SNOWSCHOOL

6th 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

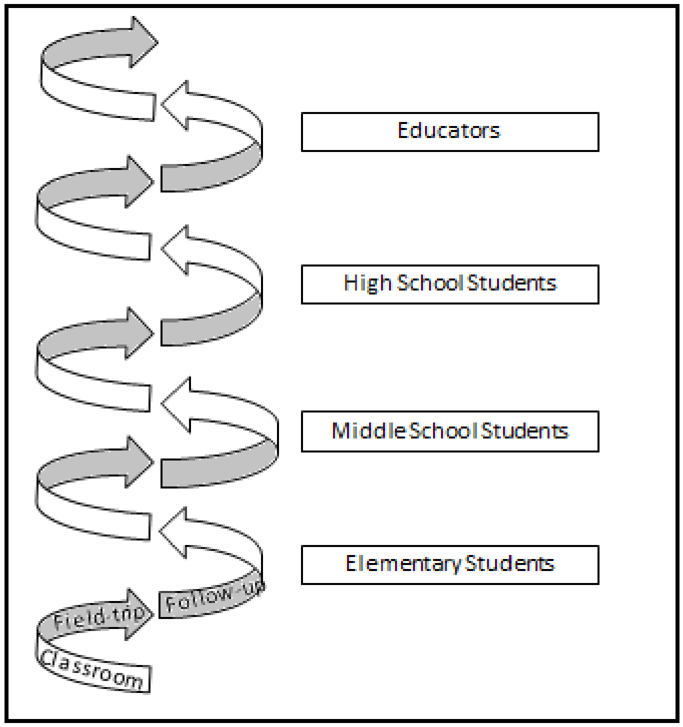


Figure 1: SnowSchool's spiraling curriculum model enables students at a variety of grades levels to explore snow science and ecology in a manner that connects classroom study, field excursions and follow-up extension projects. Eventually SnowSchool students might one-day become volunteer SnowSchool educators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

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.

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 curriuculum). 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.

6th Grade One Page Curriculum Outline

Group: 30 6th Grade Students

Focus: Snow and Water Science

Objectives (what we want the students to learn):

- Students will explore properties of snow/snowpack; variability of depth, density, and albedo
- Students will explore watershed systems and the local role of snow in the water cycle

Outcomes (how we will know the students learned):

- Students will have the opportunity to describe what they know about snow
- Students will create a model of their local watershed
- Students will make hypotheses, predictions and draw conclusions based on results of snow science experiments and activities

Three Phases of the SnowSchool experience:

Classroom Intro

- Students are introduced to relevant science concepts in their classroom by their classroom teacher

Field Experiences

- Students measure snowpack depth and SWE
- Studnets build a watershed map
- Students complete snowpack dust experiment

Follow-up Project

- Students participate in the Snowpack Prediction Contest

Watershed Map
6th Grade

Background: This activity draws on the students' natural desire build with snow. This is a more advanced version of the 5th grade Watershed Map activity. Before beginning the activity, review with the students the concept of a watershed.

Prep the students: Break the students into teams. Introduce the challenge: *Work together with your team members to build a model of your local watershed in the snow*. Talk with the teams (show pictures if you have them) about the elements of your local watershed mountains, streams, lakes, rivers, reservoirs, cities/towns, forest, farmland, valleys, dams, and anything else of note. Give the students time to come up with a plan for their model.

Head outside: Give each team their own space to work on creating of their watershed.

Share: Lead the students through a "Gallery Walk" of each of the teams model. Ask the group – *What elements of our watershed were captured well with this model? What elements of our watershed were missed?*

Curriculum Connection:

NGSS (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

Snow Water Equivalency Experiment 6th Grade

How to do it: This is a simple activity that builds on the 5th grade version and challenges the students' knowledge about the nature of snow and water. Several (2-3) clear plastic cylindrical containers are necessary. Use these SWE containers to sample the snow. For the first sample try to retain the true density of the top layer of fresh snow (that means don't pack it in, do your best to collect an as-is sample). For the subsequent samples try to find or create some denser snow. Consider sampling the snow farther down in the snowpack, or find some windblow/drifted snow or even just pack the snow into the container with your hand.

Ask questions: *How full will each of these containers be once the snow melts? Will there be significant difference?* It's helpful if your container has some depth/percentage markings on the side to help illustrate quantity. Get a hypothesis from every student. Then have the students feel how heavy each container is and weigh them.

Run the test: Melt the samples (slowly overnight or use a microwave)

Discuss the results: Show the kids how much water there is. Here are some good follow up discussion ideas: *How close were your guess? What percentage of water was the snow? What does this mean in terms of the water content of our local snowpack? How would variability in snow density make it challenging for scientist to estimate the amount of water stored in the mountain snowpack? Given the varying density and depth of the snow in the schoolyard right what is the range of possible SWE?*

Make connections: It's nice to have some facts to share about how much local water comes from the snowpack. For example, in the Western US 80% of the local water supply comes from mountain snow. This fact helps highlight how important snow is to the local ecosystem and human community.

