Supporting the Development of Ecoliteracy in Middle School Students through the use of Phenology

By

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A capstone project submitted in partial fulfillment of the requirements for the degree of Master of Arts in Education: Natural Science and Environmental Education

Hamline University
Saint Paul, Minnesota
December 2018
This project was designed to answer the question *How does knowledge of local phenology impact the development of ecoliteracy?* A set of lesson plans and an accompanying website were created to support students as they build a base knowledge of where they live and what the surrounding ecosystem is composed of. The target audience for this project is students in grades six, seven, and eight in a middle school setting in science classes.

Ecoliteracy, one of the foundational parts of environmental education, strives to prepare youth for the challenges they will face regarding the condition of the environment and how humans have changed the Earth’s surfaces and structures (Goleman, Bennett, & Barlow, 2012, p. 2). To be ecoliterate, one must understand ecosystems and the relationships between all living things found within them. Sustainability and the protection of basic needs for life is driven by compassion and engagement. The Earth is treated as a living thing and decisions are based on the overall health of the global community as a whole. “Ecologically oriented citizens believe that we have a moral obligation to achieve sustainability, so that we do not diminish the chances of future generations to meet their needs” (Callenbach, 2005, p. 47).

Phenology, or the study of how seasonal biological changes happen over time, is one of the longest scientific traditions known and dates back to pre-agricultural times (BudBurst, 2018). Seasons have guided human activities and behaviors for as long as they have been on the planet and over time formal and informal data has been collected to track and plan for life and survival. Early journals and notes have paved the way for formal publications, all of which have provided a rich and detailed record of conditions and how they have changed over time.

In order for students to be able to collect data about living things in an area, they need to develop skills to identify what they are seeing. The lessons in this project help students learn
how to observe the natural world, understand similarities and differences between species for identification purposes, use field guides in order to accurately identify organisms, and document observations over time. The goal for this unit is not to memorize a list of animals, trees, plants, or birds. Instead, students will be able to readily recognize some very common organisms but, more importantly, develop skills of observation and understand tools they can use to identify organisms as they encounter them.

The intended audience of this project is sixth grade students, which is the grade level I will be teaching when running the project, but lessons and work could be adapted to other grade levels. According to data from the Minnesota Report Card (2018, p. 1), there are 930 students in our middle school in grades six, seven, and eight. Ethnic backgrounds represented in our building, by percents, are 5.8% Hispanic/Latino, 0.5% American Indian/Alaskan Native, 7.0% Asian, 7.7%, Black/African American, 74.7% White, and 4.2% identifying as Two or More Races. English Language Learners account for 2.4% of our population, 14.1% of our students qualify for Special Education Services, and 20.2% of our population receive free or reduced lunch support.

The lessons in this unit follow a structure developed and used by the school district where I work. The format was originally used for a Science, Technology, Engineering, and Math (STEM) certification cohort I was a part of and used to develop curriculum that would be shared within our district. As this unit is intended to be used in our district, I wanted to use a format that was consistent with previous work. Our district has been developing units after committing to adopt Next Generation Science Standards (NGSS) into our updated curriculum and the state of Minnesota is currently in the process of revising grade level science standards based on NGSS.
guidelines. I anticipate that the format of these lessons will be changed to fit updated expectations and approaches once standards at the state level are formalized in May, 2019.

The website, Phenowatch, was built to demonstrate how observations are documented and to provide background information and resources for students in our region. I chose two sites to make observations in, Lake Elmo Park Reserve and Oak-Land Middle school. The sites are just over two miles apart and are located in Washington County, Minnesota. They share the same geographic features and natural history and allow for a direct comparison to native vegetation. The same observation format used in the last lesson of the unit is followed for observations on the website so that students have examples of how data was collected. I also include pictures from each visit to document changes or note points of interest.

Homepage of website
Site Descriptions

Originally the City of Oakdale, starting in the mid-1800's, included what is now the city of Lake Elmo. The region was cleared for farming and railways in addition to the construction of hotels, refueling stations, businesses, homes, and cottages in the hopes that nearby lakes would draw visitors and bring tourism to the region. In 1951 the process of splitting Oakdale into smaller...
Observation (using same template as students are expected to use) with slideshow from visit

Observation

11/3/2018  0 Comments

Location: Lake Elmo Park Reserve, Southeast trail along Bald Eagle Lake and up along east side

Weather: 36° F, overcast, ENE winds 5 mph (NOAA forecast)

Birds: Nuthatch (multiple), Blue Jay, Black-Capped Chickadee (multiple), Canada Goose (6)

Mammals: Eastern Gray Chipmunk (at least 2)

Insects: none seen or detected

Reptiles/Amphibians: none seen or detected

Flowers: none seen

Trees: Bur Oaks still have a lot of leaves on them, dried Sumac berries left on tips of branches while leaves have all dropped off

Humans: Heavier use on this end of trail. Youth group orienteering and leaders have campfire going near parking lot. Smells really nice.

