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Integrating Augmented Reality Into Place Based Native Tree Identification

Chase Evertz

INTEGRATING AUGMENTED REALITY INTO PLACE BASED NATIVE

TREE IDENTIFICATION

by

Chase Evertz

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Capstone Project Facilitator: Laura Halldin
Content Expert: Scott Birklid

Project Description

Integrating augmented reality into place based native tree identification project was written to integrate technology into an outdoor experiential science education class. The main driving research question behind this project was, does the use of cell phones outdoors by 12th grade experiential environmental education students have a positive effect on the learning process? To answer this question I wrote a two to three week curriculum for formal and informal educators to use which has students using augmented reality to learn about native trees to Minnesota. The curriculum is split into five parts and an educator could pick and choose any of the five parts if their location or needs do not match this specific curriculum. Part one is an introduction to native trees of Minnesota and how to use a dichotomous key, part two is the history and how to make maple syrup, part three is designing an augmented reality app for the native tree species, part four is using augmented reality for native tree identification, and part five is revisiting the tapped trees to see if making maple syrup is sustainable.

This curriculum is designed for 12th grade students in an outdoor experiential science education class but can be modified to be used at any high school grade level. The curriculum was written for formal and informal secondary or adult educators with aspirations that the local park system can use the augmented reality for the community to use. The participants will need a smartphone or tablet with the Vuforia View software downloaded. The augmented reality can be downloaded before going outside so the use of cell phone data is not required. The curriculum will need to take place both inside and outside the classroom and the students will need access to a variety of native trees to

Minnesota. If the educator would like to make syrup, access to maple trees, box elders, or birch trees will also be required. The project must take place in the spring when the daily high temperatures are above freezing and the daily low temperatures are below freezing at night, in my area this is early to mid March. Students will need access to all of the maple syrup making supplies listed in the curriculum materials and also a place to evaporate the sap. The syrup making can be a small scale demonstration on a hot plate in a science classroom or a larger scale multiple day lesson outside. Students participating in this curriculum will need to be trusted to work independently and follow the safety guidelines set forth by the educator.

I used the Understanding by Design curriculum framework to develop these lessons. The Understanding by Design framework was great for this project because it allowed me to think about what I wanted the students to learn and know throughout this unit, the big picture. By writing the learning goals first I designed assessments and rubrics to assess the students to see if they actually learned what I wanted them to. Lastly I designed the learning activities and daily plans to ensure the students were engaged and learning throughout the lessons. Environmental education is more than just learning facts, it is about seeing the whole picture, and using the UbD framework I feel confident students will benefit from these lessons.

Unit Overview

Lesson Name	Summary	Number of Days
Winter Tree Identification Introduction	Students will learn the vocabulary associated with native trees in Minnesota. They will apply this knowledge in a formative assessment at the end of the class period.	1
Using Dichotomous Key in the Field	Students will practice what they learned in the field. Teacher will lead students around to various tree species to identify with dichotomous key. Starting as a large group then breaking into smaller groups or individually.	1-2
Tapping Maple Trees	Students will tap maple trees and start the collection process.	1
Maple Sap Collection/ Augmented Reality Development	Students will collect the sap from the night before at the beginning of each day. The remainder of the hour will be used for research on their tree species and the development of their Vuforia augmented reality project.	3-4
Maple Syrup Evaporation	Students will boil down their collected sap while putting the finishing touches on their augmented reality project.	1-2
Native Tree Identification Using Augmented Reality	Students will use the augmented reality app to practice identifying native trees in Minnesota while on the school grounds. Class will start with large group identification and becoming more individual as they become more familiar with the Vuforia View app. Students will also be writing down ten annotated observations while using the augmented reality program.	1
Native Tree Identification using AR Assessment	Students will be assessed in the field by identifying the native trees to Minnesota in the field. Students will have the option to use the dichotomous key for winter tree identification key or use the augmented reality to use the summer tree identification key.	1
Is Maple Syrup a Sustainable Food Source	This lesson will be after the trees have leafed out. Students will be brought back to the trees they tapped to compare them with the trees that were not tapped.	1
		10-13

LESSON PLANS

Lesson One- Winter Tree Identification Introduction

Established Goal(s)/Content Standard(s):
- MN Benchmark: 9.4.1.2.4 Explain the function and importance of cell organelles for prokaryotic and/or eukaryotic cells as related to the basic cell processes of respiration, photosynthesis, protein synthesis and cell reproduction.
- MN Benchmark:9.1.3.1.1 Describe a system, including specifications of boundaries and subsystems, relationships to other systems, and identification of inputs and expected outputs.