Materials: SWE container and microwave

Curriculum Connection:

NGSS (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

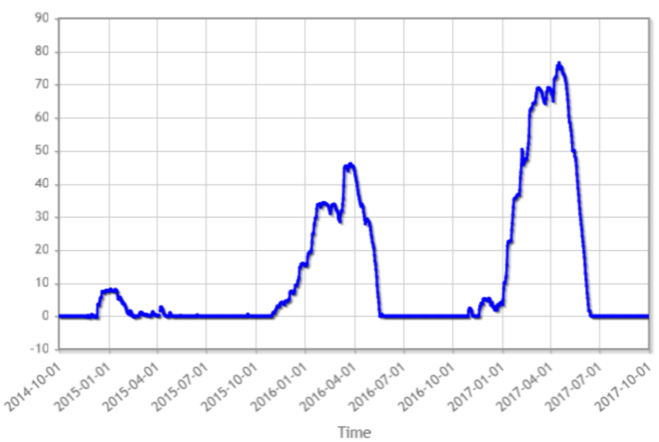
Common Core State Standards (CCSS.MATH.CONTENT.6.RP.A.3) - Use ratio and rate reasoning to solve real-world and mathematical problems.

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 6th Grade Students:

- *What trends over time do you see?*
- *Based on your snowpit experience do you think the depth would be different if the snow survey was in a slightly different location?*
- *Using the percentages of water you found by completing the snow/water equivalency experiment, estimate the depth of water in your schoolyard right now?*

Curriculum Connection:

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

Snowpack Dust Experiment 6th Grade

Background Science: Dust settling on the surface of the mountain snowpack is itself an increasingly frequent phenomenon and a research topic of interest to snow scientists. And while studying dust particles on the surface of mountain snow might sound obscure at first, the impacts are so profound that some snow scientists are now suggesting that dust may be a more significant driver of accelerated snowpack melt than air temperature. Thus, this experiment makes for an ideal SnowSchool activity with the potential to provoke rich science-based discussions among student participants.

Materials: Depth probe or measuring stick, shovel, 2-4 pieces of cardboard (at least 3 feet long), various natural debris such as dust, sand, dirt or duff, flagging

Setting it up: This activity requires very little equipment, but it does necessitate a bit of preparation. Depending on the time available, you could opt to either set this up yourself, or have your students help you. The first step is to identify an undisturbed patch of snow to do the experiment. This should be in an exposed spot free of shade. The next step is to create 1 meter x 1 meter plots covered with dust, duff and/or sand (also, be sure to leave a control plot that is just snow). In the example below, we made two plots using dark colored duff and a greyer granitic sand. Both were found on site and collected using a metal shovel. Using the same amount of each element, we created the plots by using recycled cardboard for borders and sprinkling the two elements over the snow.

The cardboard was a simple but critical component that created the square shape and well-defined snow/sand border that later helped capture the students' attention visually. We used a probe to measure the snowpack depth in the center of each of the three plots (sand, control and duff) and took notes in order to make accurate comparisons later.

Wait and let the sun work: Keep in mind this experiment is best done in spring, and depending on the amount of sun it may take a couple of days to see significant changes. In this example, we waited approximately 1 week before inviting the students to make observations.

Exploring the results with the students: A week after making the plots we came back and measured the changes, which you can see recorded in the chart below. This activity reminded us of investigating animal tracks in the snow with students- it's a fascinating but very fragile phenomenon! In order to avoid your experiment getting trampled in the first 10 seconds of the activity it's important to set-up a border. We used irrigation system flagging, which worked well. We explored two approaches to framing the activity with students:

As a Science Experiment: When the students arrived at the site, we informed them that we were doing a science experiment and asked them if they would like to help. After capturing their interest we spread out around the plots and asked a series of questions:

- *Based on what you see, what do you think I am studying here?*
- *What has happened so far in this experiment?*
- *What are the differences between the three plots?* (Note: We had the total loss/melt for each plot written on large pieces of cardboard)
- *Why did the darker plot melt faster than the other two?*
- *Why would we care to study this?*
- *What or who would this affect?*

Plots=	**Sand**	**Snow**	**Duff**
Depth Before	64cm	70cm	56cm
Depth After 1 Week	36cm	58cm	21cm
Total Loss (Melt)	**-28cm**	**-21cm**	**-35cm**

As a Snow Mystery: Sometimes it is simpler and less contrived to just ask a curious group of kids to describe what they see and invite them to solve a natural mystery. In this case, you may be able to explore the science of snowpack albedo without actually having to frame the activity as a science experiment. In some cases the absence of a science-based agenda may provoke a richer and more authentic analysis of the plots.