Unusual Activities or Changes I noticed: groups of young people with maps and compasses

I Wonder: why I am hearing so few birds lately...
Common species information

Bur Oak Trees
11/2/2018 0 Comments

Bur Oaks, Quercus macrocarpa Michx., are a part of the Fagaceae, or Beech, family and are the most common type of oaks found in Minnesota. They are relatively slow-growing and typically reach two hundred to three hundred years in age with some native stands reaching four hundred or more years. They can be found across all but a small section of Northeastern Minnesota extend north into Canada; West into the Dakotas and parts of Nebraska, Kansas, Oklahoma, and Texas; South through Iowa,

Bringing together the lessons and website, students will be able to identify and describe the world around them and begin to document what they see and learn. With those connections, we as a science teaching team can build on the idea that we are a part of something bigger and the part we play matters.
Unit Name and Description

This unit is called Phenology Studies and will focus on the skills needed to be able to identify living things within a local ecological system. Students will develop skills to be able to differentiate between species of plants and animals in order to list and describe how their local system appears and changes over time.

The website associated with this unit plan is called Phenowatch and can be found at http://www.phenowatch.com/. The site will be updated and future unit plans will include student input as guest citizen scientists.

Unit Overview Rationale

Students will need identification skills and strategies in order to understand how ecological systems have interdependence. This unit will form the foundation for exploring how humans impact living systems, what their role is in those systems, and how to work with others to promote positive change and conservation. After completing this unit, students will begin work with whole systems and the interactions within and with humans.

Standards Addressed In Unit

Next Generation Science Standards (NGSS), written as Middle School Standards for Grades 6-8 Science and Engineering Practices; Obtaining, Evaluating, and Communicating Information MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.
Minnesota State Standards

Science, Written by grade level but based on Next Generation Science Standards (NGSS) - First draft for 2019 Standards published November 2018. Final draft expected to be completed and approved by May, 2019.

Social Studies Standards

6.3.4.10.1 Describe how land was used during different time periods in Minnesota history; explain how and why land use has changed over time.

Minnesota English Language Arts Standards

Reading

6.5.4.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings.

6.5.7.7 Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.

Writing

6.7.10.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Unit Goals

Students will be able to understand how identification keys and guides are used in order to identify species of plants and animals. Students will also develop procedures for recording what they see and how they interpret and represent the world around them.
**Big Ideas/Essential Questions**

The natural world is not static, there are changes that can be tracked and recorded over time.

Even in winter, change is happening and living things continue to grow and survive.

**Lessons In This Unit**

Lesson 1, Similarities and Differences

Lesson 2, Observations vs Inferences

Lesson 3, Nature/Observation Journals

Lesson 4, My Tree

Lesson 5, Dichotomous Keys

Lesson 6, Minnesota Tree Identification

Lesson 7, Field Guides/ Minnesota Birds

Lesson 8, Phenology

Lesson 9, Collecting and Reporting Data

**Future Units;**

Building a Website and Online Safety

Ecology and Ecosystems

Climate and Environment

Human Interactions and Impacts
Phenology Lesson 1

Similarities and Differences

Name: Amy Hamernick

Subject Taught: Science

Grade Level: 6

Topic of Lesson: Comparing and contrasting based on observable characteristics

Unit: Phenology Studies

Objective:

Students will be able to group items based on shared observable traits. Students will be able to justify their reasons for categorizing items.

Standards:

NGSS

Science and Engineering Practices; Obtaining, Evaluating, and Communicating Information

MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

Minnesota Reading

6.5.7.7 Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.

Rationale:

When using identification tools like field guides, students will need to be able to identify characteristics and traits that distinguish living and non-living things from each other. This
activity allows students to determine how objects are similar and different.

**Instructional Strategies:**

Guided Discovery

Small working groups

**Duration:** 45 minutes

**Materials:**

- Sorting sets with enough to have one packet per student group (I have them in folders and ask students not to write on sheets, you could use plastic protector sheets. I have also numbered the bottom objects on each section in order to give students a way to identify which of the items they are choosing for the activity)

- science notebook and pencil per student

- Group Sorting Sheet

**Resources:**

Table or desk space to share sets of sorting sheets

**Activities:**

- Introduce activity using the first page Creature Card 1 Gligs. Read through the three sets of items and ask student teams to determine which of the third group are gligs. They can list their choices for Gligs (easier if you have numbered the items in the third set) on a shared/group sheet of paper.

