

Earth is a complex planet made up of systems which are constantly moving matter and energy in and around each system. Understanding these systems is an integral part of understanding the Earth and how we can coexist with it. Each of Earth's spheres, separately, are in of themselves a complex system revolving around major physical and chemical processes (Orion, 2019). When educating students about the Earth It is wise to teach each sphere individually so that the students may grasp the individual sphere and all of its complexities. This will then allow for connections between the spheres to be drawn much easier since the students will have all of the available information at their disposal. Traditionally Earth science has been taught with separate units moving through each individual sphere not necessarily highlighting/showing any sort of overlap. Orion(2007) refers to this as the “reductive method” and feels that this is a common practice influenced by the scientific community itself. Earth Scientists tend to be solitary, focusing on their field of study, privately seeking funding and conducting research. When their results are published, there is not much publicity surrounding it, most Earth Scientists are not recognized until there is some sort of a natural disaster and news outlets want to interview an expert. In recent years, Orion (2007) mentions that the public and politicians have become more interested in the research surrounding Earth Science for reasons of prediction for natural disasters, safety precautions, and of course the aftermath support for regions in distress. With increasing public interest, there is a major need for the public to understand earth processes, their complexities, and how they influence one another.

Within the last 20 years, As the internet has gained popularity and consequently more information has become more available to educators. A simple search for information about content they are covering could lead to many examples in a variety of locations. Now more than ever before information and advanced technologies are more available to both the scientist and the general population. The scientific community is sharing amongst each other as well as with the general population highlighting major earth science events that are shaping the earth and all of its spheres. (Doering et al. 2007)

In order to get our current and future population to understand how complex a system the earth is and how our behaviors are affecting the earth, we must shift our methods of teaching earth science, move away from the reductive method where each system is separate and move to the holistic approach. This requires our teachers to be informed and knowledgeable with access

to engaging resources. A NASA professional development program called Endeavor is a satellite professional development opportunity for educators. Their focus is to train educators to teach Earth Science in a more holistic approach, encouraged to learn about the earth's spheres and their respective processes through data analysis. It has been noted that using data to study earth science helps the students expand their knowledge base, experience scientific inquiry and relate spheres more concretely. Eyes on the Earth was one such course that highlighted the available data NASA provides to support teaching spheres individually but then also provide lessons that could intertwine the spheres to show their influence. NASA as well as many other organizations are doing research with better equipment that makes it easier and more available to share with outside entities like educators. In the classroom it is then possible for students to look at changes over a longer period of time and compare locations that are similar but in geographically different locations. So my historic events of the past will not be lost, but instead can be used for comparison. (Marro et al., 2016)

The Endeavor program also strives to incorporate the use of Next Generation Science Standards as a basis for science education. These standards also support a holistic approach to using technology, engineering and math (STEM) in addition to science to cover topics. Unfortunately not all districts are moving to NGSS at the same rate and not all districts are providing the needed professional development educators need to properly integrate the STEM learning. I know for myself I have not received any training on NGSS and it was through my own research and desire to further my knowledge and education in Earth Science that I came upon the Endeavor Program. Orion (2019) suggests this lag in information and support is due to the fact that earth science is viewed by decision makers as a less rigorous discipline and lacking substance when compared to other sciences. This is clearly evidence as the national science test is Biology. Many of the biology standards in the ecology and evolution units discuss habitats and research used as evidence for evolution; these topics are rooted in the earth spheres of geology and biology which are then influenced by other spheres of Earth. Since our focus in Biology is to cover the topics that will be covered on the national test we often gloss over these correlations. As long as earth sciences are viewed as second class science, this pattern will continue, NGSS won't progress, and earth will suffer for it. More avocation needs to be made for earth science highlighting how superior and beneficial it is for our citizens and ultimately the earth.

The hydrosphere is arguably the “easiest” sphere as its presence, and sometimes absence, is felt all over the Earth in every village and town. It can be observed in real time which allows a better, fuller understanding of how the hydrosphere affects a student and their environment. Understanding the Atmosphere, however, helps an individual better understand the hydrosphere. The changes in atmospheric pressure and temperature can affect the evaporation and condensation occurring in the hydrosphere resulting in changing weather patterns and over time climates. Unfortunately the atmosphere itself is a complex system that needs to be mastered before its complexities can be applied to the hydrosphere or any other sphere. More so, Earth's spheres change regularly, often because of their influence on each other. We must understand the influences so that when these changes inevitably occur, we can better predict how the other spheres will react. (Orion, 2019)

The Lithosphere and the Cryosphere are two such spheres whose effects I find are difficult for students to grasp. Major changes in these cycles require an accumulation of time, in the order of millions of years not days or weeks. There are some changes in these spheres that can be noticed in real time, however, one must be in the right place at the right time. When the Lithosphere shifts and changes, unless you are living near a plate boundary you will not be able to notice these changes. Even still you will most likely only feel the changes through an earthquake or tsunami; noticeable mountain building and fracture formation take time. The cryosphere is temperature specific; locations of high latitudes or altitudes are going to be able to fully experience the consistent presence of ice and yet it takes a long time for enough ice to form or melt for the general population to notice.