Understanding (s) Students will understand that:	Essential Question(s):
- There are two types of trees in Minnesota. - For trees there are anatomical structures responsible for basic functions of life.	- How are deciduous and coniferous trees different? - What vocabulary terms are associated with identifying MN native trees? - What adaptations have native trees made to be successful in Minnesota?

Student objectives (outcomes):

Students will be able to:
- LT 1: I can identify parts of a tree.
- LT 2: I can differentiate between conifer and deciduous trees and explain why each are successful in MN.

Stage 2 – Assessment Evidence

Performance Task(s):	Other Evidence:
- Students will work through a hands on practice using the vocabulary terms learned during the lesson. - Vocabulary practice assignment	- During lecture questions will be asked to check for understanding. Both independent and partner questions. - Science notebook warmup - Teacher observation during activity

Stage 3 – Learning Plan

Lesson Overview:
- Students will be asked to reflect on a tree that they are familiar with and sketch the setting in their science journals. Teacher will lead a short lecture on introduction to trees including climate of Minnesota, parts and systems of trees, photosynthesis, and adaptations to survive in Minnesota.. Students will have time to work on a practice hands on activity and a practice worksheet.

Materials:
- Lecture materials to introduce the vocabulary and how trees survive here in Minnesota
- Samples that include:
    - One cross section tree cookie
    - One maple or ash tree branch to show opposite branching
    - One pine tree bundle of needles
    - One cedar tree branch with leaf showing scales
    - One branch to show alternate branching
    - One or more leaves to show margins and simple vs compound leaves
    - Two jars, one with sap and one with resin

Learning Activities:
- Warm up
    - In their science journals have students write a response to this question: Think of a tree that you are familiar with. Describe the appearance, write why you chose this tree or if there is any special connection to the tree, and make a quick sketch with the details you can remember.
- Activity
    - Teacher led lecture with an intro to trees. Lecture should include climate of Minnesota, parts of a tree, difference between coniferous and deciduous trees. More vocabulary terms are attached to the lesson activities.
    - Students should complete the vocabulary practice either by drawing pictures or complete sentence definition.
    - Students should walk around room from station to station applying what they learned to answer the questions to the activity.
- Wrap up:
    - Have students write a few sentences in science notebook about the challenges or what they learned from the hands on practice.
    - Address the expectations and what to wear when going outside during class.
    - Remind students they will be outside for the class period tomorrow and to dress appropriately. Use Remind101 or google classroom.

Resources:

- Video with introduction to dichotomous key using vocabulary from today. https://www.youtube.com/watch?v=cAH9-QmSSJw

Vocabulary Practice

Name_____

Procedure: Use information learned today to define or draw pictures of the following terms.

- Parts of tree:
  - Tree vs shrub
  - Crown
  - Roots
  - Stem
  - Barch
  - Xylem vs phloem
  - Heartwood
  - Annual Rings
- Conifer vs Deciduous:
  - Sap vs resin
  - Leave vs needles
  - Colligative properties of each
  - Limiting northern and southern range of each
  - Angiosperm vs gymnosperm
  - Hardwood vs softwood forests
- Branching:
  - Opposite
  - Alternate
  - Deciduous:
  - Sap
  - Broad leaf
  - Simple Leaf
  - Compound Leaf
  - Whorl
- Leaf Margins:
  - Entire
  - Lobed
  - Toothed
  - Petiole
  - Veins
- Conifers:
  - Bundles
  - Scaly
  - Evergreen

Tree Vocabulary Practice

Name_____

Sample 1:

Are the leaves flat and broad or needle like?_____

If flat and broad, are they simple or compound?_____

If needlelike, are the in clusters or sclay?_____

Are the branches opposite, alternate, or in a whirl?_____

Sample 2:

Look at the leaf margin. Is it entire, lobed, or toothed._____

If toothed, is it single or double toothed?_____

Sample 3:

Is the liquid in the jar sap or resin? How do you know?_____

Sample 4:

Are the leaves flat and broad or needle like?_____

If flat and broad, are they simple or compound?_____

If needlelike, are the in clusters or sclay?_____

Are the branches opposite, alternate, or in a whirl?_____

Sample 5:

How old is this tree cookie?_____

What historical event took place when this tree germinated?_____

Sample 6:

Look at the leaf margin. Is it entire, lobed, or toothed._____

If toothed, is it single or double toothed?_____

Sample 7:

Are the leaves flat and broad or needle like?_____

If flat and broad, are they simple or compound?_____

If needlelike, are the in clusters or sclay?_____

Are the branches opposite, alternate, or in a whirl?_____

Sample 8:

Based on your observations do you think this tree would be successful in the boundary waters? Why or why not?

Lesson Two- Winter Tree Identification Field Day

Established Goal(s)/Content Standard(s):
- MN Benchmark: 9.1.3.1.1 Describe a system, including specifications of boundaries and subsystems, relationships to other systems, and identification of inputs and expected outputs.

Understanding (s) Students will understand that: ● A dichotomous key is a tool that can be used to identify MN native trees. ● Tree vocabulary is needed to use a dichotomous key.	Essential Question(s): ● How do you use a dichotomous key to identify native MN trees in the winter?

Student objectives (outcomes):

Students will be able to:
- LT 3: I can identify winter trees with a dichotomous key.

Stage 2 – Assessment Evidence

Performance Task(s): ● Large group, small group, and individual practice identifying native MN trees using a dichotomous key. ● Students will be assessed based on their answers.	Other Evidence: ● Before field practice students will use a google form to review terms from day one. ● Frequent check ins with groups of students during the lesson.

Stage 3 – Learning Plan

Lesson Overview:
- Students will be led by teacher to about 5-8 trees on campus or in the local area, teacher should have identified the trees prior to the lesson and have a plan to identify each one. Trees should be both deciduous and coniferous trees native to Minnesota. Students will need access to the dichotomous key for trees in the winter, a link is attached in the resources.

Materials:
- Class set of MN native tree identification dichotomous keys
- Example of two or three branches to use as a warm up before going outside
- Teacher needs to have a plan of where they are taking their class
- Student copies of tree identification chart

Learning Activities:
- Warm up:
  - Hold up several examples of tree branches without any leaves. Have students use the vocabulary from yesterday to write down as much as they can from each example.
  - Have students answer the formative assessment questions on the google form.
- Activity:
  - Teacher should lead students around to each tree species they have identified.
  - First tree should be completed as a large group.
  - Depending on how students are doing, the remainder of the trees can be large group, small group, or individual.
- Wrap up:
  - Have students write a reflection statement about their day, including any challenges or victories in their science journals.
  - Remind students to bring in some sort of sap collection bucket for tomorrow. This needs to be food grade with a lid and cleaned out with soap and water (ex. Gallon milk jug).

Resources:
- If there are not enough trees near campus students can use this link to practice tree identification.
  https://www.uwsp.edu/cnr-ap/leaf/Pages/TreeKey/treeToIdentify.aspx?feature=Main
- University of Steven's Point Winter Tree Dichotomous Key
  https://www.uwsp.edu/cnr-ap/leaf/Documents/LEAFWinterTreeIDKey.pdf

Example of Formative Assessment

Tree Formative Assessment

Form description

What type of branching is this? *

○ Alternate

○ Opposite

○ Whorled

Which of the following pictures shows needles in bundles?   ◉ Multiple choice ▾

Suggestions: D

○ A   ✕

○ B   ✕

○ B   ✕

○ Add option or **ADD "OTHER"**

Native Tree Identification Worksheet

Name_____

Tree Number	Tree Type Deciduous I Coniferous	Branching Alternate I Opposite	Destiguishing Features	Wildlife Observations	Bark Description	Name of Tree
1						
2						
3						
4						
5						

Lesson Three- Maple Syrup Tapping

Established Goal(s)/Content Standard(s):
● MN Benchmark: 9.4.2.2.1 Use words and equations to differentiate between the processes of photosynthesis and respiration in terms of energy flow, beginning reactants and end products.

