be in biology, chemistry, and physics.
- Suggested distribution of NGSS PE's is in Appendix K, but may vary.
- Teachers with no Earth science background will need content help!
- We need to see these as enhancements to biology, chemistry & physics - **broadening** their applicability.

Earth Science topics in Biology 1 - History of Earth & Life

ESS1.C - History of the Earth

HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

HS-ESS1-6. Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history.

ESS2.E - Biogeology/Earth Systems

HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. This PE is also in chemistry.

Evolution can be thought of as these steps for all complex systems, biological or physical:

differentiate >> select >> amplify >> repeat

Resources >>> next slide.

Earth Science topics in Biology 1 - History of Earth & life

Earthviewer - <http://www.hhmi.org/biointeractive/earthviewer-online-and-downloadable-version>

MD Geology for Education - web map showing the geology of Maryland:

<http://mdgeoed.maps.arcgis.com/home/webmap/viewer.html?webmap=d7cfa7a928f14d89ae9556612001033b>

Geology of all states: <https://mrdata.usgs.gov/geology/state/>

Video on evolution of Earth, especially atmosphere (from Big History):

<https://www.youtube.com/watch?v=Gyn754vw8ZQ>

Two more short videos that are reasonably accurate:

<https://www.youtube.com/watch?v=Z6k3NRy-YWs>

<https://www.youtube.com/watch?v=8qnnoePeHlk>

NOVA video (53 min.) *Life's Rocky Start* - good overview of solid Earth changes (chemical evolution) and relations between solid Earth and life; for MD teachers, it's nice that this ends at Calvert Cliffs MD:

<http://www.pbs.org/video/2365642819/>

Brief story on above video and other related items: <http://www.smithsonianmag.com/science-nature/life-and-rocks-may-have-co-evolved-on-earth-180957807/>

Earth Science topics in Biology 2 - Environmental impacts

ESS3.B - Hazards/Sustainability

HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. This PE is also in chemistry.

<http://ngss.nsta.org/Resource.aspx?ResourceID=156> - resilience.

GeoInquiries = map + lesson; Earth science ones include climate change, mining, and watersheds:

<http://education.maps.arcgis.com/home/group.html?id=35e85b33879643a999d23cf8a86e7e75&sortField=title&sortOrder=asc&start=1&view=list#content>

ESS3.C - Human Impacts/Sustainability

HS-ESS3-3. Create a computational simulation to illustrate the relationships among management of natural resources, the sustainability of human populations, and biodiversity.

<http://ngss.nsta.org/Resource.aspx?ResourceID=416> - fisheries.

HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

<http://ngss.nsta.org/Resource.aspx?ResourceID=60> - climate solutions.

<http://ngss.nsta.org/Resource.aspx?ResourceID=407> - human footprint activity.

More resources >>> next slide.

Earth Science topics in Biology 2 - Maps for ecosystems & environment

More resources on human impacts & environmental considerations:

Ecosystem explorer - <http://ecoexplorer.arcgis.com/eco/maps.html>

Ecosystem examples (story map) -

<http://story.maps.arcgis.com/apps/MapJournal/index.html?appid=dc91db9f6409462b887ebb1695b9c201&webmap=dd6f7f93d54341a69a47002696cf5744>

Anthropocene -

<http://story.maps.arcgis.com/apps/MapJournal/index.html?appid=d14f53dcaf7b4542a8c9110eeabccf1c>

Megacities - <http://storymaps.esri.com/stories/2014/growth-of-cities/>

Earth Science topics in Chemistry 1 - Chemical evolution of the Earth



HS-ESS2-7. Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth. This PE is also in biology.

Earthviewer - <http://www.hhmi.org/biointeractive/earthviewer-online-and-downloadable-version>

PS1.C - Nuclear processes (secondary connection)

HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.

Using radioactive decay as a way to date items is probably already included in chemistry classes.

More plate tectonics: See Geolnquiries for Earth science.

Page 7 to 9 here: <http://volcanoes.usgs.gov/about/edu/dynamicplanet/nutshell.php>

Map of plate tectonics evidence:

<http://mcdgis.maps.arcgis.com/home/webmap/viewer.html?webmap=8a2dac6c50fa4d538f22d5e3b44cf817>

HS-ESS1-6. Apply scientific reasoning and evidence from ancient Earth materials, meteorites, and other planetary surfaces to construct an account of Earth's formation and early history. Resources - see in biology above.

Earth Science topics in Chemistry 2 - Water

ESS2.C - Role of water in surface processes

HS-ESS2-5. Plan and conduct an investigation of the properties of water and its effects on Earth materials and surface processes.

Properties of water - already in Chemistry.

<http://ngss.nsta.org/Resource.aspx?ResourceID=535> - soil chemistry & color.

Effects = weathering reactions (need to know the chemical nature of common minerals).

Earth Science topics in Chemistry 3 - Carbon & climate

ESS2.D - Weather and climate

HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. This PE is also in physics; see resources there.

HS-ESS2-6. Develop a quantitative model to describe the cycling of carbon among the hydrosphere, atmosphere, geosphere, and biosphere.

<http://ngss.nsta.org/Resource.aspx?ResourceID=537> - carbon tracker.

ESS3.D - Global climate change

HS-ESS3-5. Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.

Expected changes in temperature and precipitation (global, U.S., or U.S. states) --

<http://www.climatewizard.org/> (= <http://cleanet.org/resources/42645.html>)

10 impacts we are seeing -- <http://cpo.noaa.gov/warmingworld/>

HS-ESS3-6. Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.

