Lesson Title: Snow Tracks Can Illuminate Many Things: A Detective Exercise

NSF GK-12 Fellow: Tommy Detmer (Boulder, CO)

Grade Level: Middle School

Type of Lesson: STEM

Objectives: 1) Learn how measurements in combination with observation can reveal information about the speed, size, and condition of the animal from its tracks, and 2) learn how to use inferential skills along with data answer questions with limited information available. The following Boulder Valley School District essential learnings for 7th and 8th grade science: *students apply the process of scientific investigation and design, safely conduct, communicate about, and evaluate such investigations; students know and understand characteristics and structure of living things, the process of life, and how living things interact with each other and their environment*.

Background Information: In sciences, as well as life, we often face situations in which we have less than an optimal amount of data and must try and draw conclusions from that incomplete information. Following animal tracks (even just people, dogs, or squirrels) and investigating how tracks are made is a fun and exciting way to develop critical thinking, measurement, and graphing skills. Understanding animal tracking is an effective way to introduce these skills because it is essentially a detective game. In order to get the most out of the tracks that are available, just like in science, one must employ observational, measurement, and mathematical skills.

Basic skills in conducting a research plan are necessary for this lab. Basic measurement and graphing skills are also important for this lab; the lab uses line graphs and may or may not use a bar graph.

References:

Gibbons, Diane. 2003. Mammal tracks and sign of the Northeast. University Press of New England, Lebanon, New Hampshire.

Forrest, Louise. 1988. Field Guide to Tracking Animals in Snow. Stackpole Books, Harrisburg, Pennsylvania.

Halfpenny, James and Elizabeth Biesiot. 1986. Johnson Publishing Company, Boulder, Colorado.

Lesson Vocabulary: Choose an effective way to introduce STEM terms and the definitions necessary for successful participation in your lesson.

Track: the imprint left on the ground by a single foot

Track length: is equal to foot length or shoe size.

Stride length: is the distance from a point of one foot to the corresponding point of the next track of the same foot

Speed – the rate of travel in units of distance over time

Correlation – the relationship or connection between two or more variables

Materials Required:

Tape measure or meter stick (1 per group of 3-4 students)

Stopwatch (1 per group)

Preparation: Part of this lesson occurs outside in the snow (fresh snow is preferable). Because of this, the students should be warned that they will be outside in the snow before the day of the lesson so that they can dress appropriately.

Safety Information: A portion of this lesson occurs outside in the snow and involves students running in the snow. Students should have clothing appropriate for the temperature, wind, and snow. In addition, students should be reminded to be careful because of the adverse conditions and all safety precautions associated with outdoor activities in the snow should be taken. If the weather or ground conditions are not safe, it is suggested that this lab be delayed or canceled.

Engagement: Explain to the students that, frequently, scientists don't have all the necessary information about a situation to understand exactly what is occurring. Not knowing all the components to answer a question is common in many occupations; the students will likely associate putting different pieces of evidence together with detective work. Successful scientists are able to use observational skills in combination with different measurements to come up with a likely answer to their question. This is analogous to imagining the picture that a puzzle creates based only on the information of some, but not all, of the pieces. To see what this is like, have the students try to complete the picture of the puzzle in the handout by finishing the picture.

An engaging way to practice the skills needed to answer scientific questions is by following, taking measurements of, and recording observations of animal tracks in snow. Ask small groups of students to describe to each other a situation where they saw a set of tracks, animal or human, and could infer something about what that animal or person was doing. Then ask the groups of students to fill out the list in the handout of things that can usually be deduced from finding a set of animal tracks (e.g., species, approximate size, speed of the animal, if it was chasing another animal, if it was digging up food, etc.). Next, ask the students if there is information that cannot be deduced from the tracks (e.g, a dog's fur color, if a person is wearing a hat or not, or what a squirrels favorite food is).

Exploration: Tell the students that the goal of today's activity is to use measurements to answer two questions with graphs and come up with evidence that describes a scenario in the snow.

The first question for the students to answer through experimentation is whether or not height of a person can be estimated from their tracks in the snow (shoe size is related to a persons height and therefore show track length is correlated with height). Tell the students that their data will be combined with the rest of the classes to help them create their graph. *If the students are struggling to come up with a method to come up with the data, remind them that because they don't have access to the general public and a million different tracks as would be ideal for this study, they will need to record their own height and their shoe track measurements*. The students will record the data for their group in the field and graph it in the classroom once they have all the other students' data.

The second question for them to address is whether or not student speed can be determined from a persons tracks. *Stride length is the distance from a point of one foot to the corresponding point of the next track of the same foot. Stride length is correlated with speed but is not the only determining factor (stride rate is also important). As a result, this graph should show a trend but not be as tightly correlated as height.*

Finally, ask the students to break into groups of twos. Have one student walk for a few steps either normally or with a limp and then switch for a few steps. Have the second student deduce which strides were normal and which were with a limp and then have them switch roles. Have the students record what evidence they used in determining which steps were made normally and which were made with the limp.

After the students have accomplished all three of the tasks have them return to the classroom to warm up and process their data.

Explanation: In the classroom, have the students describe what data they collected for the two graphs and what observations they recorded that helped them decide if the other student was walking normally or with a limp.

Compile all of the data of student track length and height, so that the students have more data to work with. Next, have them create a graph describing the relationship between track length (foot size) and height (this is clear as a scatter plot). If the students are familiar with statistics, have them draw a trend line and write the equation relating foot size to height. Ask the students whether or not they think this can be done with other animals and what other data they would collect if they came across a set of tracks in the woods.
Finally, ask the students to complete their graph for their group relating stride length to speed and have the students display their graphs. There are many correct ways of doing this, most students will create a scatter plot to mimic the first graph but others may create a bar plot showing walking and running as different bars. Both of these methods are correct and convey the message that a strides length increases as speed increases.

