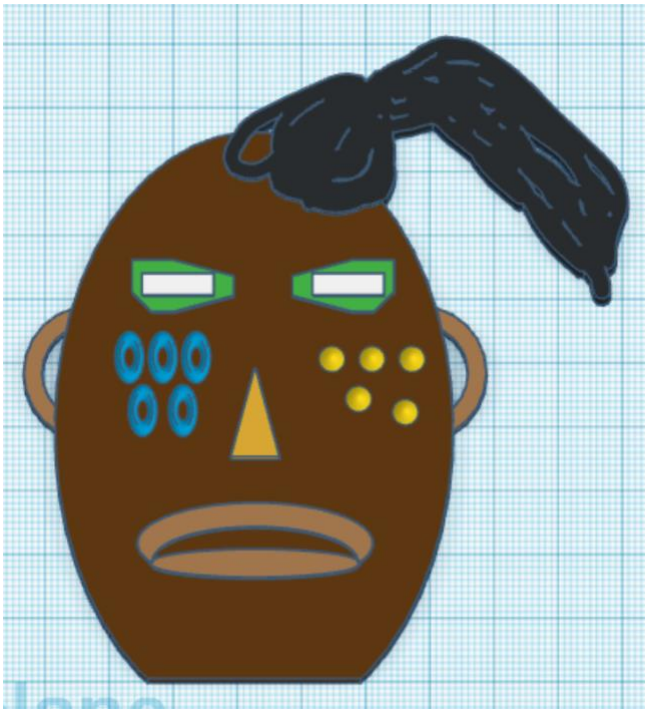
PROJECT TITLE – AFRICAN MASKS AND GEOMETRY



Steam Integration:

STEAM Integrations		
Math	Modeling/Visualization	Visual Art

- Note: This project can push into Science Standards as well. Ex: Biomes of Africa
- ELA component could be added into this project through documentation of their research findings.

Topic:

This lesson is an Arts Enhanced STEAM lesson, with possible Arts Integrated lesson options, that brings together Math, Modeling/Visualization, and Visual Art using Social Studies as the prompt to promote visual arts research.

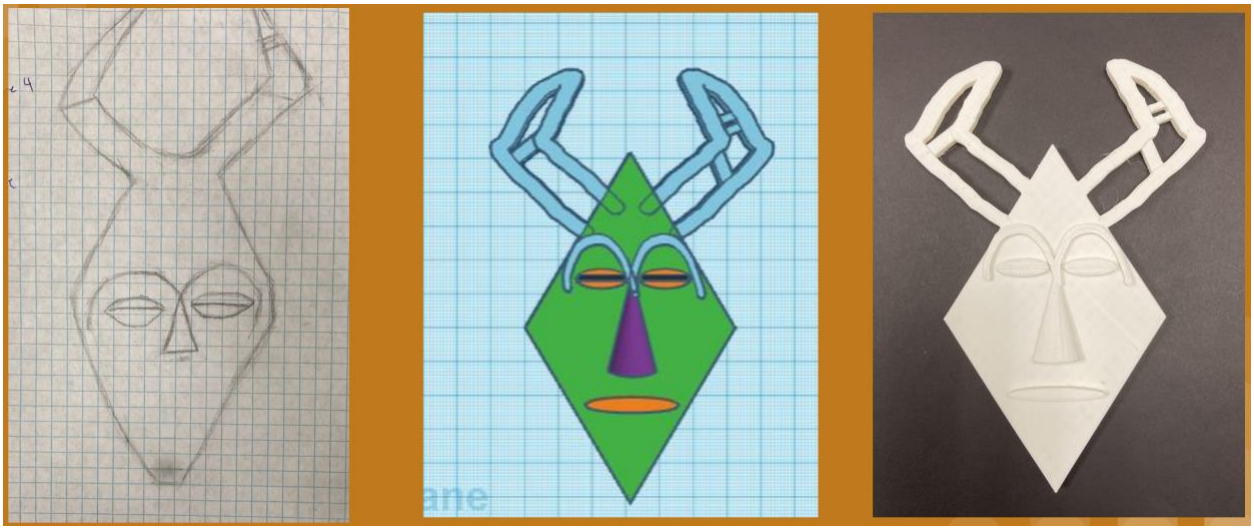
Targeted Age Group:

7th grade students, could be scaled up to 10th grade depending on required standards.