Understanding (s) Students will understand that: ● Sugar and minerals are stored in the roots over winter. ● Sap flows in the phloem ● Tapping the tree correctly is a sustainable food source.	Essential Question(s): ● How do you tap a maple tree to collect sap to boil down to maple syrup in a sustainable manner? ● How does the sap flow from the roots to the limbs of the tree? ● What nutrients and minerals are contained in the sap?

Student objectives (outcomes):

Students will be able to:
● LT 4: I can identify maple trees and successfully tap the tree for maple sap.
● LT 5: I can explain the process the maple tree undergoes in the spring.

Stage 2 – Assessment Evidence

Performance Task(s): ● Students will tap a tree in small groups. ● Rubric will assess students tapping of the tree.	Other Evidence: ● Written reflection about the experience will also be used. ● Group discussion after the tapping.

Stage 3 – Learning Plan

Lesson Overview:
● Students will be led to the maple trees in your area, box elder and paper birch may also be used. If using another tree species make sure to keep the sap separate to compare and contrast. Teacher should have the maple tapping supplies (drills with 7/16" bit, taps for each group, tubing) students are responsible for bringing old milk jugs or some other sap collecting bucket. Teacher will explain the process and what they are collecting as well as historical information about how the American Indians were the first to boil down sap to make sugar and syrup.

Materials:
- Two or more battery or hand powered drills
- ⅜" inch plastic tubing (one for each group)
- Plastic sap taps (one for each group)
- Student brought collection container for collecting (two for each group)
- Two or more small hammers
- Winter dichotomous keys

Learning Activities:
- Warm up:
  - Show examples of natural maple syrup versus store bought table syrup. Ask students who has ever tasted the natural maple syrup. Have students write down similarities and differences in the appearance of both types and what ingredients are in both.
  - Encourage students to share what they wrote about maple syrup with the large group.
- Lecture:
  - Teacher should lecture about what tissues students are tapping into and what exactly they are collecting. Other items should include how large the tree needs to be to tap and how many taps per tree.
  - Make sure to include why there is sugar in the sap and how low the temperature can be until the tree can not survive. Compare this to the conifers and how their resin is different and how low the temperatures can get to survive.
- Activity:
  - Take the students outside to the maple stand of trees and have the students use their dichotomous key to identify a tree they would like to tap.
  - Once students have identified their tree meet around one. Teacher should talk about historical significance about maple tree tapping.
  - Have one group tap a tree as an example. Teacher should be commenting step by step. Remind students they need to take pictures of the important steps of the process.
  - Have groups of students tap their trees they've identified.
  - Meet back in a location and head back inside as a class.
- Wrap up:
  - Have students reflect on their experience in their journals.
  - Teacher should introduce the project for the next few days.
  - Remind students to bring a clean collection bucket to swap out tomorrow.

Resources:

How to tap maple trees https://www.youtube.com/watch?v=tvWMdF0QkKA

Rubric for Tree Tapping Self Assessment			
Criterion	3	2	1
Tapping Hole Depth	Depth is 1.25-1.5" deep, clean, and no sap leaking	Depth is more than 1.5" but clean with little sap leaking	Depth is less than 1.25" with sap leaking
Tap inserted correctly	Tap is inserted lightly and cannot be pulled out easily with hand and 2-3' above the ground	Tap is inserted but sap is leaking out the bottom and 2-3' above the ground	Tap is inserted in a fashion not designed by manufacturer and less than 2'or higher than 3' above the ground
Tree Selection	Tree is greater than 10" in diameter at 4.5' above the ground and is a maple tree	Tree is 10" in diameter at 4.5 ' above ground and is a maple tree	Tree is not 10" in diameter at 4.5' above ground or is not a maple tree

Lesson Four- Maple Sap Collection and Augmented Reality Project

Established Goal(s)/Content Standard(s):
● MN Benchmark: 9.4.2.2.1 Use words and equations to differentiate between the processes of photosynthesis and respiration in terms of energy flow, beginning reactants and end products. ● MN Benchmark: 9.1.3.2.2 Analyze possible careers in science and engineering in terms of education requirements, working practices and rewards.