- As a whole group, ask students to share which are gligs and why. Discuss any disagreements to come to class consensus. Make sure they have clarified what Gligs are (open shapes) and what they are not (closed shapes).
• Talk about how scientists classify living and nonliving things based on things that can be observed and compared or contrasted. The goal of sorting is to be able to distinguish between things we are studying.

• Continue as a group with the Globs page, come back together to discuss responses. Again, make sure that students have clarified what Globs are (curved, closed figures) and what they are not (figures with straight sides and angles)

• If students have the idea, ask them to continue working as a team to identify the figures for each section with characteristics/descriptions included. They will fill in their Group Sorting Sheet as a team.

• Have groups check their answers with you before moving on to each next set.

• When done, ask students to create their own set of figures with rules in their science notebooks.

Extensions:
Students could be introduced to field guides (trees, birds, mammals, plants) to start exploring how they are organized. They will get more formal instruction in a later lesson.

Accommodations & Modifications:
Make sorting sheets available digitally with an online shared answer sheet

Assessment:
Check notebook entries for figures and rules
Collect group sheets to check for understanding
<table>
<thead>
<tr>
<th>Group Names</th>
<th>Characteristics that are</th>
<th>Characteristics that are not</th>
<th>Identify</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glorbs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plubs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Zergs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foobs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sprogs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bleems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Migwogs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Galoops</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Phenology Lesson 2

Observations vs Inferences

Name: Amy Hamernick

Subject Taught: Science

Grade Level: 6

Topic of Lesson: How inferences differ from observations

Unit: Phenology Studies

Objective:

Students will be able to determine the difference between inferences and observations when viewing a picture or assessing a situation.

Standards:

NGSS

Science and Engineering Practices; Obtaining, Evaluating, and Communicating Information MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

Minnesota Reading 6.5.7.7 Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.

Rationale:

When making observations and collecting data, students will use both observations (taking note of things we can sense through touch, taste, sound, sight, or hearing) and inferences (to explain
what we are seeing or experiencing based on research, information, and experiences). Phenology involves the collection of data as observations along with the interpretation over time of what has been observed.

**Instructional Strategies:**

Direct instruction

Large group discussion

Small working groups

Individual work time

**Duration:** 45 minutes

**Materials:**

- Examples of observations vs inferences images, particularly the *Goat by the Water* picture
- You could also use magazine pictures, either sharing images on a board or having sets that are used by table groups
- Old magazines that can be cut up or have pages removed
- Science notebooks, loose sheets of paper, and pencils

**Resources:**

Desks or table space to work

Glue or tape

**Activities:**

- Show students the image you selected to share, either on the board or as copies for student groups. Ask them to list, on a piece of paper, what they “see”. Each thing they
list should be on a separate line. Check in after about 5 minutes to see if students need more time or are finished and adjust accordingly.

- Using a T-chart in science notebooks (does not have to fill a full page, should be no longer than a third to half a page), ask students to list Observations on the left side and Inferences on the right side

- Define observations in the left space below the T-chart line. Observations can be quantitative (measurable) or qualitative (describing qualities like size, color, or shape). Observations tend to be objective in nature.

- Define inferences in the right space below the t line. Inferences are made using observations and information we gather to explain something. Inferences require people to think about cause and effect relationships and allows us to fill in gaps in a story based on what was observed and what we know or have learned. Inferences consider patterns and trends from observations.

- Direct students to go back to their lists and identify, using an O or an I, each of their comments on their lists

- Have student groups compare their responses and O/I identification, then come together as a group to discuss results.

- Allow students to choose between drawing or finding a picture in a magazine and using the t-chart in their notebooks, identify observations and inferences. Pictures from magazines can be taped into notebooks for later reference.

**Extensions:**

Follow with nature observations work
Accommodations & Modifications:
Create T-chart ahead of time to tape or glue into notebooks

Assessment:
Science Notebook check using scoring rubric
Phenology Lesson 3
Nature/Observation Journals

Name: Amy Hamernick

Subject Taught: Science

Grade Level: 6

Topic of Lesson: Recording observations

Unit: Phenology Studies

Objective:
Students will be able to document observations through lists, sketches, and photographs.

Standards:
NGSS

Science and Engineering Practices; Obtaining, Evaluating, and Communicating Information

MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

Minnesota Writing

6.7.10.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Rationale:
In order to record observations, students need to practice and develop routines and procedures to accurately document what they are experiencing. In Phenology, accuracy and scientific methods
are expected when collecting data.

