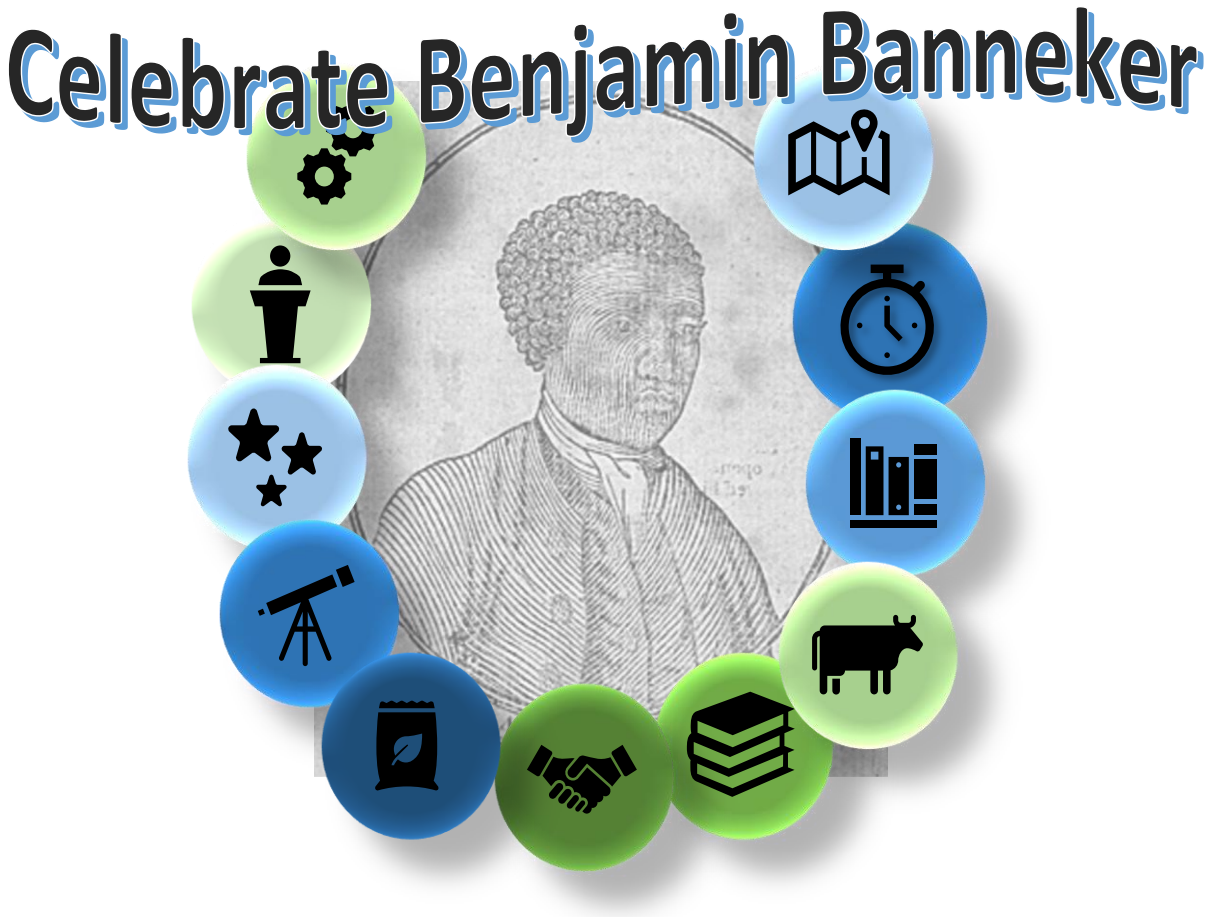
BENJAMIN BANNEKER INSPIRED LESSON PLANS



The lesson plans included in this Teacher's Guide offer a few ways you could celebrate the life and accomplishments Benjamin Banneker with your students!

