SNOWSCHOOL

12th Grade Activities for Schools *Surrounded by Snow!*

About this Guide:

The SnowSchool program was created in 2001 to introduce America's youth to the joy of exploring winter wildlands. Since those early beginnings the program has grown into national network of dozens of sites. Today many SnowSchool sites are located in nature centers, Nordic centers, national forests, national parks and ski areas that engage thousands of participants each winter. This model has worked effectively for reaching students in urban areas, but in many rural mountainous areas students don't need to get on a bus and drive to a nature center to explore the wilds of winter-- they have public land right out the front door of their school. To take better advantage of this opportunity, SnowSchool is now collaborating with schools that are "surrounded by snow" to develop a new program model designed especially for this context. This represents one critical approach in an increasingly diverse array of strategies that WWA is using to connect kids with nature and help them understand the importance of our nation's public lands. By combining our nationally recognized snow science curriculum with fun outdoor exploration, SnowSchool participants gain both an emotional connection to winter wildlands and a greater understanding of their important ecological role.

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The SnowSchool Curriculum

The SnowSchool program aims to inspire a lifelong interest in exploring the wonders of our winter wildlands. Thus the curriculum that accompanies the program is designed to match the interest and abilities of individuals as they grow through life. SnowSchool has been around long enough that, in some places, the first generation of students have now grown up and become educators!

SnowSchool also strives to be much more than a limited "one-and-done" field trip program. Research conducted on the SnowSchool model and field-trips in general demonstrates that in order to maximize student benefits these learning experiences must extend over time and connect classroom study to the field-trip itself. We've designed a spiraling curriculum model (right) to do just this, and the details of how to make it happen at your site are captured here in this guide.

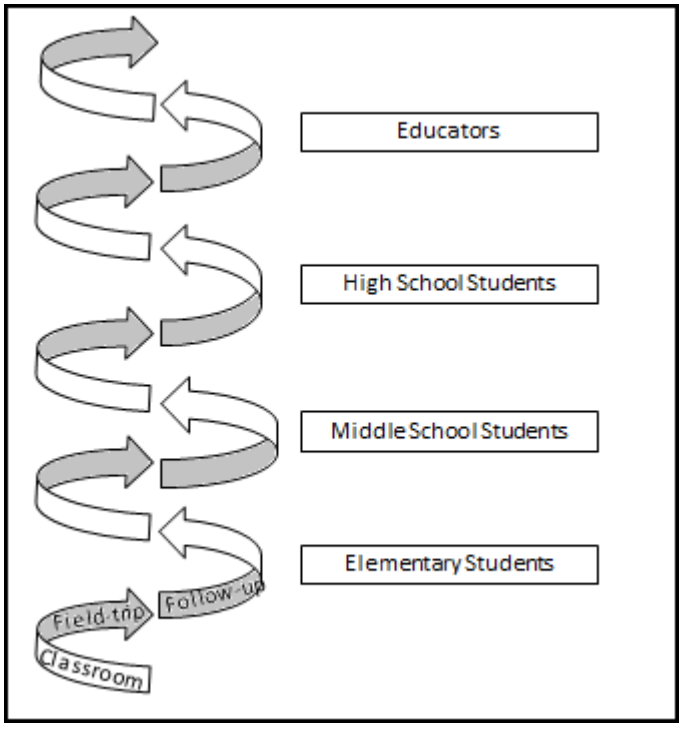


Figure 1: SnowSchool's spiraling curriculum model enables students at a variety of grades levels to explore snow science and ecology in a manner that connects classroom study, field excursions and follow-up extension projects. Eventually SnowSchool students might one-day become volunteer SnowSchool educators and continue their learning through teaching, self-guided study and ongoing SnowSchool trainings.

Additionally the SnowSchool curriculum is designed to align with existing state science standards, the newer Next Generation Science Standards and the Common Core State Standards. This is important component of the program because SnowSchool is intended contribute to K-12 students' overall learning and academic achievement. Also, when field-trips are aligned with teachers' required curriculum it makes it much easier for them to justify their students' participation. Details regarding this curriculum alignment appear throughout this document.

Between 2012 and 2017 Winter Wildlands Alliance conducted a series of evaluations of the program's science curriculum. For this evaluation hundreds of students completed pre and post SnowSchool science quizzes. The results showed that when students participated in three simple and specific experiential snow-science/water-cycle activities during the SnowSchool program, dramatic increases in student science learning occurred. These "three essential" activities are fun, help students learn through firsthand experience and encapsulate an important theme of ecological interconnectedness between snowpack, watershed systems and human use of water. To fit into the context of a K-12 school that is surrounded by snow, the SnowSchool three essential activities (snowpack depth assessment, snow/water equivalency experiment and watershed map) have been modified to help students explore these topics each year during their entire K-12 career (hence the spiraling curriculum). Together these activities combine to create a powerful learning experience that solidifies the connection between nature, science and the students' own lives.