**Instructional Strategies:**

Direct instruction

Individual work

**Duration:** 2 - 45 minute sessions, then ongoing at regular intervals

**Materials:**

Science notebooks

Pencils

Color pencils/art pencils

Pictures of local leaves, trees, or birds OR samples of local leaves, acorns, seeds, other items to sketch

**Resources:**

Outdoor space

*Keeping a Nature Journal* by Clare Walker Leslie and Charles E. Roth

**Activities:**

- Introduce nature journals and why we keep them (helps us record what we experience when outdoors, allows us to find creative ways to remember events or sites, gives us a way to track changes over time, nature often inspires music/art/writing).

- Show selections from *Keeping a Nature Journal* (and emphasize that this is by someone with a lot of practice and time put into their work - students are not expected to show this level of skill but it is something we can aspire to). I typically mark specific pages that inspire me or show the process of sketching like pages 11, 23, 24, 29, 43, 72, 79, 111,
129, 138-139, 167, 184-185. Some are more loose and simple, but still give you a picture of what was observed, and some are more detailed to see how a sketch may develop.

- Using either a projection screen with pictures of common local trees, leaves, birds, or animals OR using samples of local leaves, seeds, acorns placed at table groups, have students practice sketching, with detail, the items you are displaying. Students are looking for general shapes and outlines before adding details to their work as they sketch in their science notebooks.

- Tell students you will be going outside to make some observations and entries into their science notebooks. They will be expected to note the date, the weather (provide this information for them) and the time you will be outside. They will then make a detailed sketch of something close (on the ground or on a plant/shrub/tree) and a “view” of an area from further away that would include layers and levels (grass, trees, shrubs, etc.).

- Remind students that they should not be picking flowers, leaves, berries, or other parts of plants, they are using their sight only. Students will need to stay on paths and mowed areas unless given specific directions to enter wooded or grassy areas and there should not be any garbage or damage left behind once they are done with the activity.

- Give students a time limit, range where they can travel, and a signal for when they will return to you, then send them to get their 2 sketches completed. I usually require that students are spaced away from each other and that they are not talking and visiting during sketch time.

- Once group has gathered back together, ask students to share their work with at least two other people and talk about what they saw and what they drew.
● Ask the group to spread out, away from each other, around you. Tell them they will now be listening and paying attention to what they see, hear, smell, and feel (with no one talking) for 3 minutes. They can write as they notice things but there should be no other sounds from the group.

● Return to the classroom

**Extensions:**

If weather does not permit, collect natural items like stones, pinecones, leaves, seeds, and grass for table groups to sketch. Provide hand lenses to work on details.

I have also had students practice sketching the two sides of one of their hands, paying attention to marks, wrinkles, folds, and other characteristics for practice.

**Accommodations & Modifications:**

Pre-print nature journal pages with prompts for sketches you are looking for (a small object, a tree, etc).

Allow students to use cameras or capture video while outside to digitally document what they observe.

**Assessment:**

Science Notebook check using scoring rubric (or digital document check using same criteria)
Name: Amy Hamernick

Subject Taught: Science

Grade Level: 6

Topic of Lesson: Observing an object with detail and having a reference point

Unit: Phenology Studies

Objective:

Students will be able to use observable characteristics to identify a tree and document how it changes over time

Standards:

NGSS

Science and Engineering Practices; Obtaining, Evaluating, and Communicating Information

MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

Minnesota Writing

6.7.10.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Rationale:

To develop skills to pay attention to details, and to understand the concept of documenting
change over time, students will identify and make regular visits to a specific tree. This tree will serve as a reference point for observations made when documenting Phenology data.

**Instructional Strategies:**

Direct Instruction

Individual work

**Materials:**

Science Notebooks

Pencils

Art pencils (optional)

**Duration:** 45 minutes, then ongoing in regular intervals throughout unit

**Resources:**

Outdoor space with trees

**Activities:**

- In science notebooks, students will start a page titled My Tree
- Students will be choosing a tree, within the parameters you set, as the tree they will visit during the school year. Depending on availability, students may need to share trees.
- Students need to sketch their tree from a distance and with close details like bark, twigs, and leaves. Bark and leaf rubbings are ok as long as no damage is done to the tree.
- Students are not required to name the tree species, this will happen later, but they can give their tree a name of their own choosing.
- Once students have chosen a tree and completed sketching and labeling tasks, they need to document the location of their tree in relation to the building or a landmark. For
example, “my tree is located by exiting door 4A, walking 100 steps straight ahead, turning 90 degrees, and walking 40 steps” or “my tree is located 50 steps away from third base on the baseball field”. They can also draw a map.

- After all tasks have been completed, have students take turns introducing their tree to the rest of the class (or their student groups) and share their sketches and observations.