Understanding (s)	Essential Question(s):
Students will understand that: ● Sap flows best when air temperatures are above freezing during the day and below freezing at night. ● Approximately forty gallons of sugar maple sap are required for one gallon of natural maple syrup.	● Does augmented reality help with the identification of Minnesota Native Trees? ● Does the difference between the high and low daily temperatures affect the amount of sap that flows?

Student objectives (outcomes):
Students will be able to: ● LT 6: I can develop an augmented reality app to help with native Minnesota tree ID. ● LT 7: I can collect enough maple sap to produce natural maple syrup.

Stage 2 – Assessment Evidence

Performance Task(s):	Other Evidence:
● Native tree identification field assessment using augmented reality. ● Students will be judged by their score on their native tree identification field assessment. ● Students will be judged by a rubric on their completed augmented reality project.	● Students will have participated in the native tree dichotomous key pre-assessment in lesson two. ● Small group discussion will also be used as other evidence.

Stage 3 – Learning Plan

Lesson Overview:
Over the next several days students will start the day by walking to the maple trees and collecting their sap from over night and replacing their bucket with a new bucket at the tree. Students will collect the class sap in a 40 gallon garbage can until enough is collected for your project. After the collection students will be working with their groups on an augmented

reality project to use to enhance the native Minnesota Tree identification. Teacher needs to have a training in the Vuforia View software to be able to help students with the design.

Materials:
- Sap collection bin for large group (40 gallon garbage can works well)
- Small group sap collection containers (plastic milk or water jugs work well)
- Computer with Tinkercad software
- Vuforia View Software

Learning Activities:
- Warm up:
  - Show examples of augmented reality and explain the project.
  - Have students fill in their data table for daily high and low temperatures.
- Activity:
  - Take the students outside to the maple stand of trees and have students swap out their sap bucket for a new one.
  - Meet back at the classroom and have students dump their group's sap into the class 40 gallon garbage can.
  - Once everyone is back in class, show the video https://www.youtube.com/watch?v=x6_IZ8e9KuE for an introduction to augmented reality.
  - Assign or have students get into groups of three and have them sign up for a tree species to research for their project.
  - Have students grab a computer and begin on the augmented reality project.
- Wrap up:
  - Have students reflect on their experience in their science journal.

- Teacher notes for Augmented Reality Project
  - Create a 3D model of the object using software such as CREO Parametric, Autodesk, or Solidworks, which are high powered, professional modeling suites. For simple and easy to access use 3D modeling that is web based, Tinkercad works well.
  - Upload the 3D file in Vuforia Studio to create a viewing experience. This program allows the designer to add interactive features such as text, part movement, audio and video, and touch points to the 3D model. Once finished designing the experience the data is stored on a server provided by Vuforia's parent company PTC.

○ The designed augmented environment is now available through any web-accessible device using the free Vuforia app. The environments can be downloaded to the device for outdoor situations where wireless is not available.

