'''TITLE:'''

The ecological effects of adiabatic cooling: Measuring changes in the atmosphere with elevation, and observing the associated changes in vegetation

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'''GOALS:'''

Measure the change in air pressure, temperature, and humidity with elevation, and observe associated changes in rocks and plants.

'''LEARNING OBJECTIVES:'''

''Process Skills''

\* Take repeated measurements of air temperature, pressure, and humidity.

\* Graph atmospheric changes as a scatterplot.

\* Identify rock formations and plant types.

\* Contrast visible plant and rock types at varying altitudes.

\* Explain why the change in physical factors occurs with elevation, and how that change affects the biological community.

''Next Generation Science Standards''

\* Needs to be added

'''INSTRUCTIONAL PROCESS:'''

'''PREPARATION'''

''Materials''

\* Altimeter (1 per group)

\* Air thermometer (1 per group)

\* Wet/dry bulb thermometer or humidity gauge (1 per group)

\* Infrared thermometer (1 per group)

\* Plant keys or guide (1 per group)

\* Rock and mineral guide (1 per group)

\* Each student needs pages 4-10 of the journal covering hypothesis forming about the changes with elevation, data table, graph axes, and follow up questions.

''Setup''

\* Have equipment available to each group, and journals for each student.

'''INTRODUCTION/ENGAGEMENT:'''

''Essential questions''

\* What are the relationships between air pressure, temperature, and humidity?

\* How do physical factors affect organisms and biological communities?

''Student misconceptions''

\* Air pressure increases with elevation

\* Humidity increases with elevation

''Learning structure''

\* Students split into groups of four, each one led by a Sky School instructor.

\* Each student is responsible for recording and graphing his or her own data, but teams work together to use take measurements.

'''EXPLORATION'''

''Step-by-step description''

\* Begin by asking students what they expect to change (or have observed changing on past trips up the mountain) with elevation. Many know there are pine trees instead of cactus, and that it is colder up there. But they do not know why.

\* Ask students to hypothesize why the summit of Mt. Lemmon will be colder than the base. Depending on their age and knowledge, you may give them hints about other factors it depends on. If students already report that lower air pressure will cause cooling, focus instead on whether that makes the air hold more or less moisture, and whether that leads to more or less rain at the summit.

\* After discussing hypotheses, choose variables to focus on measuring. Suggest the group measure a few additional variables as well, since many field scientists will take measurements or at least notes about additional factors in case something else turns out to be important. These include things like the hottest and coldest microclimates at each site, since animals and plants might respond to their immediate surroundings more than the average air temperature.

\* Provide equipment to your group to take these measurements, and perform the first set of observations. Compare notes with other groups, then proceed to the next two stops to take repeat measurements. Have students rotate who takes each measurement at different sites so everyone gets a turn, but emphasize the importance of standardizing their methods – taking air temperature in the shade, held far away from their body heat, for example. Engage with students to discuss the trends they see at each site: has humidity changed yet? Is it going up or down? Is that what they expected?

\* After the fourth set of measurements, ask students to revisit their original hypotheses. Why did they think it would be colder – was it related to an increase or a decrease in pressure? Ask them to plot this data on the axes provided on pages 7-8 of their journal, then draw conclusions about whether or not it supports their hypotheses, supported by their evidence. Discuss their conclusions, and additional data or relationships that might clarify the picture. Ask students to contrast the biological community

'''APPLICATION'''

''Why does it matter?''

\* This explains the change in vegetation students are observing between Tucson and the summit of Mt. Lemmon. It provides students a basis on which to predict what organisms to expect when traveling to other places based on climate.

\* These questions connect several disciplines that are thought of as separate.

''Extensions and/or follow-up activities''

\* Needs to be added

'''ASSESSMENT'''

''How will you determine if students “got it”?''

\* Students will successfully take measurements of study variables and record them in the data table on page 6.

\* Students will successfully point out and name several plant types and rock types.

\* Students will successfully create a scatterplot of at least one pairs of the physical factors, and interpret \* their graph to conclude how physical factors changed.

\* Students will hypothesize what causes those atmospheric variables to change the way they did.

\* Students will hypothesize how the changes in the observed biological community relate to the physical conditions.

'''RESOURCES'''

''List any websites, texts, or journals to help others better understand the material in order to teach it''

\* Google imaging “adiabatic cooling” and “mountains” will give you an intuitive idea of the general idea.