**Extensions:**

If cameras or devices are available, take pictures of trees and students to add to notebooks or in a digital file

**Accommodations & Modifications:**

If number of trees available is limited, assign groups to specific trees or choose a class tree to observe together and monitor over time.

**Assessment:**

Science Notebook check using scoring rubric
Phenology Lesson 5

Dichotomous Keys

Name: Amy Hamernick

Subject Taught: Science

Grade Level: 6

Topic of Lesson: Using dichotomous keys to categorize objects

Unit: Phenology Studies

Objective:

Students will be able to separate a set of items into individual, named parts

Standards:

NGSS

Science and Engineering Practices; Obtaining, Evaluating, and Communicating Information

MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

Minnesota Reading

6.5.4.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings.

6.5.7.7 Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.

Rationale:

Documenting Phenology observations requires the ability to name the living and nonliving things
in an ecosystem. To practice using Dichotomous Keys, students will need to understand how we
categorize and differentiate among items based on characteristics that make them unique.

**Instructional Strategies:**

Direct Instruction

Small group work

**Materials:**

An assortment of small objects (8-10 per group) which could include marbles, rubber balls,
cars/trucks, rubber bands, thumb tacks, erasers, crayons, paper clips, pom poms, barrettes, dice,
golf pencils, pieces of pipe cleaner, squares of paper, wood chips, and brass fasteners. Try to get
some things of the same color (plastic coated paper clips, etc.) so that there are similarities and
differences

Science Notebooks

Pencils

**Resources:**

Desks or tables for sorting

Trays or dishes to hold items

**Activities:**

- Explain to students that the word dichotomous/dichotomy means to break down into two
  parts (dicho = two, tomous = to cut or divide) and that you will be working on an activity
  to break a set of objects down into individual parts so that you can identify each (students
  can add this information to their notebooks)

- To start, we look for ways to divide items into two parts (parts do not have to be equal).
Give students a few minutes to look through the items and then ask for suggested categories. This might include metal/non-metal, toy/office item, or other ideas.

- Once you have enough examples generated, ask student groups to choose the category they want to start with and list in their notebooks at the top of the page and underneath the title Objects. Space the two categories below the word Objects so that a pyramid/triangle shape starts to form. There will be two starting groups for the first sort, then each group will be split into two groups below until all items are separated out. Remind students throughout that they do not have to be equal halves when dividing.

- With one of the groups of the items, instruct students to determine a new way to break items down into two groups. This could include size (greater than 1”/less than 1”) or other characteristic. They will write the two new categories below the half they chose to work with first.

- Continue until items have been singled out/individually identified. Once that happens, name the object (paper clip, rubber ball, etc.). Continue with the second group (from the original sort) until all items have been named.

- Have students walk around the room at end of activity to see what categories other groups decided on.

- Relate this activity to how we can name items we see in nature.

**Extensions:**

Sort groups of leaves, seeds, or dried beans to try to separate items

**Accommodations & Modifications:**

Create a flow chart/diagram ahead of time for students to fill in as they work
Allow students to sort out items on a table, then take a picture of the final sort. Insert picture into a digital document and add labels to show the categories.

**Assessment:**

Science Notebook check using scoring rubric (or digital document check using same criteria)
Phenology Lesson 6
Minnesota Tree Identification

Name: Amy Hamernick
Subject Taught: Science
Grade Level: 6
Topic of Lesson: Identifying common trees of Minnesota
Unit: Phenology Studies

Objective:
Students will be able to use a dichotomous key to identify trees commonly found in the state of Minnesota

Standards:
NGSS
Science and Engineering Practices; Obtaining, Evaluating, and Communicating Information
MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

Minnesota Reading
6.5.4.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings.
6.5.7.7 Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.
Rationale:

Documenting Phenology observations requires the ability to name the living and nonliving things in an ecosystem. To practice using Dichotomous Keys, students will need to understand how we categorize and differentiate among items based on characteristics that make them unique. Trees are one of the most universally found species in any setting, the focus in this lesson will be on local trees.

Instructional Strategies:

Direct instruction
Small group work

Duration: 1-2 45 minute sessions, then ongoing at regular intervals through duration of unit

Materials:
Collection of leaves and pine needles (make sure bundles are intact), leaves on branches (if possible) would be helpful for this activity. There should be either a set for stations or a set of each leaf to have per table group.

A Beginner’s Guide to Minnesota Trees at least one copy per two students

Hand lenses/magnifying glasses

Resources:
Table or counters space for stations
Computers

Minnesota’s Native Trees link

Activities:

- Pass out booklets and ask students to turn to page 1. Review coniferous and deciduous
tree definitions

- At the bottom of page 1, review how dichotomous keys are made (refer to previous Dichotomous Key activity) and how this key works.