Snow Science Background Information:

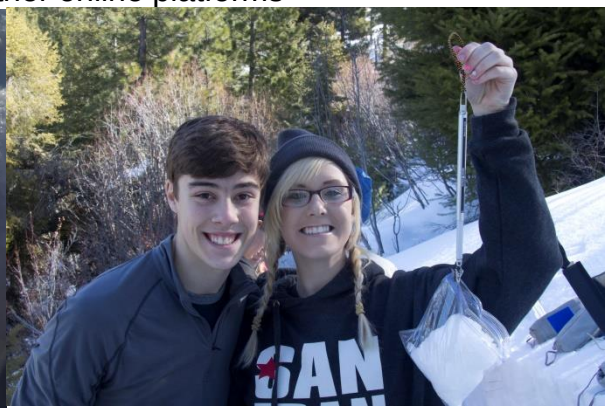
You will most likely want to review some of these foundational science concepts in the classroom before heading outside with your students:

- **Snow science** is a current field of science exploring questions in three main realms- Water Supply (*How much water do we get from snow?*), Avalanche Forecasting (*What types of snow conditions produce avalanches?*) and Climate Science (*How is annual snowfall and global snow distribution changing over time?*) The SnowSchool program focuses primarily on exploring snow science in the context of Water Supply and Climate Science.
- Snow is part of the **Water Cycle**. Water cycles through the Earth's landscape in an endless process and goes through many changes along its way from the ocean to the mountains and back again. The sun heats the liquid water in oceans and lakes causing the liquid to ***evaporate,*** or turn into a gas. The water molecules then rise on warm air currents into the atmosphere where they begin to cool which causes ***condensation***. Condensation of water molecules from a gas to a liquid usually occurs around a dust particle. When enough molecules condense clouds begin to form.If the condensation process occurs at temperatures below 32 degrees F then ice crystals begin to grow from the water and form ***snow crystals*** or flakes. Once enough water molecules condense either as a liquid (rain) or as a solid (snow) and join together, they get heavy enough to fall back to the earth. This is called ***precipitation.***
- A watershed is an area of land where all the water drains to the same place. Most watershed are named by the river or stream to which they drain. The start of the watershed is located high above at the tops of the surrounding mountains.
- Accumulated mountain snow, usually referred to as the **snowpack**, is a critical component of many watersheds. When it melts it provides liquid ***runoff*** water for plants, animals and fish in streams and rivers, as well as for human needs such as irrigation and drinking water. In the Western US, for example, snow provides 75-80% of the annual water supply (that's eight out of every 10 glasses students drink at home)! Domestic and commercial use, irrigation supply and recreation are a few of the social and economic impacts that snowpack has on a region. Understanding the important ecological connection between a local community and its snowpack is an essential SnowSchool goal.
- **Depth** is an important measurement of the snowpack that is monitored closely by scientists. Because of factors like elevation, sunlight, shade, plants, temperature and wind the depth of the snowpack varies immensely.
- **Density** is another important measurement of the snowpack that is monitored closely by scientists. Because of factors like melting/freezing temperatures, crystal size/shape, snowpack weight and wind loading, the density of snow can vary greatly within the snowpack. Because the density of water never changes, the density of snow is synonymous with water content. For example, if you melted a container of snow and discovered it was half water, you could say that the density of the snow was 50%.
- **Snow water equivalent** is the depth of water that would result if you instantaneously melted all the snow on the ground in a specific location.

Snowpit Analysis and Citizen Sci. 12th Grade

Objective: Students will conduct a snowpit analysis to record snowpack depth, density and SWE. Students will submit data as part of ongoing citizen science research.

1) Students use shovels to expose north facing wall of snowpack
2) Students measure total depth with meter stick
3) Students use thermometers to measure and record the thermal gradient of the snowpack
4) Using visual observations and a hand hardness test students identify and record prominent layers in the snowpack stratigraphy
5) Using macro scopes and blue cards (with millimeter grids) the students will record the grain size and type (new snow, rounded, faceted).
6) Students use personal cameras to capture images of snow crystals
7) Students discuss the presence of depth hoar, ice, wind loaded layers and how this might influence depth/density readings.
8) Ask students to predict SWE
9) Students use 250 cubic centimeter density cutters to extract stratified samples of the snowpack.
10) Starting with the top layer of the snowpack students take a snow sample every 10 centimeters.
11) Students use the spring scale and plastic bag (tare first)
12) Each sample is weighed on the spring scale the weight (grams) is recorded on data sheet provided.
13) Students calculate density (% water = (weight in grams x 4) / 10)
14) Students calculate Snow/Water Equivalent (SWE = average density x depth)
15) Students discuss the accuracy of their predictions, tools, techniques and measurements
16) Students will enter the data online via Mountain Hub or Snow Obs http://communitysnowobs.org/ or other online platforms



Curriculum Connection:_NGSS (HS-ESS2-2): Earth's Systems: Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.