Elaboration, Extension: If there is time and it isn't too cold you can do the next two tasks outside, if not both can be done in small groups conceptualizing and sketching the following scenarios. First, follow animal tracks (dog or squirrel will do) and try to determine what the animal is doing and what measurements could be useful in describing the animal's activities or comparing across a larger population of that species. Second, break the class into small groups and have each group of students act out a story either as people or as animals. Then have each group analyze each other group's tracks and try to decipher the story using the evidence that is available. Have the students list the evidence as well as measurements that may be important in supporting their ideas about what occurred and see how well it matches the story.

Evaluation: Have the students fill out the final question of the handout.

Wrap-up: Have the students consider and record in their science journals how they could use the skills they learned in this lab in analyzing other events, such as a car sliding on the snow.

Snow Tracks Handout

Name: _____
Section: _____

Often times in science we don't have all the pieces to the puzzle for the question we are trying to answer. Using the information that is available fill in the rest of the picture below. In what areas are you most confident about what you are drawing? What areas are you least confident about what you are drawing?

In science we often need to decide what information we know and what information we don't know. If we were to find a set of dog tracks what information would we know or could we discover through observation and measurement? What information do we not know or can't find out?

What we know or can find out?	What we don't know or can't find out?
1. Approximate dog size	1. The dog's color
2.	2.
3.	3.

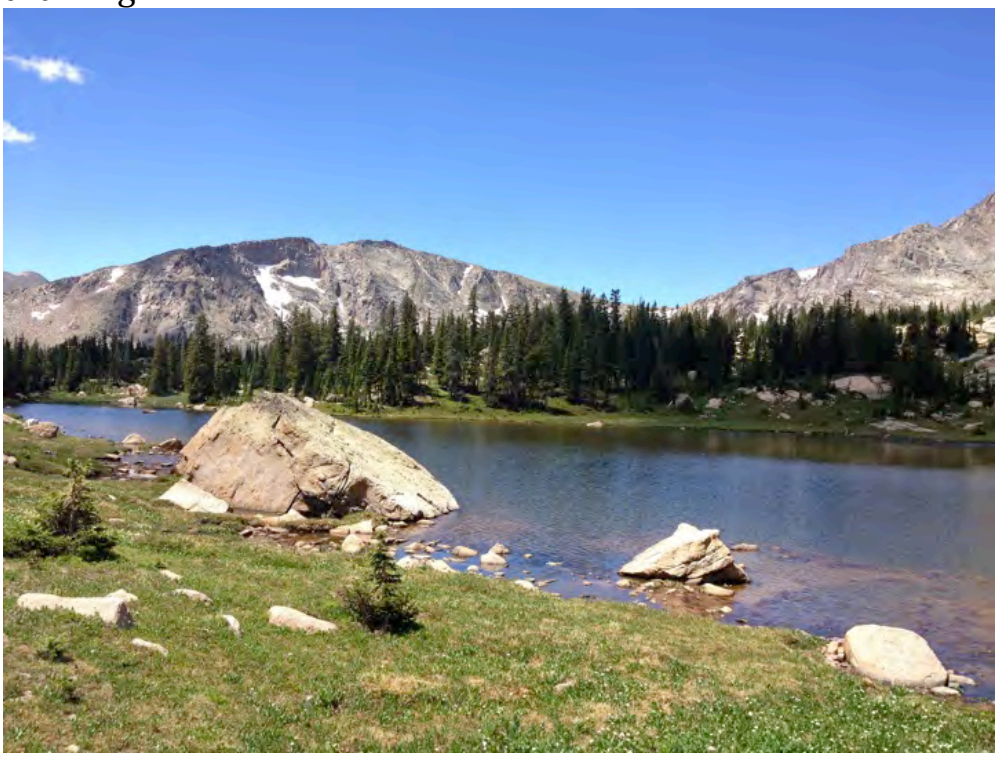
Snow Tracks Handout

Imagine you are in the woods and find a fresh set of animal tracks in some fresh snow. Write a list of characteristics you know about the animal that made the tracks. After following the tracks for a short distance you notice that the stride length of the animal doubles. What does this tell you about the approximate speed of the animal?

Snow Tracks Handout Answer Key

Name: _____
Section: _____

Often times in science we don't have all the pieces to the puzzle for the question we are trying to answer. Using the information that is available fill in the rest of the picture below. In what areas are you most confident about what you are drawing? What areas are you least confident about what you are drawing?



In science we often need to decide what information we know and what information we don't know. If we were to find a set of dog tracks what information would we know or could we discover through observation and measurement? What information do we not know or can't find out?

What we know or can find out?	What we don't know or can't find out?
1. Approximate dog size	1. The dog's color
2. *Speed of the dog*	2. *Where the dog came from*
3. *If the dog had any injuries*	3. *What the dog looked like*

Snow Tracks Handout

Final question
Imagine you are in the woods and find a fresh set of animal tracks in some fresh snow. Write a list of characteristics you know about the animal that made the tracks. After following the tracks for a short distance you notice that the stride length of the animal triples. What does this tell you about the approximate speed of the animal and what may be going on?

This is a very open ended question and many answers are correct. The best answers are creative answers based on the environment and how the animal is interacting with the environment.

You will likely know the species of the animal, what it was doing, it's approximate speed, and if it had any injuries. You also know what it is not doing if it isn't going near a nearby river to get water it likely isn't thirsty.

A tripling in stride length typically indicates a dramatic increase in speed and is likely because the animal is chasing prey or being chased.