CREATIVE CLOCK (ELEMENTARY)

Grade Levels

- K-5

Standards

- CCSS-M
  - Kindergarten: K.CC.A.3; K.NBT.A.1
  - Grade 1: 1.OA.C.6; 1.OA.D.7
  - Grade 2: 2.NBT.B.5; 2.MD.C.8; 2.OA.C.4; 2.OA.C.3
  - Grade 3: 3.OA.D.9; 3.OA.A.4
  - Grade 4: 4.OA.C.5; 4.NBT.A.2
  - Grade 5: 5.OA.A.2; 5.OA.B.3

Lesson Objective

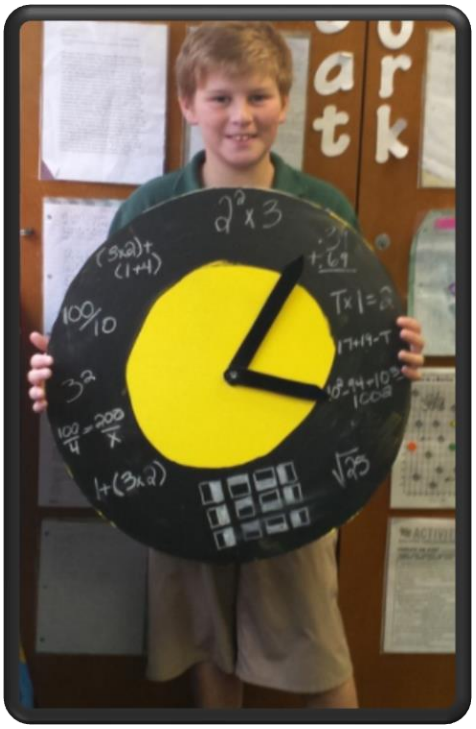
- The Learner will use their knowledge of mathematics to **design a clock face** using their creativity connect their learning of Benjamin Banneker and his contributions to our society to mathematics.

Materials

- Benjamin Banneker biography and video (http://bbamath.org/index.php/benjamin-banneker/)
- Blank clock templates

Instruction

1. Who was Benjamin Banneker? Share Benjamin Banneker biography and video with students.
2. Discuss how Benjamin Banneker built a working clock using a pocket watch as his model. Questions could include:
   a. *How do you think Benjamin Banneker was able to construct a working clock?*
   b. *What was important about Benjamin Banneker's clock?*
   c. *Why do you think Benjamin Banneker used wood to create his clock?*
   d. *How is Benjamin Banneker's clock similar or different from any clocks you have seen?*
   e. *What is an analog clock?*
3. Learners will use a variety of mathematical representations (based on the grade level focus) to replace each of the numbers shown on the face of an analog clock. Students may use the blank clock templates or create their own artistically designed clock. You may show learners examples of completed clocks to help them think of ways they might want to design their own clock face.

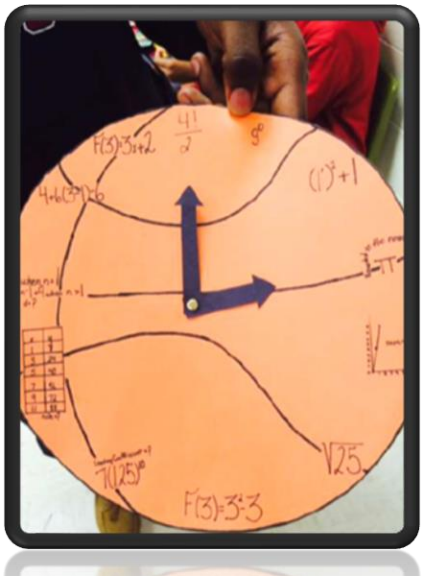


Creative Clock Example Topics:

- Kindergarten – How could each number on the clock be represented by a **picture of objects**?
- First Grade – How could each number on the clock be represented by an **addition or subtraction sentence**?
- Second Grade – How could each number on the clock be represented by a **length shown on a measurement tool, like a ruler, yardstick, meter stick, or measurement tape?**
- Third Grade – How could each number on the clock be represented by **multiplication and division expressions**?
- Fourth Grade – How could each number on the clock be represented by **the sum / difference / product / quotient of all prime numbers?** How could each number on the clock be represented by **the sum / difference / product / quotient of all composite numbers**?
- Fifth Grade – How could each number on the clock be represented by **a mathematical expression containing parenthesis and brackets**?

4. Offer students the opportunity to share a closing ticket:
    a. Example: 3, 2, 1 Activity– **3** things you learned about Benjamin Banneker; **2** things that connect with something you already learned; and **1** thing you would like to learn more about.

