

Name: Jacob Turner



Lesson Title: Introduction to Geographic Information Systems (GIS)

Curriculum Area: Science and Technology

Technology Strand: GIS

Grade Level: 7

Essential Question: How is a Geographic Information System (GIS) useful?

Activity Summary

This lesson is an introduction to GIS using data that students collected during their Maple syrup production project in conjunction with ArcGIS 10. When each sugar maple tree was tapped, the location was recorded with a GPS. Also measured was the diameter of each tree, the amount of sap water during two short collection periods, and the total collected for each tree. Before the lesson, I created a shape file with all of their trees in it referenced to the co-ordinates that we collected with the GPS.

Curriculum Objective

Enter the objective number and the objective as it is stated in the North Carolina Standard Course of Study. If necessary, go to [Learn NC](#)

Competency Goal 1: The learner will design and conduct investigations to demonstrate an understanding of scientific inquiry.

1.02, 1.05, 1.06, 1.07, 1.08, 1.09, 1.10

Competency Goal 2: The learner will demonstrate an understanding of technological design.

2.01, 2.02, 2.03, 2.04

Technology Objective

Please enter the objective number and the objective as it is stated in the North Carolina Standard Course of Study. Go to [Learn NC](#) to locate the objective. If this lesson does not address a technology objective, leave this area empty.

Technology is included in the competency goals listed above. I did not trace the special technology objectives if there are any outside of what I have reported here.

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Activating Strategies

Activate students' prior knowledge through the use of engaging strategies designed to focus learning

This lesson is an in class introduction to a larger land use project.

The activating strategy here is to get the students to use the GPS coordinates that they collected in the field and enter them into the computer so that they can begin to understand that the points they collect can actually be used to locate things, draw and bound objects.

Cognitive Teaching Strategies

Provide a structure for learning that actively promotes the comprehension and retention of knowledge through the use of engaging strategies that acknowledge the brain's limitations of capacity and processing. Write step by step instructions for teaching the lesson.

ENGAGE: When we started the Maple Syrup project, each core had 2 trees of 8 from which they collected data. The lesson starts by displaying a winter 2010 orthoimage of Welborn Middle and the sugar maple trees next to it. The image was downloaded from:

<http://data.nconemap.com/geoportal/catalog/main/home.page>

The students were asked to identify their trees in the image. Most will get close, but may struggle with the precise location of the trees. After the students try to identify the trees in the image, get a volunteer to enter the coordinates of one of the trees into the GOTO XY dialog box in ArcGIS 10. When this is done correctly, a point will appear in the location that corresponds with one of the Maples in the image. Up to this point, the students have used a GPS in the field on several occasions, and will be able to observe firsthand how the coordinates that they collected are used to locate things, and how they are used to georeference other types of information.

EXPLORE: Display the point shapefile of all of the sugar maples in the viewer, open the sugar maple attribute table so that it can be read in the viewer alongside the shapefiles, and ask the students to answer the following questions:

Which two trees did your class tap?

Of all 8 trees:

Which tree was the largest?

Which two trees produced the most sap overall?

On each collection date which tree produced the most sap?

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Two trees didn't produce any sap- which ones are they? Are they close together in space? Are they similar in size?

This should be done by taking volunteers to come up and select the answers from the table: first on screen, then with a mouse so that the answer(s) is/are highlighted on the display. Conversely, if the select features button is used to select a tree from the overlay, the corresponding record will be highlighted in the table. This will also demonstrate how the records are linked to cartographic objects. In this instance the objects are trees that the students are familiar with.

EXPLAIN:

A Geographic Information System (GIS) is a computer program that is used to visualize, store, organize, and analyze data that is associated with a location. For example, the coordinate information that we collected with our Global Positioning System (GPS) units can be used to record the absolute location of individual trees, using a point to represent them. Following that, we are able to attach many other kinds of data related to that place.

Using coordinate systems, a GIS is able to model the entire range of possible locations for objects on the earth's surface digitally. We can represent real world objects by using *points*, like our tree data, or we can use a series of points to create *lines*, if they represent our objects better than points. We can also draw shapes or *polygons* around *areas* that we want to represent as a single thing. Objects drawn within a GIS that use points, lines and polygons are called *vector* data.

Sometimes it is hard to draw lines around things that occur in the natural world (think vegetation, or temperature) with the hard lines and points that vector data provide. For example, in our exercise, the image that we use is another type of spatial data known as *Raster* data. Rasters cover an area with *evenly spaced cells*, or *pixels that hold a single value*. In the case of our orthoimage, or any other kind of digital photo, the cells represent the amount of light reflected from an object. This is more commonly thought of as *color* when thinking of digital photography. The physical space represented by each cell is known as the raster's spatial resolution. While imagery is a very common raster dataset used within a GIS, other continuous things like elevation or temperature can be represented in space using the raster data model.

