

Modeling the Garden Creek Mounds

By Stephanie Morgan from Pisgah High School
for the 2021-2022 World View Global Fellows Program

Overview of Lesson: The Garden Creek mounds are located approximately 1.7 miles from Pisgah High School, along the Pigeon River near Canton in Haywood County, North Carolina. After learning about the history of the periods in which these mounds were constructed and the history behind them, students will model the amount of earth used to build these mounds with volume formulas for three-dimensional solids using dimensions provided on the Ancient North Carolinians website.

About the Project: American Indians lived in the area we now call North Carolina for at least 15,000 years. Archaeologists study the remnants of their communities to learn who these people were and how they lived and prospered for thousands of years. The lesson presented below was developed as part of the 2021-2022 UNC World View Fellows Program, [Exploring Indigenous Cultures: Ancient North Carolinians, Past and Present](#). It is one in a series of lessons that the Fellows created for K-12 schools and community colleges to help students learn about the ancient peoples that lived here and those who represent today's vibrant American Indian populations. Lessons connect past to present day by exploring multiple resources within the [Ancient North Carolinians: A Virtual Museum of North Carolina Archaeology website](#) to examine how communities changed over time and what influenced these changes. Understanding past Indigenous lifeways—their complexity, resiliency, and vitality—allows for a greater appreciation of the contributions American Indians made to the past and continue to make to the present and future of North Carolina.

Suggested Grade Level: 10th & 11th (standard, inclusion, and honors)

Subject: NC Math 3

Corresponding National and State of North Carolina Standards:

[NC Math 3 Standards:](#)

NC.M3.G-GMD.4: Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects

NC.M3.G-MG.1: Apply geometric concepts in modeling situations

- Use geometric and algebraic concepts to solve problems in modeling situations
- Use geometric shapes, their measures, and their properties to model real-life objects
- Use geometric formulas and algebraic functions to model relationships
- Apply concepts of density based on area and volume
- Apply geometric concepts to solve design and optimization problems

Essential Questions:

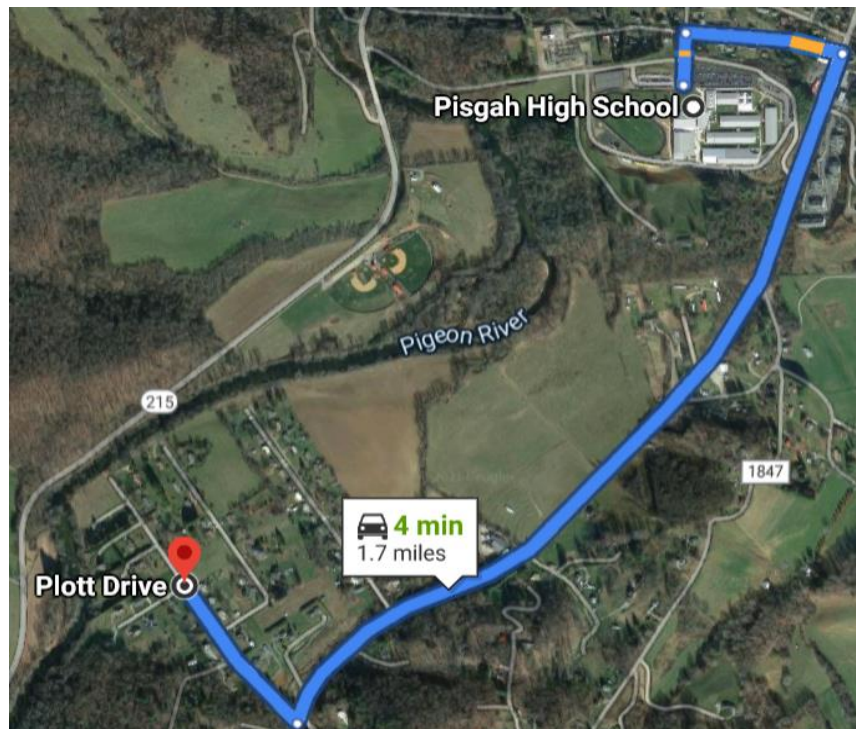
1. Prior to European arrival, who lived in the area around the Garden Creek Mounds? Where do they live today?
2. What are the key features of each solid (prism, cylinder, pyramid, cone, sphere)?