CREATIVE CLOCK (SECONDARY)



Grade Levels

- 6-12

Lesson Objective

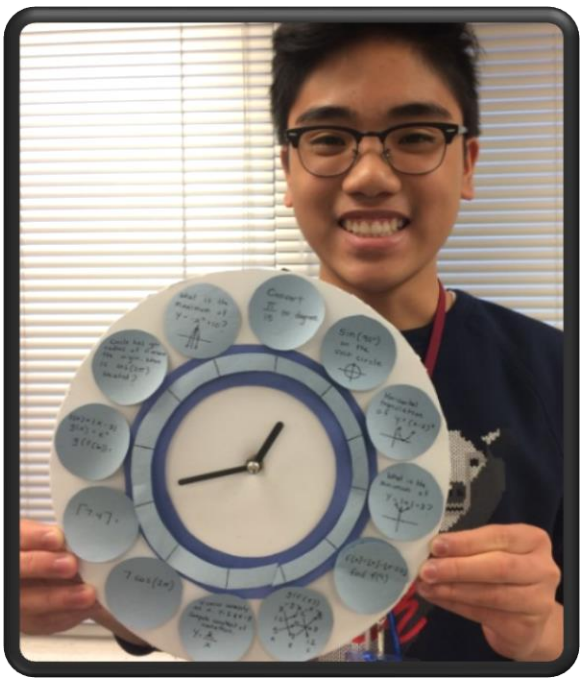
- The Learner will use their knowledge of mathematics to **design a clock face** using their creativity connect their learning of Benjamin Banneker and his contributions to our society to mathematics.

Materials

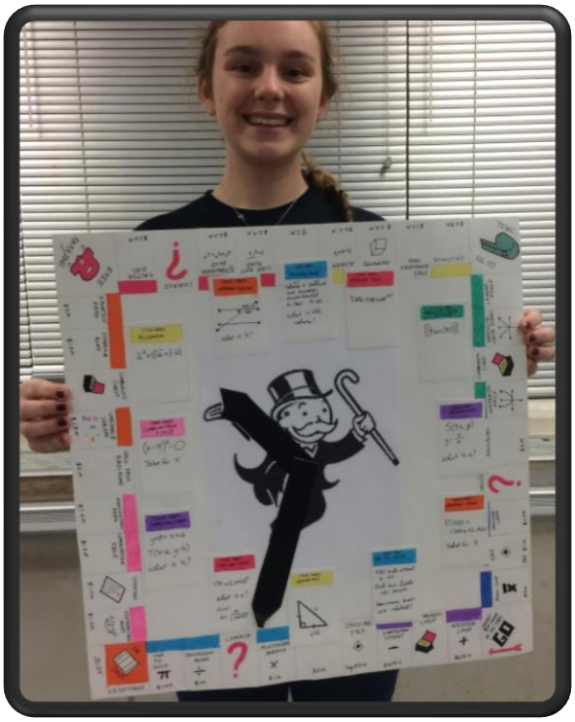
- Benjamin Banneker biography and video (http://bbamath.org/index.php/benjamin-banneker/)
- Blank clock templates

Instruction

1. Who was Benjamin Banneker? Share Benjamin Banneker biography and video with students.
2. Discuss how Benjamin Banneker built a working clock using a pocket watch as his model. Questions could include:
    a. *How do you think Benjamin Banneker was able to construct a working clock?*
    b. *What was important about Benjamin Banneker's clock?*
    c. *Why do you think Benjamin Banneker used wood to create his clock?*
    d. *How is Benjamin Banneker's clock similar or different from any clocks you have seen?*
    e. *What is an analog clock?*



3. Learners will use a variety of mathematical representations (based on the grade level focus) to replace each of the numbers shown on the face of an analog clock. Students may use the blank clock templates or create their own artistically designed clock. You may show learners examples of completed clocks to help them think of ways they might want to design their own clock face.



Creative Clock Example Topics:

- rates and ratios
- percentages
- fractions
- addition / subtraction / multiplication / division
- factors and multiples
- expressions and equations
- integers
- properties of operations
- exponents
- functions
- polynomials

4. Offer students the opportunity to share a closing ticket:
    a. Example: 3, 2, 1 Activity– **3** things you learned about Benjamin Banneker; **2** things that connect with something you already learned; and **1** thing you would like to learn more about.

HOW DID HE DO IT?