- Using a leaf or needle sample, projected on board if possible, ask students to determine what page to turn to next.

- Follow the key directions to identify the tree leaf/needle you chose and remind students that each step gave two options to choose from.

- Once students are comfortable using the key, have them identify the samples you have in the classroom. Students can work in pairs or alone, they will need to sketch each leaf or needle in their notebooks and correctly identify the tree species. Hand lenses/magnifying glasses can be with each sample or station to help see details.

- Once group has completed task, or during the next class session, use the link to Minnesota’s Native Trees to see more pictures and descriptions of their trees and see other species that may be in the area.

**Extensions:**

Explore invasive and non-native tree species that are found in the area. Discuss why humans introduce things into ecosystems and what impacts they can make over time.

**Accommodations & Modifications:**

Have digital copies of the identification booklet available for students to use

**Assessment:**

Science notebook check using scoring rubric
Phenology Lesson 7
Field Guides/Minnesota Birds

Name: Amy Hamernick

Subject Taught: Science

Grade Level: 6

Topic of Lesson: Becoming familiar with how field guides are organized and used

Unit: Phenology Studies

Objective:

Students will be able to use field guides to identify common local Minnesota species of trees and birds. Students will develop the skills to be able to be able to use other field guides to identify local species.

Standards:

NGSS

Science and Engineering Practices; Obtaining, Evaluating, and Communicating Information

MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

Minnesota Reading

6.5.4.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings.

6.5.7.7 Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.
**Rationale:**

Students will need to be able to use field guides to identify living things when collecting data for Phenology. Because birds and trees are two of the most common species seen in any setting, the focus of this lesson will be on birds. The use of a field guide can then be applied to other species as time and needs permit.

**Instructional Strategies:**

Direct instruction

Small group work

**Duration:** 2-4 45 minute sessions, then ongoing at regular intervals throughout unit

**Materials:**

Regional field guides for trees and birds. The Peterson First Guides series are an inexpensive way to start if you are building a classroom set and have identification help at the beginning of each book. The trees and birds Peterson guides will be referenced for this lesson but modify according to the guides you are using.

Additional regional field guides for mammals, flowers, reptiles/amphibians

Science notebooks

Pencils, art pencils

Optional (if available) items could include binoculars, phones or tablets to take pictures or use field guide apps

**Resources:**

Computers
Activities:

- Not all field guides are organized as Dichotomous Keys. Inform students that today you will work with field guides to identify different living things they might see outside.

- Pass out Peterson First Guides Birds books and ask students to start by looking at page 2, parts of a bird. Review the different parts of a bird and talk about how you can use markings and shapes to help you identify birds, especially when they move around a lot and can quickly fly away. Being able to identify and not key characteristics can help.

- Page 5 describes how to use the guide and pages 6-13 describe different characteristics you can look for when observing birds. Review pages together and point out basic shapes and behaviors.

- Pages 14 - 17 show shapes and outlines. This is helpful when the sun is behind a bird or it is flying overhead and you can only see an outline.

- Tell students that they might not always be able to see a bird because of leaves and branches or if they are in the grass, but they can also identify birds by their songs or calls.

- Give students time to look through the guide, then have them get computers and use the Minnesota Bird Calls and Minnesota Birds links to work on identification practice. Students can use the online source to look at birds and see if they can find them in the field guide. Then, if available, they can listen to the call or song.
- During the next class period, students will be going out to their tree (the tree chosen for the My Tree activity) to try to identify it. They will need to have an identification key available to them.

- Take students outside and give them time to identify their trees. Keep in mind that there may be some non-native or less common trees that are not in the guide, more investigation may be needed.

- While outside, or during another class session, ask students to identify birds in the area using guides and calls. Students will need to practice being quiet and still in order to hear and see. Binoculars would be helpful for this activity.

- Encourage students to make sketches of at least one item they see. Pictures could also be taken if there are things that are not easily identifiable, keys can be used indoors at a later date.

**Extensions:**

Use additional field guides to practice identifying local animals and plants. Common species should be the focus (White-tailed deer, skunks, snapping turtles, painted turtles, etc.), pictures could be provided for students to use to identify based on characteristics.

**Accommodations & Modifications:**

Field Guide Apps for phones, tablets, or computers could be used in place of books or as a supplement. Compare and contrast printed versus digital options for ease of use, accuracy, and formats.

**Assessment:**

Science notebook check using scoring rubric
Phenology Lesson 8

Phenology

Name: Amy Hamernick

Subject Taught: Science

Grade Level: 6

Topic of Lesson: Collection of Phenology Data

Unit: Phenology Studies

Objective:

Students will be able to collect and record observation data for a specific area over time and document change.