Lesson Objectives:

- Students will have a better understanding of the Indigenous population that lived in the area that has become our community and the authentic artifacts and architectural constructions of the Cherokee.
- Students will correctly utilize the proper formulas to model three-dimensional solids.
- Students will modify formulas for three-dimensional solids to model non-standard shapes.

Background information for the educator:

The Garden Creek mounds are the focus of this lesson due to the proximity to Pisgah High School.



If a teacher wishes to consult the [Ancient North Carolinians website](#) for information on other mounds near their own institutions (specifically the [Archaeology in Your County](#) page), this lesson can be adapted to be more applicable to that area/region.

The historical focus of this lesson can be found on the Ancient North Carolinians website, specifically the pages describing Garden Creek [Mound 1](#) and [Mound 2](#). The history of these earthen mounds, their uses, and the shapes/dimensions will be explored and then utilized to ask students to begin to model the mounds geometrically.

Discussion Questions:

- What was the purpose of these ancestral Cherokee and Cherokee mounds?
- What was located at the two mounds at Garden Creek?
- Discuss which formula(s) to use to make their models.
- Discuss the pros and cons of their models and whether they will yield over- or under-estimates.
- Students will ask one another 'Why did you pick that specific solid?'

Student Activities:

- The first 10-15 minutes of class will be used to review the previous day’s lesson, go over any questions from the previous day’s assignment, and allow for any clarification or extension
- (Next 30 minutes) Show students the [NC Historical Highway Marker for the Garden Creek Mounds](#)
 - If a teacher is going to use a site found on the Ancient North Carolinians website that is closer to their school, he or she may want to consult the [NC Historical Highway Marker](#) website to see if there is a marker for that location.
- Lead discussion into asking one of the essential questions: Who lived in the area around the Garden Creek Mounds before Europeans arrived and who lives there today?
 - The students are likely to know about the Eastern Band of Cherokee Indians in western North Carolina and will answer accordingly.
 - Explain that the Eastern Band of Cherokee Indians (EBCI) is a federally-recognized tribe that has lived, and continue to live, in the area of Garden Creek. EBCI is also one of eight state-recognized American Indian tribes and four urban Indian organizations in North Carolina. Please use this map and the [Ancient North Carolinians website](#) to connect to tribes in your area.