HOW BENJAMIN BANNEKER USED SCALING AND PROPORTIONS

Benjamin Banneker was born a free man in Maryland on November 9, 1731. A land-owning farmer of modest means, Banneker nevertheless lived a life of unusual achievement.

But it was his clock invention that really propelled the reputation of Benjamin Banneker. Sometime in the early 1750s, Benjamin borrowed a pocket watch from a wealthy acquaintance, took the watch apart and studied its components and inner workings. He made a drawing of each component, then reassembled the watch and returned it, fully functioning, to its owner. From his drawings Banneker then proceeded to carve, out of wood, enlarged replicas of each part. Calculating the proper number of teeth for each gear and the necessary relationships between the gears, he completed construction of a working wooden clock in 1753. The clock was amazingly precise. As the result of the attention his self-made clock received, Banneker could start up his own watch and clock repair business.

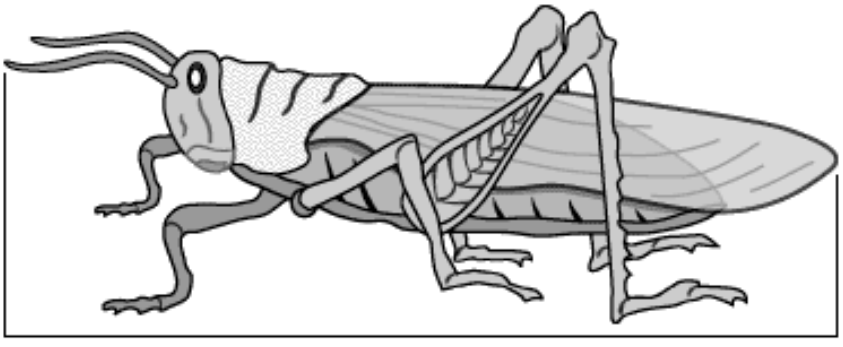
Banneker's clock kept accurate time and struck the hours for over 50 years until it was destroyed along with most of Banneker's other belongings in a mysterious house fire that took place on the day of Banneker's funeral. Benjamin Banneker has been credited for making the first clock to be built completely in America.

An important mathematical aspect of Benjamin Banneker's accomplishment was the concept of **scales and proportions**.

Scale of 1:1

Scale of 1:2

Scale refers to the size of an object (a whole) in relationship to another object (another whole). It is not always possible to draw on paper the actual size of real-life objects such as the real size of a car, an airplane. Also, as the case with Banneker's clock, objects too small may need to be enlarged. We need scale drawings to represent the size like the one you see here.



Scale of 2:1

In art the size relationship between an object and the human body is significant. In experiencing the scale of an artwork, we tend to compare its size to the size of our own bodies.

Proportion refers to the relative size of parts of a whole (elements within an object). We often think of proportions in terms of size relationships within the human body.

To find the **scale factor** we use **ratios** to set up proportions. **Proportional** means having the same ratio. A **scale factor** is the ratio of the model measurement to the actual measurement in simplest form. A model car with the scale factor of 1:20 means that the car is 1/20 times the size of the actual car. It also means that the car is 20 times the size of the model.

Grade Level

- 6-12

Standards

- 6.RP.1; 6.RP.2; 6.RP.3
- 7.RP.1; 7.RP.2; 7.RP.3
- HSG.SRT.A.1; HSG.SRT.A.2

Instructions

- Create a scale model of your classroom. Your model must include three-dimensional objects to represent the different materials and furniture in your classroom!

BENJAMIN BANNEKER
THE SURVEYOR

Background

As a young man, Banneker developed a working relationship with a surveyor named Andrew Ellicott. **Surveying** is the technique of measuring to determine the position of points, or of marking out points and boundaries. These points may be above, beneath, or on the earth's surface. Surveying is as old as civilization and dates to early Egypt. Every year, after the Nile river flooded and washed out farm boundaries, new boundaries were fixed by surveying. Three of the four presidents on Mount Rushmore started as surveyors—George Washington, Thomas Jefferson, and Abraham Lincoln. It was an important task in a young country where land records needed to be made.

In 1791, Ellicott was given the task of surveying land for the new federal district that would become the capital of the United States. Ellicott hired Banneker to help him. They worked to set accurate boundaries for the District of Columbia. Banneker is credited with positioning the starting point at Jones Point in Alexandria, Virginia.