Standards:

NGSS

Science and Engineering Practices; Obtaining, Evaluating, and Communicating Information

MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Minnesota Reading

6.5.7.7 Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.

Minnesota Social Studies Standards
6.3.4.10.1 Describe how land was used during different time periods in Minnesota history; explain how and why land use has changed over time.

**Rationale:**

Students have developed skills to make observations based on characteristics and behaviors. They will now formally collect data from specific sites so that they are able to note changes in seasons and conditions over time.

**Instructional Strategies:**

Individual or small group work

**Duration:** 45 minutes, then ongoing at regular intervals throughout unit

**Materials:**

Science notebook

Pencil

Art pencils

Binoculars, cameras/phones/tablets as available

Field guides (printed or digital)

**Duration:** 45 minutes, then ongoing at regular intervals throughout unit

**Resources:**

Computers

[Phenowatch.com](http://phenowatch.com) site link

[Jim Gilbert’s Phenology](http://www.jimgilbert.com/phenology)

[Minnesota Phenology Network](http://www.umn.edu/phenology)

[Budburst](http://www.budburst.org)
Activities:

- By this point, students should have had multiple opportunities to be outside to visit their trees, make observations, and practice identifying commonly found organisms.
- Introduce the term Phenology - the study of cycles and changes over time in living systems. Phenology relies on collecting information and recording dates, times, and conditions so that we can see the cycle of seasons and how organisms respond to those changes.
- Tell students they will be visiting some phenology websites to see how different people record and share data and information. Have them get computers and use the links above to find out more about Phenology and how it has been collected and used.
- Ask students to respond to the following prompts in their science notebooks;
  - What is the purpose or use of phenology?
  - How do citizen scientists collect data?
  - What is one question you have about our school grounds that you might be able to answer by collecting data?
- Before end of class, ask students to share what they learned or their responses written in their science notebooks.

Extensions:

Introduce written work by local authors who have recorded data or observations of the natural world. Many offer daily or monthly notes of what you might see in nature, excerpts or sections could be read at the beginning of class for duration of the unit.

Phenology-style works for Minnesota could include;
Backyard Almanac by Larry Weber and illustrated by Judy Gibbs

Minnesota Phenology by Larry Weber

Minnesota’s Outdoor Wonders by Jim Gilbert

Memoir/observation-style works for Minnesota could include;

Webwood, Seasons of Life in the North Woods by Larry Weber

A Place in the Woods by Helen Hoover

Various works by Sigurd F. Olson, including Reflections From the North Country

Accommodations & Modifications:

Provide a more structured tour of the websites and guide them through what they are reading or exploring

Provide a digital copy of the questions for students to complete which can be printed and glued into notebooks or kept in a digital file

Assessment:

Science notebook check using scoring rubric
Phenology Lesson 9

Collecting and Reporting Data

Name: Amy Hamernick

Subject Taught: Science

Grade Level: 6

Topic of Lesson: Field Observations

Unit: Phenology Studies

Objective:

Students will be able to use identification and recording skills to document components of ecosystems familiar to them.

Standards:

NGSS

Science and Engineering Practices; Obtaining, Evaluating, and Communicating Information

MS-LS2-2. Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

MS-ESS3-3. Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

Minnesota Reading Standards

6.5.7.7 Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.
Minnesota Writing Standards

6.7.10.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Minnesota Social Studies Standards

6.3.4.10.1 Describe how land was used during different time periods in Minnesota history; explain how and why land use has changed over time.

Rationale:

Phenology relies on the documentation of sites and regions over time in order to understand how living systems change over time. Students have been practicing observation and identification skills in order to facilitate recognizing and listing what they see. A focus has been made on easily recognizable organisms and skills have been developed to help identify unknown entities based on characteristics.

Instructional Strategies:

Independent work

Duration: 45 minutes, then ongoing at regular intervals throughout unit. Provide weekly time in class to make observations until end of unit or school year.

Materials:

Field identification guides (printed or digital)

Science notebooks

Pencils

Art pencils
Observation sheets, 2 per student

Binoculars, cameras/phones/tablets as available

**Resources:**

Computers to visit identification sites and to record observations

**Activities:**

- For the next class period, students will be making a formal observation using observation sheets and their science notebooks.
- Observation sheets can be printed out and taped into notebooks or kept separately. Students can also use the observation sheet as a template and write all responses in their science notebooks (to conserve paper)
- Explain to students that today they will be making more formal observations. These observations will require them to be silent and paying attention for an extended period of time in order to be able to see and hear what is happening around them.
- Students will be required to make one observation at school during time provided in class and one observation at a site near or at their home per week. This will continue either for the school year or for the duration of the unit.
- Review the observation sheet with students and help them plan where they will be making their observations at school and at home. Remind students that they need to be safe and their chosen spot at home does not have to be outside of their own yard/courtyard/building property. An adult needs to know where they are when they are making observations.
- Provide the time, date, and weather conditions for students to record on their observation
sheets. Show them where they can find that information online - [NOAA](https://www.noaa.gov) is a reliable site for this and can be searched by city or zip code.