Extending involvement: The most impactful activities are both science-based AND hands-on for the students. To further engage your students one possibility may be to have some large plots ready for them to conduct their own experiment. Invite them to take even handfuls of sand/duff and spread them as evenly as possible over the plots (you will notice some less-than-even sprinkling in the photo below). Make sure to have a control plot for comparison. Lastly, ask them to make a hypothesis about how many days it will take for them to melt all the way to the ground.

Curriculum Connection:

National Science Education Standards (Earth Science) - Students should develop an understanding of the structure of the earth system

NGSS (MS-PS4-2): Develop and use a model to describe that waves are reflected, absorbed, or transmitted

NGSS (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 (MS-ESS3-5): Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

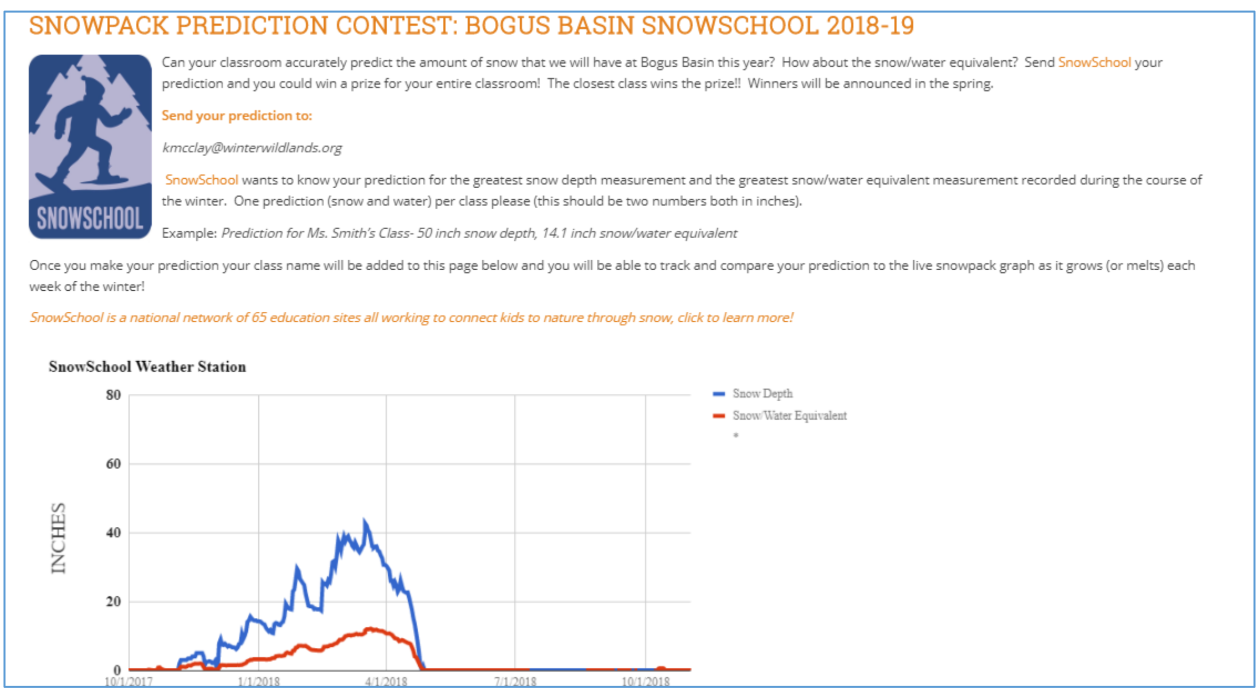
Common Core State Standard MP.2: Reason abstractly and quantitatively

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:



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:

Common Core State Standards (CCSS.ELA-Literacy.W.3.8) - Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.

Next Generation Science Standards (5-ESS2-2) – Describe and graph the amounts and percentages of water and fresh water in various reservoirs to provide evidence about the distribution of water on earth.

Common Core State Standards (CCSS.SL.5.5) – Include multimedia components and visual displays in presentations when appropriate to enhance the development of main ideas or themes.

Next Generation Science Standard (4-ESS2-2) - Analyze and interpret data from maps to describe patterns of Earth's features.

Common Core State Standards (CCSS.5.G.A.2) – Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane and interpret coordinate values of points in the context of the situation.

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.

Common Core State Standards (CCSS.MATH.CONTENT.6.SP.A.2) - Understand that a set of data collected to answer a statistical question has a distribution which can be described by its center, spread, and overall shape.

Common Core State Standards (CCSS.MATH.CONTENT.6.RP.A.3) - Use ratio and rate reasoning to solve real-world and mathematical problems.