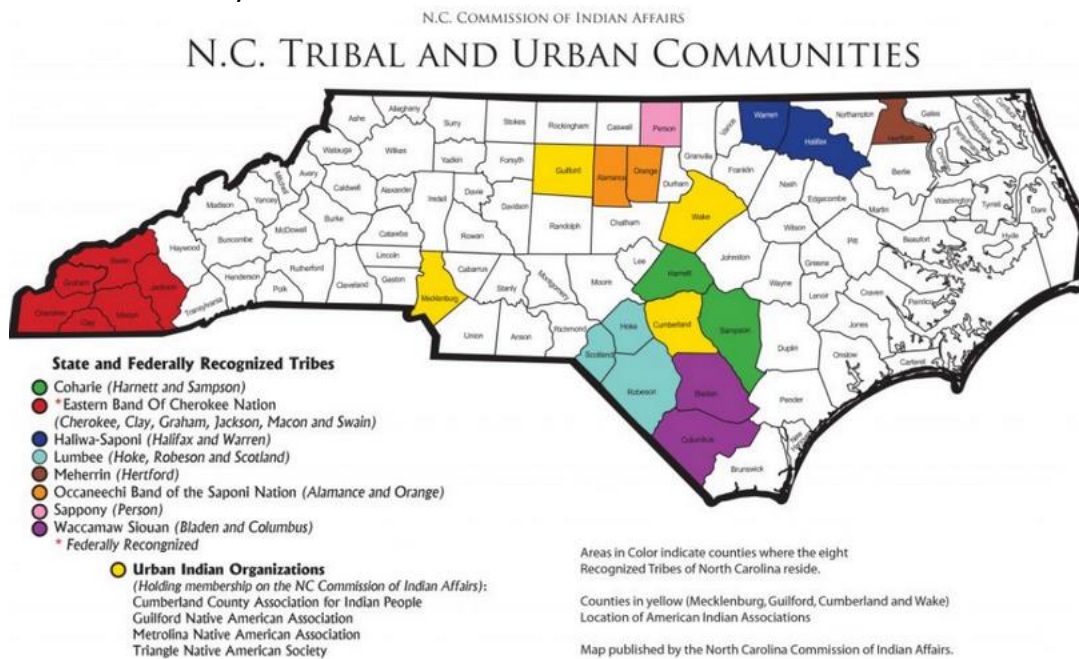


Image: NC Tribal and Urban Communities Map. North Carolina Commission of Indian Affairs.

<https://ncadmin.nc.gov/about-doa/divisions/commission-of-indian-affairs>

- Students will turn their attention to Garden Creek – they will access information about the two sites ([Mound 1](#) and [Mound 2](#)) and the excavations in 1976. Students will be grouped in groups of 3 or 4 and will be assigned one mound about which to read. They will be given 15 minutes to read about their mound site and converse, as a small group, about the key mathematical facts and figures they think they may need.

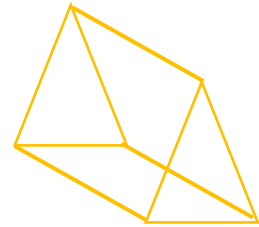
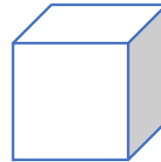
- Teachers may elect to use this [graphic organizer](#) to help students take notes as they read about each mound.
- Teachers may also choose to have students focus on specific paragraphs for key information, which can then be recorded in the graphic organizer.
- After each group has compiled the information they believe important from their reading, all Mound 1 groups and all Mound 2 groups will come together to compare and create one final list of facts and figures they believe they will need. They will be given 5 minutes to compile this final list. Some facts that may be highlighted in lists are:
 - [Mound 1](#) – Dates to the Mississippian Period ca. 1000 to 1450 AD (a time known archaeologically as the Pisgah phase), so the mound is considered to be an ancestral Cherokee site
 - The mound was 7 ft high (likely reduced by several feet due to agricultural plowing and erosion) and 150 ft x 130 ft (wide and long).
 - Heye, in 1919, described the mound as being “conical” in shape.
 - The site started as two earth lodges, semi-underground and earth embanked.
 - Ultimately, it become a rectangular mound with elevated surface measuring 50 ft x 70 ft.
 - A total of 24 human burials were found during excavation in 1976. Half of the individuals were associated with the Pisgah phase. (Note: Today’s archaeological ethics do not permit the excavation of human graves without permission of the affiliated contemporary American Indian tribe (The Research Laboratories of Archaeology at UNC Chapel Hill adopted this practice in 1980s)
 - Most individuals were buried in simple graves, but some were buried in shaft-and-chamber graves that had chambers dug off to the side.
 - More than half of the dead were accompanied by grave goods, items interred with the deceased by family and friends.
 - [Mound 2](#) – Carbon dating through excavation dates the site back to Middle Woodland Connestee phase (200-600 AD)
 - A landowner wanted to use this mound for fill dirt but was convinced of necessity for and importance of archaeological excavation.
 - It was a low platform mound that served to elevate public buildings.
 - The mound was built on a midden (ie. trash remains), which indicated people lived there before the mound was constructed.
 - The primary or first mound measured ~40 ft x 60 ft and little less than 2 ft high (1.7 ft to be exact). The second mound was 80 ft x 60 ft and between 7 and 9 ft high.
 - “Exotic” artifacts were found that showed connections with other Indigenous people across the Appalachian summit and northward into the Ohio Valley.