For my students, who all live in the mid-Atlantic states, things are fairly quiet as far as geologic and ice processes are concerned. We do not have volcanoes, earthquakes, or major episodes of mudslides or avalanches in our locale. While we do see freezing temperatures and must deal with snow and ice, it all eventually melts when winter is over. What information we get is typically televised and only pertaining to geologic processes. News reports on changes in the ice layers are not something that makes our local news.

Students/people living in locations like Hawaii, Iceland, and other active volcanic sites are able to witness eruptions and their effects, whether it be the addition of new hard surfaces or changes it causes in the landscape. Locals of the Northern parts of North America, ice is an ingrained part of their life. Their understanding of these two spheres becomes more personal and

part of their daily lives and therefore their understanding of these processes and their effects on the other spheres is less of a struggle. Orion (2019) suggests that the best way for individuals to learn is to stimulate the emotion and the cognitive understanding will follow. My students are missing this emotional connection to these two spheres and their mental understanding of their effects are lacking. Using real time data from the USGS and NASA allows us to manipulate data from real time events and makes the students feel more like they are there and witnessing the changes. Satellite imagery, data points that can be graphed and analysed by the students really help to show changes in habitat over time which will make it easier for students to see the connection between the effects of one sphere on others.

My own teaching experiences had me teaching each of the spheres with this reductive approach. During this time I explained each cycle and had the students investigate all of the physical and chemical processes which mostly highlighted the evidence that we have. Most of my information is/was out of date with old photos or news footage about any sort of major event. Looking back on my own education experience, that was how I learned as well. Looking back I remember learning about the volcanic eruption of Mounts. St. Helens in Washington State and Mount Vesuvius in Pompeii Italy, I then used those examples I taught my students, it was what I knew and understood and it was relevant to the lessons I was teaching about plate tectonics and the geosphere cycles. Most information and activities educators use in the classroom are provided by the publishing company of the textbook their respective district uses. These supplemental resources are provided once, at the purchasing of the textbook. This means that much like my experience with Mt. St. Helens, the publisher is highlighting an event that happened in the past, potentially decades before the book was written/published.

These eruptions are absolutely historic and totally worth a discussion, however, It left me and I am certain my students thinking that volcano eruptions are always major catastrophic events only occurring every 100 years or so. It also implies that volcanoes are rather inactive the rest of the time. In reality some volcanoes do behave that way while other volcanoes erupt all the time with minor disturbances. This information was not translated to me during my academic career, nor did I translate that to my students.

What also did not translate well was the fact that volcanoes are a notable source of nutrient cycling in the geosphere as well as other spheres. It should be mentioned that a lot of the ocean water chemistry stems from vents and ridges releasing volcanic gas and magma. Ash

adds nutrients to terrestrial soil and adds to the chemistry of the atmospheric gases facilitating cloud formation. These in turn support a lot of life on land as well as deep on the bottom of the ocean floor. When teaching each sphere independent from one another, individuals (myself included) are left with the task of drawing the connections between each sphere on their own. The general population does not often give these connections much thought.

Therein lies the importance of Earth Science Education, educators need to highlight these connections and teach the students how to critically think about the repercussions associated with the fluctuating spheres most importantly how humans influence these changes. The current students become tomorrow's voters and workforce. They must be aware of how policy changes can affect the earth. A controversial subject in my area is fracking and I find most students and most likely their parents do not understand the process of fracking along with any of the environmental repercussions fracking may cause. One can assume then, that when it is time to vote on policies and the individuals making the policy, they are truly uneducated. (Orion 2019)

So far my experience with the Endeavor program I have been informed of many outlets of real-time real world data and have been educated on ways to use such data in my classroom so that I can break out of my reductive teaching and enter into a much more holistic approach. Using NASA data I can have my students correlate how the biosphere, atmosphere, and hydrosphere interact with each other by researching sea surface temperatures, chlorophyll levels in the oceans and wind direction and speed. These characteristics collectively produce weather pattern phenomena that are felt far and wide. NASA tracks volcanic ash production which can then be correlated with the atmosphere, hydrosphere, and biosphere so that students may make sense of "air quality" measurements often reported on weather apps and daily news broadcasts. That ever controversial topic of fracking occurring in my region, can be studied by my students using data about land usage, soil moisture, and plant growth pattern data. By connecting the old earth science standards with real data and real local topics, student engagement, content understanding and retention is bound to make a positive impact.

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