MN Native Tree Research Sheet

Name_____

Name of your tree species:

Scientific name of your tree species:

Leaf or needle description:

Type of branching:

Maximum growth height:

Maximum growth diameter:

Maximum growth width of canopy:

Growing conditions:

Biome commonly found in:

Bark description:

Fruit Description:

Twig Description:

History of name:

Growth factor to estimate age:

Benefit to ecosystem:

Rubric for Augmented Reality Project				
Rubric Criterion	4 Points	3 Points	2 Points	1 Point
Augmented Reality Project	Project is complete and high quality	Project is mostly complete and good quality	Project partially complete and average quality	Project is incomplete and low quality
Three Dimensional Model	Model is to scale and contains all required parts	Model is to scale but parts missing	Model is not to scale and parts are missing	Model is incomplete and parts are missing
Leaves	Leaves are to scale and can be used in tree identification	Leaves are to scale but missing detail to identify tree	Leaves are not to scale and can not be used to identify tree	Leaves are incomplete and can not be used to identify tree
Required Information	All additional required information is present and accurate	All additional required information is present but not accurate	Most of the additional required information is present	Some or none of the additional required information is present

Daily Sap Collection vs Daily Temperature Difference

Name_____

Day	Date	Overnight Low	Previous day high	Difference in Temperature	Gallons of Sap Collected
1					
2					
3					
4					

Using the data construct a graph comparing the overnight low with the number of gallons collected by the class the next day. Analyze the graph and answer the question if the temperature difference has an effect on how many gallons were collected.

Lesson Five- Maple Sap Evaporation

Established Goal(s)/Content Standard(s):
- MN Benchmark: 9.4.2.2.1 Use words and equations to differentiate between the processes of photosynthesis and respiration in terms of energy flow, beginning reactants and end products.
- MN Benchmark: 9.4.4.1.3 Describe contributions from diverse cultures, including Minnesota American Indian tribes and communities, to the understanding of interactions among humans and living systems.

Understanding (s)	Essential Question(s):
Students will understand that: - Maple sap contains sugar and other nutrients and can be boiled down to make natural maple syrup. - It takes approximately 40 gallons of sap to make one gallon of syrup. - Sugar was a scarce resource pre European settlement and the Native Americans discovered a way to make sugar.	- What is the process to boil maple sap into natural maple syrup? - How much volume of syrup can I get from the amount of sap I collected? - How do I know when the maple sap has turned into maple syrup?

Student objectives (outcomes):

Students will be able to:
- LT 8: I can boil down maple sap into maple syrup.
- LT 9: I can explain what is found inside the maple sap and maple syrup.
- LT 10: I can explain how the Native Americans boiled down maple sap and how they use the maple syrup and maple sugar.

Stage 2 – Assessment Evidence

Performance Task(s):	Other Evidence:
- Rubric will be used to assess students' understanding through a journal entry.	- Formative assessment that includes a google classroom questions about maple syrup collection process before we start.

Stage 3 – Learning Plan

Lesson Overview:
Students will be responsible for monitoring the evaporation process. Teacher can make this day or two what they want. Evaporation can be just an intro and use beakers on a hotplate in a science classroom and use one class period to boil a little amount of sap into syrup or turn it into a multi-day lesson and boil down many gallons of sap.

Materials:
- Heat source (depending on how big of a scale you want items could include: commercial grade evaporator, deep fryer, student built fire evaporators, bunsen burners, or hot plates)
- Heat safe evaporator pans or jars
- Heat resistant gloves
- Food grade thermometer
- Hydrometer (optional)
- Small cup or bowl to transfer sap into evaporator container
- Cheesecloth for filtering
- If storing syrup for later use: mason jars or bowl for refrigerator.

Learning Activities:
- Warm up:
  - Check in with groups to see where they are at with their augmented reality project.
- Activity:
  - Start up your heating source and have the students monitor the progress of the sap. When there is about an inch left in your pan have students add more sap.
  - Once the sap is boiling have groups monitor to make sure it doesn't get burned.
  - When the liquid has reached a boiling point of 219 degrees fahrenheit the syrup is considered done.
  - Filter the sap into collection jar.
  - Clean up and put away supplies.
- Wrap up:
  - Tell students the plan for tomorrow.
  - Have students reflect on their experience in their science journal.

Lesson Six- Native Tree Identification Using Augmented Reality

Established Goal(s)/Content Standard(s):
- MN Benchmark: 9.1.3.4.1 Describe how technological problems and advances often create a demand for new scientific knowledge, improved mathematics, and new technologies.
- MN Benchmark: 9.3.2.3.1 Trace the cyclical movement of carbon, oxygen and nitrogen through the lithosphere, hydrosphere, atmosphere and biosphere.