- Mounds were subject to intermittent habitation and could have been used for seasonal gatherings.
- Each group will have 5 minutes to present their lists to the other groups and take questions (10 minutes total).
- (15 minutes) Having read about the engineering that went into constructing the mounds on the website, our focus will then shift toward understanding the scope and size of these mounds
 - Begin by producing a 1-ft³ cardboard cube to help students visualize size
 - Then briefly discuss archaeological practices using clear visual example from a nearby ancestral Cherokee village (known as the Warren Wilson site). All information is also provided in the [Calculating Volume of Soil Excavated Worksheet](#).
 - Here, archaeologists excavated a series of 10 ft x 10 ft units (11 units total; count the rectangular soil pedestals at the corner of each unit in the image in the worksheet) to form a long trench, initially removing about 12" (or 1') of what is known as *plowzone* (ie. the upper layer of soil that has been disturbed by agricultural plowing) to reveal the ancient settlement.
 - Show students the photo of the excavation and ask them to calculate the volume of soil (using rectangular prism) that was removed within each 10 ft x 10 ft excavation unit. Then ask how much was removed from the whole trench (n = 11).
 - Returning to the Garden Creek sites, ask students to calculate the volume of soil for the following semi-subterranean architectural features that were found below Mound 1:
 - Earth Lodge 1: 24 ft² and a depth of 2.2 ft
 - Earth Lodge 1, Clay Bench: 4.5" x 11" x 1"
 - Earth Lodge 2: 28 ft² and a depth of 1.2 ft
 - The Earth Lodge discussions will be helpful in linking volume to (*base area*)(*height*) and recognition that the calculation of (*length*)(*width*) has already taken place with the squared measurement
 - Ask: Can you estimate how many of these cubes (hold up the 1-ft models), or how much earth, was removed to construct the two earth lodges? And, how much soil was added to construct the clay bench?
 - This leads into the modeling aspect – What do we need to know to make the appropriate model of the actual Garden Creek Mounds?
 - Size – We have dimensions from the websites
 - Formulas – But what formulas should we use? What are the formulas connected to?
 - Shapes – What shapes are most appropriate, and why?
 - Students have dealt with 3-D solids in middle school math, but may or may not remember all of them or the formulas

- Explore and define the shapes we need to focus on:

- Prism:

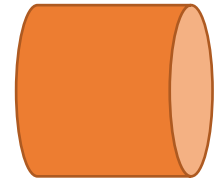
- Types of prisms (rectangular (cube as a specific type), triangular, etc) and how they are named (by base)



- Formula: $V = Bh$ (where B = area of the base & h = perpendicular height (distance between bases))

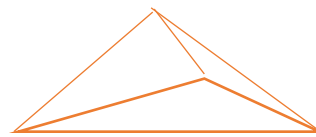
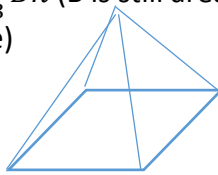
- Cylinder: How is a cylinder like a prism?

- Essentially, prisms with circular bases
- $V = Bh \rightarrow V = \pi r^2 h$ (as πr^2 is the area of a circle)



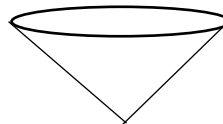
- Pyramid: Similar to a prism – would it have a greater or smaller volume?

- Smaller volume – in fact, is exactly $\frac{1}{3}$ of the volume of a prism with identical dimensions
- Named by base (rectangular pyramid, triangular pyramid, etc)
- $V = \frac{1}{3}Bh$ (B is still area of the base, height is still perpendicular distance to base)



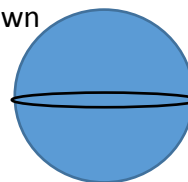
- Cone: Similar to a cone – would it have a greater or smaller volume?