Banneker had learned surveying reading a book "Gibson's Treatise on Practical Surveying" and had discussed the book with the Ellicotts. In 1791 when Major Andrew Ellicott was chosen to survey the boundaries of the new district where the federal city was to be, he selected Banneker as part of his team. Celestial readings were key to measuring out the boundaries, and Ellicott knew Banneker's excellent work in this area. At that time, with no advanced equipment for measuring land, an astronomer used the parallax effect to ascertain distances; Banneker's primary job was making astronomical observations for the starting point of the survey and maintaining a clock that was used to relate points on the ground to the positions of the stars at specified times.

Image taken from http://bit.ly/2ifSkc9

By George Washington's choice, the land for the federal city lay along the Potomac River, taking sections from Maryland and Virginia. To survey what was to become the District of Columbia meant hacking one's way through brush and fording streams to mark off an area of 10 square miles (16 km). Ellicott's team placed boundary stones at every one-mile point along the border of the new district.

After spending the first several months with the team, Banneker, at 59, became concerned about his farm and returned to the family land.

Some experts denigrate Banneker's contribution to the project, but given his knowledge and the long-term friendship he shared with the Ellicotts, there is no evidence that indicates he was anything but a full team member during the time he worked on the survey.

From colonial times and through the 1800s, surveying was performed using a crude transit, or compass, and a chain. The chain was designed by Edmund Gunter in the late 1500s and is sometimes referred to as "Gunter's chain." The most common chain used was 66 feet long and had 100 links. Each link was equal to 7.92 inches. The compass was mounted on a tripod or a single pole, called a "Jacob's Staff." These tools were cumbersome to carry and difficult to maneuver through thick brush. More modern methods of surveying include the Theodolite, an electronic distance measurement, GPS (Global Positioning System), and robotic surveying systems.

Lesson Plan – Surveying: 19 Chains and 50 Links

(http://oklahoma4h.okstate.edu/aitc/lessons/upper/survey.pdf)

Grade Level

- Grades 6-8

Objective

- The learner will use geometric skills to practice the art of surveying. Students learn about land surveying and the Homestead act. Students solve mathematical problems related to land surveying.

Image taken from http://bit.ly/2gNR7Zi

IT WAS WRITTEN IN THE STARS:
BENJAMIN BANNEKER THE ASTRONOMER

From 1792 through 1797 Benjamin Banneker, an African American mathematician and amateur astronomer, calculated ephemerides (tables of the locations of stars and planets) for almanacs that were widely distributed and influential. Because of these works, Banneker became one of the most famous African Americans in early U.S. history.

Benjamin Banneker made several contributions to the field of astronomy. At the age of fifty-eight Banneker became interested in astronomy through the influence of a neighbor, George Ellicott, who lent him several books on the subject as well as a telescope and drafting instruments (tools used in astronomy). Without further guidance or assistance, Banneker taught himself the science of astronomy. He had a very interesting way of studying astronomy: he would lie on his back at night gazing into the heavens until the early hours of the morning. After reading several borrowed books--Mayer's Tables, Ferguson's Astronomy and Leadbetter's Lunar Tables--Banneker devised a plan to project a solar eclipse. While researching the information needed to follow through with his plan, Banneker detected several errors in calculation. In 1789, he wrote Ellicott: "It appears to me that the wisest men may at times be in error; for instance, Dr. Ferguson informs us that, when the sun is within twelve degrees of either node at the time of full, the moon will be eclipsed; but I find that according to his method of projecting a lunar eclipse, there will be none by the above elements..." After correcting these mistakes, Banneker went on in 1792 to develop his first almanac; at the time, almanacs were the most comprehensive medium of scientific information available. He included projections for solar (of the Sun) and lunar (of the Moon) eclipses and computed ephemerides for his almanac.

NASA Math Challenges (https://eclipse2017.nasa.gov/math-challenges)

One of the reasons ancient peoples could not predict total solar eclipses was because they did not appreciate the mathematics involved in forecasting. Also, many of the parameters needed to accurately predict eclipses had not been astronomically measured until the first century. If you are taking a trip to visit a relative in another town and want to predict the time at which you will arrive, it really helps to know how many road miles you will be traveling and how fast you will go!

NASA has created a selection of math challenges that will take you through some of the mathematics related to the August 21, 2017 eclipse. The mathematics involved spans all grades and abilities, including proportions, algebra, trigonometry and calculus!

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