Lesson/Project/Unit Overview (Summary):

The first step is to introduce the PBL and demonstrate Tinkercad to the students. A good entry event is to take the students to a museum to view and learn about actual African Masks.

After completing the geometry module in math class, students then research African masks and design them on graph paper. Once the design is complete, they have an overview in Tinkercad and examples of careers where design capacity in 3D design tools is needed. Then they are given time to create their masks in Tinkercad. Once reviewed and approved, they are printed and optionally painted and shown to the students.



Project Length

6-9 Hours Instructional Time

Learning Goals

STEM Learning Goals	Arts Learning Goals
• To demonstrate proficiency in a three-dimensional design tool, Tinkercad. • To build cognitive models of geometric concepts and formulas, using Tinkercad as a representational modelling tool. • To solve a real-world mathematical problem, by using Tinkercad, for example, scaling.	• To learn how to effectively investigate diverse cultures to create inspiration for a work of art. • To learn how to visualize and connect ideas and inspiration into a work of art. • To document idea by creating a preliminary sketch. • To develop an original, three-dimensional work of art, using technology, with Tinkercad as the tool.

Learning Standards

National Standards
International Society for Technology in Education (ISTE) 1.4 Innovative Designer - Students use a variety of technologies within a design process to identify and solve problems by creating new, useful, or imaginative solutions. 1.4.a - Students know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts, or solving authentic problems. 1.4.b - Students select and use digital tools to plan and manage a design process that considers design constraints and calculated risks.

State Grade Level Standards

MGSE7.G.1 Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.

SS7.G.2 Explain environmental issues across the continent of Africa.

SS7.G.4 Analyze the diverse cultural characteristics of the people who live in Africa.

Background knowledge required of teachers/students

Teachers should have a working understanding of the Tinkercad platform and how to create 3D designs. Tinkercad provides tutorials that are available for users.

Teachers should have a background in 3D printing and access to a 3D printer. Alternatively, if the school has a maker space with a 3D printer, that is also ideal. There are also several online services like https://www.xometry.com/ where you can upload your design file and the 3D printed masks will be mailed to you if no 3D printer is available.

ENGAGE:

Section Goal: Students understand the problem of social misconceptions of African civilization and culture, and how art can help change this. Also, students should understand what can be designed in Tinkercad, and what professions and industries use graphic arts. This helps students see the problem and see what's possible.

Section Activity (Budget 45 minutes):

- Introductory discussion: Start the lesson by facilitating a discussion around real-world problem-solving, specifically the lack of understanding of African culture and civilization.
    - What are some misconceptions?
    - What are some ways to address those problems? What are some ways to build awareness of those problems?
- Facilitate a discussion with the class to enable students to gain an understanding that creating art can help people build awareness of a problem and can help change people's perceptions and behaviors.
- Show the students some images of African masks, with a brief discussion of characteristics of the masks. The Carlos Museum in Atlanta has several masks in its collection as well.

- Excerpt from Afrikanza.com blog post:
    - *Geometric and symmetrical patterns often play a prominent role in the design of African masks.*
    - *These include parallel lines, curves, spirals, and cruciform shapes all are found.*

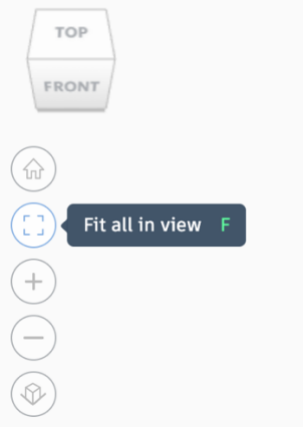
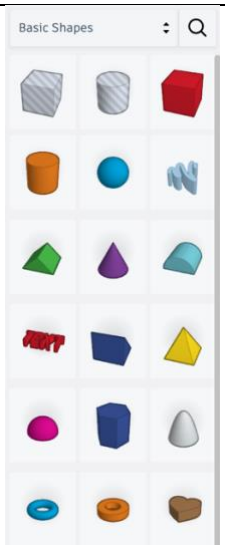
- Show sample Tinkercad designs for the class. If possible, have a 3D printed sample mask available to be passed around during class while the Tinkercad demonstration is taking place.
- Facilitate a discussion on professions and industries where 3D modelling is used:
    - Engineers, Artists, Video Game Creators, Architects, Animation, Films (CGI), Home Designers, Interior Designers, Automotive Designers, Fashion Designers, etc.
    - Optionally, you can show clips of these videos to show how 3D (CGI) is used in film.
        - **Black Panther**