- Take students outside. They will go to their chosen spot (this may be near the tree they chose to focus on in the My Tree activity), away from other students, and spend the first 5-10 minutes silently making observations. At your signal, students will silently spend the last 5 minutes moving around their spot and making observations of plants, trees, flowers, and other things they notice.

- Bring students back together and share observations

- After returning to the classroom, ask students to enter their data using a copy of the Observation Sheet (make sure it is locked and they need to make a copy before being able to edit) to save in a Google document. If they made sketches, they can use their computer to take a picture of their pages and upload into the document. Students who took pictures can upload images and add to their documents.

**Extensions:**

Have students choose one organism they observed to research and learn more about.

Sign up with one of the phenology websites and share observations.

Students or groups could be weekly guest contributors to the teacher’s phenology website.

**Accommodations & Modifications:**

Pre-print observation sheets and make into booklets for students as needed.

Scan observation sheets or take pictures so that students do not have to type responses into the provided Observation Sheet template

**Assessment:**
Students have collected and recorded in Google documents at least two observations per week for the duration of the unit or end of the school year. Using the Science Notebook scoring sheet, students will be scored, per entry, each week.
You will be expected to make one observation per week in an area near your home. You will also be expected to make one observation per week at school, time will be provided for you during class.

Choose the same area to visit each time you collect data, you may want to bring something to sit on as you quietly listen and watch what is happening around you. Plan to spend at least 15 minutes per observation session.

Remember, you will not be collecting samples, picking flowers, or doing any damage to the areas you visit. You should, however, move around your observation area to see if there are changes or signs of activity like nests being built or an area being disturbed.

For observations about birds, mammals, insects, reptiles/amphibians, and humans please describe where you see them and what they are doing.

For observations of trees and flowers, note any changes in color or condition of leaves, stems, or branches, or when you notice anything bloom.

Depending on the season, you may not see some of the categories on the list. When you see no activity, please write “none observed”
<table>
<thead>
<tr>
<th>Name</th>
<th>Date</th>
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<table>
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<tr>
<th>Location</th>
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<tbody>
<tr>
<td>Weather</td>
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<tr>
<td>Birds</td>
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<tr>
<td>Mammals</td>
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<tr>
<td>Insects</td>
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<tr>
<td>Reptiles/Amphibians</td>
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<tr>
<td>Flowers</td>
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<tr>
<td>Trees</td>
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<tr>
<td>Humans</td>
<td></td>
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<tr>
<td>Unusual Activities or changes noticed</td>
<td></td>
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<tr>
<td>I wonder...</td>
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</table>

Sketch or picture
## Science Notebook Scoring Rubric

<table>
<thead>
<tr>
<th></th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Organization</strong></td>
<td>All writing is legible, work is neat and organized</td>
<td>Majority of writing is legible, work is generally organized and understandable</td>
<td>Writing is not done with care, work has little organization</td>
<td>Writing difficult or impossible to read, work is not organized or understandable</td>
</tr>
<tr>
<td><strong>Content</strong></td>
<td>All responses show understanding of topics and use of vocabulary</td>
<td>Most responses show understanding of topics and use of vocabulary</td>
<td>Understanding and use of vocabulary is limited and inconsistent</td>
<td>Understanding of topics and vocabulary is not evident</td>
</tr>
<tr>
<td><strong>Details</strong></td>
<td>Table of contents is updated, dates and titles are included for each writing session</td>
<td>Table of contents is updated, most dates and titles are included for each writing session</td>
<td>Table of contents is not updated, some dates and titles are missing</td>
<td>Table of contents is not updated, most or all dates and titles are missing</td>
</tr>
<tr>
<td><strong>Visuals</strong></td>
<td>All drawings, sketches, and diagrams are clear, labeled, and include details</td>
<td>Most drawings, sketches, and diagrams are clear, labeled, and include details</td>
<td>Some drawings, sketches, and diagrams are clear, labeled, and include detail but some work is missing</td>
<td>Drawings, sketches, and diagrams are difficult to read, lack labels and details, or missing</td>
</tr>
</tbody>
</table>
References