Understanding (s) Students will understand that:	Essential Question(s):
● Trees can be identified in the summer using their leaves. ● Augmented reality can enhance the learning process	● What summer characteristics can help identify trees? ● What are the dormancy benefits of deciduous trees?

Student objectives (outcomes):

Students will be able to:
- LT 11: I can identify Minnesota native trees using augmented reality and the summer tree dichotomous key.

Stage 2 – Assessment Evidence

Performance Task(s):	Other Evidence:
● Identification of trees using a summer dichotomous key and augmented reality. ● Annotated observations of each tree species	● Formative assessment that includes google classroom questions about summer tree identification. ● Teacher observation for participation in small and large groups.

Stage 3 – Learning Plan

Lesson Overview:

Students will go from tree to tree using their cell phone and the augmented reality that their classmates created by scanning the QR codes on the tree. If the teacher would like an extension to the lesson they could use this as a geocaching activity to find the trees on campus. Otherwise, the teacher can lead students from tree to tree.

Materials:

- Summer Minnesota native tree identification dichotomous key
- Cell phone or personal device for each group or individual student with Vuforia View app
- Notebook for recording observations
- Map of school campus
- Hand out or digital copy of student tree identification chart

Learning Activities:

- Warm up:
    - Explain the procedure for the day.
- Activity:
    - Teacher should bring students from tree to tree and have them identify the species using their augmented reality program. Start as a large group and split into smaller groups as they become more comfortable using the app.
    - Students should record observations about the tree to use later as a reference for their annotated observations.
    - Students should also fill in the attached chart as they move from tree to tree.
- Wrap up:
    - Remind students of the Minnesota Native Tree identification test tomorrow.

Annotated Observation Rubric

Name_____

Rubric Criterion	4 Points	3 Points	2 Points	1 Point	0 Points
Annotated Observations Recording of information gathered through augmented reality. Each Observation is 2-4 sentences long that describes what was learned from the app.	All ten annotated observations. Excellent effort shown in summaries and writing is in an easy to follow manner and consistent throughout. Questions or ideas are written for further learning.	Nine annotated observations. Good effort is shown in summaries and writing is easy to follow and consistent with questions or ideas expressed.	Seven or eight annotated observations listed. Average effort shown. Summaries are inconsistent and/or hard to follow. No ideas or questions posed for further learning.	Six annotated observations are listed. Poor effort shown and summaries are hard to follow. Lacks organization and no further questions are posed or ideas created.	Less than six annotated observations. Many grammatical errors and very little effort shown throughout the lesson.

Student Tree Identification Chart

Name_____

Leaf or Needle	Simple of compound	Leaf Shape	Leaf Arrangement	Leaf Margin	Other characteristics	Tree Name

Lesson Seven- Native Tree Identification Assessment

Established Goal(s)/Content Standard(s):
- MN Benchmark: 9.4.2.1.2 Explain how ecosystems can change as a result of the introduction of one of more new species
- MN Benchmark: 9.1.3.3.2 Communicate, justify, and defend the procedures and results of a scientific inquiry or engineering design project using verbal, graphic, quantitative, virtual, or written means.

Understanding (s)	**Essential Question(s):**
Students will understand that: - Students will use what they learned during the unit to identify Minnesota native trees in the field.	- Can an augmented reality app help with tree identification?

Student objectives (outcomes):
Students will be able to:
- LT 12: I can identify Minnesota native trees using either a winter or summer dichotomous key.

Stage 2 – Assessment Evidence

Performance Task(s):	**Other Evidence:**
- Students will identify trees individually on a google form.	- Teacher observations during assessment - Conversations with students about their thought process

Stage 3 – Learning Plan

Materials:
- Planned out trees for students to identify during assessment
- Google form answer sheet or handout

Learning Activities:
- Warm up:
  - Explain the procedure for the day.
- Activity:
  - Teacher will lead the students from tree species to tree species for them to identify individually on the google classroom assessment assignment.
  - Students may use the augmented reality app with the summer dichotomous key or their winter tree identification dichotomous key.