While a GIS can make maps and is often associated with this task, it can provide many more functions as demonstrated above with the information linked to our trees via a table.

It will be helpful to explain who uses a GIS, and how prevalent it has become.

Ask the students who might need to have maps that are linked to a database and kept current on a day to day basis? Newspaper, Television, Police, Fire and EMS come to mind very quickly. Department of Transportation, City water management, Electric Companies, etc

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Who uses maps that may not include roads or buildings like the maps that most everyone knows? Forestry, Biologists,

EXTEND

Sugar Maple distribution in North Carolina

Leaving the tree layer on so that the class knows where they are in the state, activate the NC sugar maple layer and zoom out so that the outline of all counties in North Carolina are visible.

NC Sugar Maple is a vector file (also called shapefiles in ArcGIS) that shows the presence or absence of sugar maples in every county in the state of North Carolina. It was created from *information* from the USDA PLANTS database...

<http://plants.usda.gov/java/profile?symbol=acsa3> READ THE FOLLOWING PERTAINING TO THE INFORMATION FROM USDA ON SUGAR MAPLE DISTRIBUTION

“Our county data are based primarily on the literature, herbarium specimens, and confirmed observations. However, not all populations have been documented, so some gaps in the distribution shown above may not be real. Remember that only native and naturalized populations are mapped!”

...using vector *shapefiles* from The National Atlas Raw Data Download:

<http://www.nationalatlas.gov/atlasftp.html>

NC Sugar maple file was created by transferring information about the simple presence or absence of sugar maples in each county in North Carolina to the shapefile from the National Atlas. I used the National Atlas data so that I could expand the lesson to other states in the south, although I did not use them here.

Students should notice right away that there is a pattern associated with sugar maple distribution in North Carolina. They are clustered in the western part of the state with a few outliers. Discuss the possible reasons for the clustering of counties with sugar maples in the western region, and why some seem to be scattered in random places.

Most will guess that temperature has a great deal to do with sugar maple distribution. Information to supplement your discussion can be found here:

http://na.fs.fed.us/pubs/silvics_manual/volume_2/acer/saccharum.htm READ THE FOLLOWING PERTAINING TO THE INFORMATION FROM the US FOREST SERVICE ON SUGAR MAPLE DISTRIBUTION

“The optimum temperature for germination is about 1° C (34° F), the lowest of any known forest species (39,108). Germination drops rapidly as temperatures increase, and little if any germination occurs above 10° C (50° F). Rapid warming of the surface soil in the spring of 1978 in northern Wisconsin, for example,

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prevented germination from the bumper seed crop of 1977, except in a few remaining snowbanks along the roads (38).

In order to demonstrate the different yearly minimum temperature zones in NC, I used a shape file overlay from NRCS Geospatial Data Gateway:

<http://datagateway.nrcs.usda.gov/>

Display the annual minimum temperature shape file over the NC maples file, open the attribute table so that the temperatures can be seen. Starting with the easternmost zone on the coast, use the mouse to select each zone moving west. Get the students to explain what is happening to the yearly minimum temperatures as you move west across the state. They will notice that the temperature decreases. Get the students to discuss potential reasons for this.

There are several interrelated factors. The temperature in the Troposphere has the tendency to cool at a normal rate with change in elevation if the air is not moving. This alone will ensure a change in temperature as one moves from the coastal plain to the mountains. This is the environmental lapse rate. Rising air, however, cools at a different, faster rate depending upon how wet or dry it is. This is known as the adiabatic rate. Air rises through the lower atmosphere by way of convection or through orographic lifting as it crosses terrain from lower areas to the higher elevations. The clustering of sugar maples in the western counties is likely due to this combination of reasons. The scattered distribution of counties with trees further east are likely due to naturalization- the trees were transported to these unlikely growing regions and established themselves following the move.

You can examine the above with the temperature shape file overlying the elevation file which shows the Southern Appalachian mountains in the state. The elevation file came from the National Atlas Raw Data Download.

What is the terrain (topography) like in the western part of the state? How does this affect the temperature and tree growth?

EVALUATE

Before the students leave, ask them to notice where GIS is being used outside of their classroom, and make a list for warm up on the following day.

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Resources (List any materials, software, and filenames of data files needed to complete this lesson.)

This lesson requires the use of special software, ArcGIS 10 by ESRI of Redlands, California. Educational site licenses start at \$500 for the first year, and 250\$ for each additional year.

Listed within this lesson are the locations for all files used in this lesson, except for the North Carolina Sugar Maple distribution file, which was customized using files from the aforementioned website and ArcGIS 10.

I can be contacted for questions and all files that I used for this lesson-
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