Weather Station Interaction Activity 12th Grade

Objective: At the snow-monitoring weather station used for the Snowpack Prediction Contest students will make observations about the site location and factors that could influence snowpack accumulation, depth and density at the Weather Station site. Students will experiment with sample weather station components to explore sensor functioning.

Procedures:

1) In groups students take notes regarding the elevation, aspect, sunlight/shade, vegetation, slope, wind and landscape. These notes will be used to inform the follow-up extension project.
2) Students are introduced to weather station, an important piece of instrumentation for snow science.
3) Students discuss weather station sensors and the purpose, each sensor provides one or multiple pieces of data to tell the current conditions and predict what's next.
4) Students discuss and propose what sensor should be included.
5) As a side project, students can be given the opportunity to work on assembling a weather station.
6) If travel to the weather station is not feasibly, studying maps online may be an alternative.

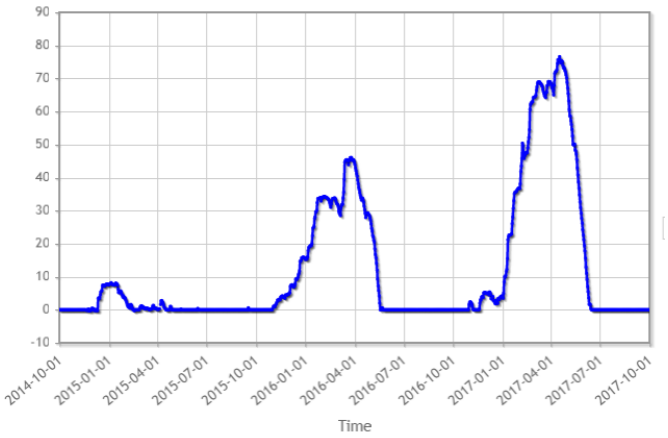
Curriculum Connection: NGSS (Practice 6) Constructing Explanations (for science) and Designing Solutions (for engineering)

Schoolyard Snow Survey

Transform your schoolyard into a multi-year snow survey site!

Background: Many of the important trends in snow science require making observations over a period of time much longer than just one day or even one winter. Thus studying snow requires collecting data across multiple years. This activity allows students to participate in this long-term effort by transforming the landscape around the school into a snow survey site. This activity starts in 3rd grade and continues with increasing sophistication through each grade level.

How to do it: The easiest way to start this activity is to place a semi-permanent snowpack depth stick in a spot that is easy to observe but also will remain undisturbed by humans (you don't want the snowpack depth to be altered by people stepping on the snow around your depth stick). **Its probably best if there is one snow survey spot and depth stick for each school.** For each day of the winter that there is snow have students go observe the depth and then record it on a classroom graph. After a couple winters you should have a graph/graphs that look something like this:



Questions for 12th Grade Students:

- *What trends over time do you see?*
- *Using the data you found by completing the snowpit analysis estimate the amount of water in your school yard.*

Curriculum Connection:

Common Core State Standard MP.2: Reason abstractly and quantitatively

Snowpack Prediction Contest

Background: The Snowpack Prediction Contest challenges students to make predictions about how much snow will accumulate in the mountains around them. It uses live data for remote weather stations in the students own watershed. This extension activity works best if students have done the three previous outdoor activities: The idea here is that entry into the contest is relatively simple and takes little time. However, as the contest continues over the course of the winter and spring teachers will continually discover opportunities to connect SnowSchool related knowledge and information to their regular classroom explorations. Additionally, the design of the contest prompts students to analyze historical snowpack data allowing for greater connection to Common Core State Standards and alignment with the Next Generation Science Standards.

How to do it: To do this activity in the manner that is outlined in this guide you will need to first have the WWA SnowSchool Director construct a webpage to host the contest for you and your students. Its important that we keep this focused on your local area so students can make connections to their own community and lives. You can view Snowpack Prediction Contests happening in your area and around the country by visiting: https://winterwildlands.org/snowpack-prediction-contests/ If you don't have one already created for you, you can request it by contacting- kmcclay@winterwildlands.org

The Snowpack Prediction Contest webpage will provide instructions, prompt students to participate in the challenge and guide the exploration to conclusion.

Note: Middle/High School students have extra challenges including entering a prediction for the amount of snow/water equivalent on April 1st and a prediction for the first day of the spring that the SNOTEL site will read "0" (AKA melt completely).

Connection to Standards- When combined with in-class presentations and the SnowSchool field trip, the Snowpack Prediction Contest may connect to the following national curriculum standards:

NGSS (CCSS-MS-ESS2-4) – Develop a model to describe the cycling of water through Earth's systems driven by energy from the sun and the force of gravity.

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

Common Core State Standard (High School Math Content): Modeling

Common Core State Standard MP.2: Reason abstractly and quantitatively