EXPLORE:

Section Goal:
Students understand Tinkercad basic capabilities and the geometric shapes available to them, and their properties. The important aspect of this section is that students are aware of the capabilities in Tinkercad. They do not have to explore each capability or shape in this section, as they will learn in later sections as the need arises.

Section Activity (Budget 30-45 minutes):

- The teacher can create a Tinkercad classroom, generate a classroom code, and invite students, if the classroom capability is to be used.
- Create a basic design with the class to demonstrate the following concepts, having the students follow along. The goal is to have the students understand these key capabilities, so they that can apply them creating their design, they do not have to practice each one, but understand the capability exists.:
- Some students may start designing their masks during this phase, and you can alternatively allow this, stopping periodically to teach some of the basic capabilities of the Tinkercad features as they need them. But they should not get too far as some design criteria need to be set when building the actual mask.

	Students explore navigation in 3D space, including the "view cube" and the buttons underneath the cube. The "Fit all in view" is important as it helps center the selected shape in view.		Students explore the basic shapes to see what is available for their designs. Students should be able to identify the cube, cylinder, sphere, prism (roof), right angle prism (wedge), and polygon.

- Students briefly explore navigation using mouse, touchpad, touchscreen, and keyboard. Students will end up using a combination of these for different operations (keyboard for small incremental moves).
- Students explore the process of creating 3D designs, by placing, moving, editing, grouping, and cutting shapes.
- Students explore key tool features such as, undo/redo, duplicate, show/hide, locking, aligning, and mirroring.

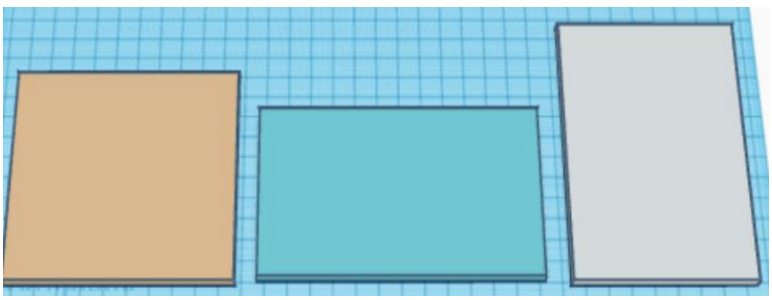
EXPLAIN:

Section Goal: Students start designing their mask in Tinkercad, based upon the design done on graph paper.

Section Activity **(Budget 30-45 minutes):**

- The first step is to set up the activity for a scaling exercise and 3D printing. Students must be given some initial design parameters to set up the scaling exercise and make sure the 3D printing is simple. Pick a maximum size that is 50% to 75% of the final size of the 3D prints. The example below shows 3 different shapes and sizes, that you can use for the parameters.

100mm x 100mm, 5mm height
125mm x 80mm, 5mm height



80mm x 125mm, 5mm height

This allows for several styles of masks.

- Make sure students are placing the shapes on the work plane, and the

bottom should be flat. If a shape is above the work plane and needs to be dropped, select the shape, and press the 'd' key. Also, shapes should have good overlap, so they do not print as separate pieces or have a small amount of plastic connecting them, as it is easy to break.

- Students at this point will have many questions similar to: "How do I make this shape?", while looking at their design on graph paper and building the design in Tinkercad. If Tinkercad does not have the organic shape they are looking for, remind them they can combine and cut shapes to best match the drawing. Also, the scribble shape allows for free form shape creation.