- Wrap up:
  - When everyone is back in the classroom have students answer the survey posted on google classroom.

Sample Google Classroom Survey

Which way of tree identification did you find more successful?

Winter tree ID   Summer tree ID with augmented reality

How valuable did you find using the augmented reality was to your learning?

Very Valuable   Somewhat Valuable   Neutral   Not Valuable

Using augmented reality sparked my interest in Minnesota Native Trees more than not using it.

Totally Agree Somewhat agree Neutral Somewhat disagree Totally disagree

I would like to use Augmented Reality in the future for other projects.

Totally Agree Somewhat agree Neutral Somewhat disagree Totally disagree

Lesson Eight- Is Maple Syrup a Sustainable Food Source

Established Goal(s)/Content Standard(s):
- MN Benchmark: 9.4.4.1.2 Describe the social, economic and ecological risks and benefits of changing a natural ecosystem as a result of human activity.
- MN Benchmark: 9.4.4.1.3 Describe contributions from diverse cultures, including Minnesota American Indian tribes and communities, to the understanding of interactions among humans and living systems.

Understanding (s)	**Essential Question(s):**
Students will understand that: ● If done correctly, maple syrup production is a sustainable food source.	● Does tapping a maple tree affect the overall health of the tree.

Student objectives (outcomes):
Students will be able to:
- LT 13: I can conclude that tapping maple trees for syrup does not harm the tree and is a sustainable food source.

Stage 2 – Assessment Evidence

Performance Task(s):	**Other Evidence:**
● Project from tree to table assessment	● Small group conversations about health of trees ● Science journal writing about health of trees using evidence

Stage 3 – Learning Plan

Materials:
- Science journal
- Computer access
- Poster paper
- Class set of colored pencils or markers

Learning Activities:

- Warm up:
    - Have students look at their pictures from when they were tapping the maple trees. Remind them of how the Native Americans have been doing this practice for hundreds of years and if we tapped them correctly they should be just as healthy as the other trees.
- Activity:
    - Bring students out to the maple trees you tapped.
    - Have students compare and contrast the maple trees that you tapped vs the maple trees that were not tapped.
    - Have them write down the appearance of each tree along with what the tap hole looks like now.
- Wrap Up:
    - In their science journal have students answer this question. Based on what you saw today, do you feel that the trees we tapped were just as healthy as the ones we did not and is making maple syrup a sustainable food source. Use evidence to justify your answer.
- Assessment:
    - From tree to table assignment

From Tree to Table Assignment

Name_____

For the last ten or so days you have spent time outdoors learning about native trees in Minnesota and how to sustainably make natural maple syrup. During this time you have slowed down and taken the time to get off the beaten path, get your hands dirty, and even taste some buds off trees to determine the species. Now is your opportunity to show what you learned with this tree to table project.

Purpose:

- To show the steps in making maple syrup

Procedure:

- Create a document or poster that includes the steps to making maple syrup from identifying the trees to evaporating the sap.
- Each step should include a picture, that you have taken, and a description to explain the process.

From Tree to Table Rubric

Criterion	3	2	1
Summary of each step in maple syrup	All steps are described and a photo or drawing is included in each step.	All steps are described but some photos or drawings are missing.	Steps and descriptions are missing along with photos or drawings.
Accuracy	All steps are described with accurate and detailed information.	Some steps are described with accurate and detailed information. Some steps are not accurate.	Many steps are missing accurate descriptions and information.
Presentation	Project is well organized, laid out in chronological order of steps, and is easy to follow.	Project is well organized but steps are not laid out in chronological order or are not easy to follow.	Project lacks organization and is hard to follow the steps.

REFERENCES

LEAF - Wisconsin's K-12 Forestry Education Program. (n.d.). Retrieved June 22, 2019, from https://www.uwsp.edu/cnr-ap/leaf/Pages/default.aspx

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Vuforia Studio. (n.d.). Retrieved July, 2, 2019, from https://www.ptc.com/en/products/augmented-reality/vuforia-studio