<http://ngss.nsta.org/Resource.aspx?ResourceID=286> - climate & hydrology.

<http://ngss.nsta.org/Resource.aspx?ResourceID=407> - human footprint.

<http://ngss.nsta.org/Resource.aspx?ResourceID=409> - water availability.

Earth Science topics in Chemistry 4 - Natural resources

ESS3.A - Natural Resources/Sustainability

HS-ESS3-1. Construct an explanation based on evidence for how the availability of natural resources, occurrence of natural hazards, and changes in climate have influenced human activity. This PE is also in biology.

<http://ngss.nsta.org/Resource.aspx?ResourceID=156> - resilience.

US hazards: https://www2.usgs.gov/natural_hazards/

Worldwide hazards: <http://sedac.ciesin.columbia.edu/mapping/hazards/#>

Seismic hazards maps: <https://earthquake.usgs.gov/hazards/hazmaps/>

FEMA flood hazard maps: <http://msc.fema.gov/portal>

Resources: Map of US Energy Industrial Complex, many layers:

<http://www.arcgis.com/home/webmap/viewer.html?webmap=e52cc3c9f0c9473da9729c48f65b68c8>

HS-ESS3-2. Evaluate competing design solutions for developing, managing, and utilizing energy and mineral resources based on cost-benefit ratios.

<http://ngss.nsta.org/Resource.aspx?ResourceID=410> - bioenergy game.

Earth Science topics in Chemistry 5 - Energy from nuclear reactions

PS3.D - Energy in chemical processes -- space systems (secondary connection)

HS-ESS1-1. Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation. This PE is also in physics.

Nuclear fission and fusion are probably already part of chemistry (or physics).

These animations are for life span of stars:

http://www.valdosta.edu/~cbarnbau/astro_demos/stellar_evol/home_stellar.html

#1 star forms - good for solar system formation

Low mass - do #3 first, then #2

High mass - to supernova

Nature of electromagnetic waves for energy transfer probably already in physics courses.

Earth Science topics in Physics 1 - Astronomy & cosmology

ESS1.A - Universe & stars

HS-ESS1-1. Develop a model based on evidence to illustrate the life span of the sun and the role of nuclear fusion in the sun's core to release energy that eventually reaches Earth in the form of radiation. This PE is also in chemistry.

http://www.valdosta.edu/~cbarnbau/astro_demos/stellar_evol/home_stellar.html

#1 star forms - good for solar system formation

Low mass - do #3 first, then #2

High mass - to supernova

HS-ESS1-2. Construct an explanation of the Big Bang theory based on astronomical evidence of light spectra, motion of distant galaxies, and composition of matter in the universe. This also has a secondary connection to PS4.B on electromagnetic radiation.

HS-ESS1-3. Communicate scientific ideas about the way stars, over their life cycle, produce elements.

See animations above for HS-ESS1-1.

ESS1.B - Earth & solar system

HS-ESS1-4. Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

<http://astro.unl.edu/naap/pos/animations/kepler.html> - Kepler's Laws.

<http://astro.unl.edu/naap/> - many other animations relating to objects in space.

Could also include how gravitational and solar wind forces affected the solar nebula to form Sun & planets.

Earth Science topics in Physics 2 - Energy & climate

Secondary connection:

HS-ESS2-4. Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate. This PE is also in chemistry.

Compare climate change possible causes: <http://www.bloomberg.com/graphics/2015-whats-warming-the-world/>

Solid, reliable data: <https://www.nap.edu/catalog/18730/climate-change-evidence-and-causes>

CO2 data animation: <https://www.esrl.noaa.gov/gmd/ccgg/trends/history.html>

HS-ESS2-2. Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

The Earth systems study could use interactions and feedbacks in biogeochemical cycles.

<http://ngss.nsta.org/Resource.aspx?ResourceID=235> - Yellowstone.

<http://ngss.nsta.org/Resource.aspx?ResourceID=536> - biomes & climate.

To see changes in Earth's surface over time - zoom in to any place on Earth (uses Landsat resolution):

<https://earthengine.google.com/timelapse/>

Change Matters Viewer -- <<http://www.esri.com/software/landsat>>

Shows 2 Landsat views for different times and calculates the vegetation differences between them. All views adjust to cover same area in all 3 views.

Earth Science topics in Physics 3 - Energy in the Earth

ESS2.A - Earth materials and systems

HS-ESS2-1. Develop a model to illustrate how Earth's internal and surface processes operate at different spatial and temporal scales to form continental and ocean-floor features.

<http://ngss.nsta.org/Resource.aspx?ResourceID=12> -- PhET model of plate tectonics.

<http://ngss.nsta.org/Resource.aspx?ResourceID=269> - plate boundaries.

IRIS seismic monitor: <http://ds.iris.edu/seismon/>.

HS-ESS2-3. Develop a model based on evidence of Earth's interior to describe the cycling of matter by thermal convection. This also has a secondary connection to PS4.A on waves.

<http://ngss.nsta.org/Resource.aspx?ResourceID=40> - interior layers.

<http://ngss.nsta.org/Resource.aspx?ResourceID=534> - interior waves. **

<http://web.ics.purdue.edu/~braile/edumod/waves/WaveDemo.htm> - wave types animations.



ESS2.B - Plate tectonics & large-scale systems (secondary connection)

HS-ESS1-5. Evaluate evidence of the past and current movements of continental and oceanic crust and the theory of plate tectonics to explain the ages of crustal rocks.