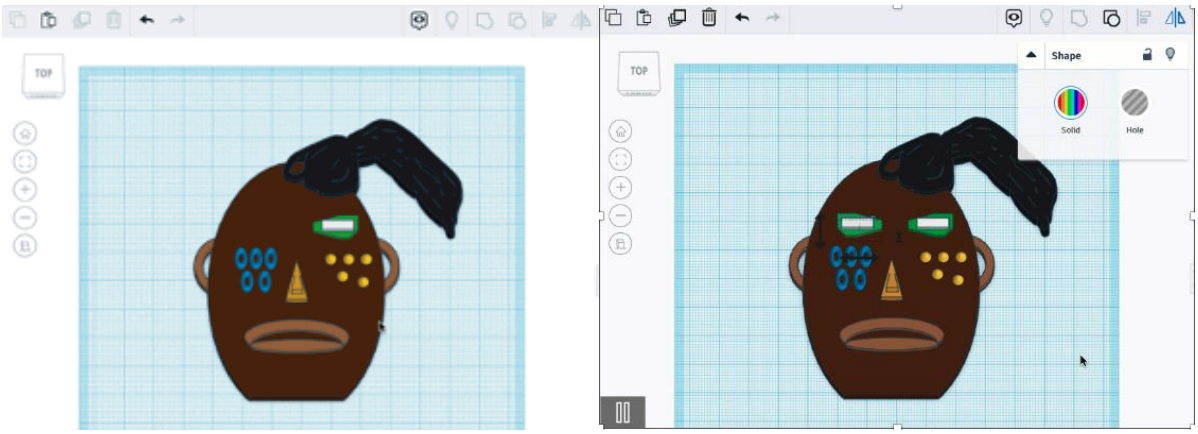
ELABORATE:

Section Goal:

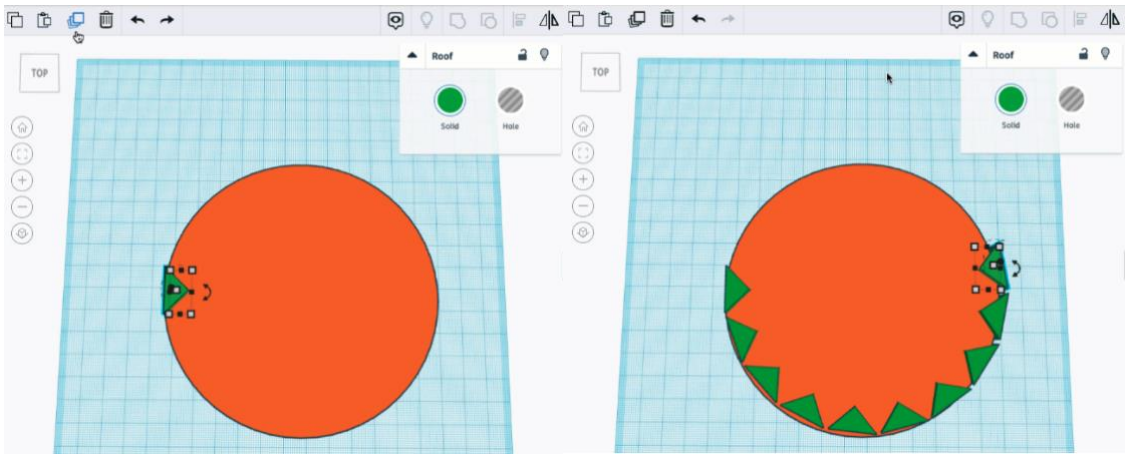
Students will understand and use as necessary some key features of Tinkercad such as mirroring (reflection, 8th grade math) and duplication. They will complete their masks.