- Smaller volume – in fact, is exactly $\frac{1}{3}$ of the volume of a cone with identical dimensions
- $V = \frac{1}{3}\pi r^2 h$



- Sphere: kind of in a league all their own

- $V = \frac{4}{3}\pi r^3$



- Now, to estimate the volume of soil needed to construct the Garden Creek Mounds.
 - Recall that Mound 1 was described as ‘conical’. Discuss what this means (ie. Implies it is shaped as a cone)
 - Calculate volume using a shape more appropriate to the mounds using the information presented above and reiterated below:
 - Mound 1: 130 ft x 150 ft x 7 ft
 - Mound 2, primary mound: 40 ft x 60 ft x 1.7 ft
 - Mound 2, secondary mound: 60 ft x 80 ft and between 7-9 ft high
 - What would happen to the volume estimate if the mounds were more half spherical in shape as opposed to conical?
- (~20 minutes) As a class, work together on the first three problems in the [3D Solids & Volumes Practice Problem Set](#) – take any questions that come with the use of the equations
 - Let students work independently on the last three examples, then review answers
 - Challenge question: How would you model the volume of the following shape with a diameter of 8 meters?



Students need to recognize here that the formulas can be manipulated – in this case, the volume of a sphere is halved to yield $V = \frac{1}{2} \left(\frac{4}{3} \pi r^3 h \right)$ or $\frac{2}{3} \pi r^3 h$

- (~10 minutes) Use the [Desmos Volume by Rotation Examples](#) to demonstrate volumes of solids by rotation (for additional visual aid, cut out a cardboard right triangle, semicircle, and rectangle to tape to a pencil and rotate for students to further visualize)
 - Students will visualize how a 2D shape can be rotated or revolved around an axis to create a 3D solid just like the ones we’ve already gone over
- To conclude, ask: Why is it important to understand ancestral Cherokee and Cherokee mounds in our own “backyard,” as it were?
 - Link to the [Nikwasi Foundation site](#) and show video about how the foundation came to be and what it’s working toward today.
 - See that this is a relevant today, not only for the preservation of culture and heritage for the Cherokee people, but for the learning and understanding of all North Carolinians and all people about our area’s history with the establishment of the Cultural Corridor and highlighting of the importance of the Nikwasi Mound and Cowee Mound
- **Assignment:** Students will attempt to create the best model for each of the two Garden Creek mound sites using what we’ve learned. They’ll use the [Ancient North Carolinians](#) website to review the dimensions and photos of the site to select the equations and methods they would use (such as identifying a 2D shape to rotate around an axis) to model each mound. Students will devise a calculation to model the volume of each mound and provide a written explanation

as to why they selected the formula(s)/method selected, as well as if their model is an over- or underestimate and why.

- Note: This modeling may come out in the class discussion of the two mounds and may be something that has been done initially as part of the large-group discussion. If that is the case, then the assignment can be modified to challenge students to create a better model that will minimize the amount of over- or under-estimation.

Materials:

- Class set of Chromebooks/iPads/Laptops/etc
- Teacher computer with speakers and connected to a projector projector
- Three-dimensional solid models (minimum of prism, cylinder, pyramid, cone, sphere)
- [Graphic organizer](#)
- 1-ft³ model for visualization (perhaps easiest made out of cardboard)
- [Calculating Volume of Soil Excavated Worksheet](#)
- 3D Solids & Volumes [Practice Problem Set](#)
- [Desmos Volume by Rotation Examples](#)
- Cardboard cut-outs of right triangle, rectangle, and semicircle to tape to a pencil

This lesson plan was created by Stephanie Morgan of Pisgah High School as part of the 2021-2022 UNC World View Global Fellows Program. For more information about the program, please visit <http://worldview.unc.edu/>