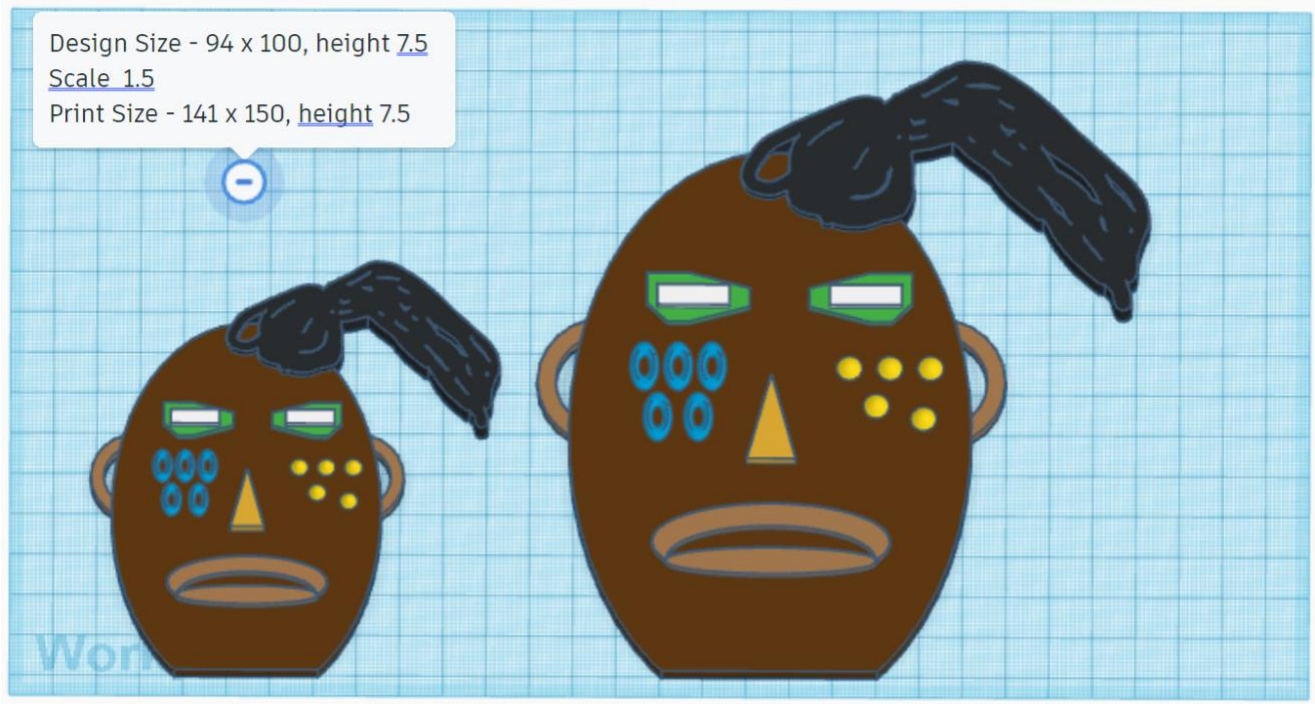
Section Activity (Budget 120 minutes):

- Students will notice that they need complex shapes they created duplicated, but reversed, such as ears or eyes. Work with the students on how the time saving mirror feature can accomplish the geometric concept of transformation-reflection (MGSE8.G.3). See the eyes below which are reflections of each other:



- Students notice that they need many shapes duplicated, but with changes in its rotation and/or location. In other words, students need to duplicate the shape and do a transformation many times (translation and rotation). This is accomplished by selecting the shape, doing the transformation, and duplicating it repeatedly, as the transformation is repeated as well during the duplication process. See below:



- Students will now complete their masks, checking to make sure all shapes are touching and have a good amount of overlap.
- The teacher will review the work and prepare the students for the final scaling.
- The next step is to have the students group the entire mask to make a single shape. They can preserve the colors if they change to a single color by selecting the color, and then selecting multicolor.
- At this point it would be good to have a 3D printed sample mask at these dimensions so they can see the need to make them larger.
- Now the teacher will provide them with the opportunity to make the masks larger, by scaling the masks to a larger scale, by providing them with a scale factor, and having them calculate the new lengths from the provided scale factor and edit the X and Y dimensions of the mask.
- 

EVALUATE:
Section Goal:

- Students will develop a narrative or statement reflecting on their mask.

Section Activity (Budget 30 minutes):

- Students will write or record a reflection on their mask, and view masks of their classmates to see the masks they have made. This can be done by presenting to the whole class or just to the teacher and having the other masks on display in the classroom.

Suggested Activity:

- Students optionally can paint their 3D printed masks. It may be easier to spray paint the whole mask and let them paint individual colors on features they prefer.

Actual Masks from Students