Mathematics: The Language of STEM
Light Painting Circles and Polygons
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CONTENT AND TASK DECISIONS

Grade Level(s): 5th Grade

Description of the Task: Students will use an art creation technique of light painting to construct circles and polygons based on properties.

Indiana Mathematics Content Standards:
5.G.1 – Identify, describe, and draw triangles (right, acute, obtuse) and circles using appropriate tools (e.g. protractor & technology). Understand the relationship between radius and diameter.

5.G.2 – Identify and classify polygons including quadrilaterals, pentagons, hexagons, and triangles (equilateral, isosceles, scalene, right, acute, and obtuse) based on angle measurements and sides. Classify polygons in a hierarchy based on properties.

Indiana Mathematics Process Standards:
CCSS.Math.Practice.MP1 – Students will have to create the geometric shapes based on angles and sides or lack thereof. They will use programming skills to draw the shapes using technology and evaluating accuracy.
CCSS.Math.Practice.MP2 – Students will make models of shapes with given abstract properties.
CCSS.Math.Practice.MP3 – Students will plan and present their painting with evidence that supports the shapes they create.
CCSS.Math.Practice.MP4 – Students will make their shapes and program to create a light painting with long exposure.
CCSS.Math.Practice.MP6 – Students will attend to the precision within the confounds of the classroom environment. Error is inevitable for students as they create in the real world, however, to what extent of deviation from perfect is agreeable will be debated within the class.

Mathematics Content Goals:
Students will be able to identify, classify, and create circles and polygons based on specific properties.

Language Objectives:
Students will use math proper terms in blueprint descriptions as well as in presentation of painting to the class.

Materials:
iPad Mini, tripod, Lightning Lab app, LongExpo app (or something that can do long shutter), Sphero

THE LESSON

Before:
Driving Question: "How can we create light painted circles and polygons that closely represent the model?"

Discuss what students learned from the previous lesson on triangles and what they already know about circles and polygons (quadrilaterals, pentagons, and hexagons). Discussion around properties and attributes that make each of them different from one another.

Explain the advanced task of programming a Sphero to draw a circle and a polygon by painting with light. The circle created must have a minimum 6-inch radius and a maximum 3 feet diameter. The Sphero programming will be one program that has the light turn off as the Sphero sets in position to create a polygon that meets the requirements of a specific quadrilateral or regular pentagon or hexagon. Tools such as protractor and rulers will be used to measure angles and sides, and students will be required to diagram before capturing the two shape photo.

Students must identify the specific quadrilaterals based on properties, pentagons and hexagons based on properties needs to be regular, and finally radius and diameter of the circles. They will then have to create a blueprint path that Sphero will travel to accurately meet the requirements/identity of a circle with a specific polygon. With evidence to support a correct path for the Sphero, go through the process of programming a long exposure light photo.

During:
Students will be introduced to the topic using enVisionmath2.0 Topic 16-2. This basic practice will launch students to work in pairs to create the two shapes.

In pairs of two, students then will create a blueprint (small scale) version of the two shapes. They will determine measurement of radius and diameter for the circle, and angles, sides (length and parallel) for the polygons. The blueprint will be presented to the teacher, as a progress check, and then given clearance to move forward in creating a full version of the two shapes to photograph. Regardless of the shapes and the combination they choose to represent, they are to include the full measurements of angles and sides for the polygons.

The teacher will need to spend time continuing the learning of programming Sphero. This can be done as a whole class or when students are ready. Students will utilize the free “Lightning Lab” app on their iPads. This will allow them to program Sphero to make the movements that follow the two shape plan engineered. Teaching and giving students a chance to explore the idea of turning off the light as Sphero transitions for the second shape will take time and you cannot rush this essential piece. In addition, the teacher will need to show students the app “LongExpo” and how to change shutter speed to capture light in a dark room to create the image.

Students will then need a dark room to capture the movement of Sphero using a long exposure to create their two shape light painting. These paintings can be displayed and presented along with mathematical thinking that supports the measurements for the circle and the properties of the specific polygons that the pairs create.

Support that students when helping them check their blueprints and that all the properties of the shapes are accurate. If mistakes are made, the teacher can reteach and have students correct their mistake before moving on to the creation phase. Another area of support will be in programming Sphero. Encourage students to experiment and take existing programs to modify based on the design of their creation. The long exposure can be tended to when issues arise.

Extensions for students can look in the way creating additional shapes for possible 3 shapes in an image that focus on a different polygon.

After:
Students will present their light paintings with evidence and justification to show circle and polygon classifications. Each pair will bring up front their image and evidence to share.

The presented project will be a print of the photo created along with notecards/information tags around the photo that will share the angle and side measurements along with any other meaningful information to support the shapes created. Students will identify based on the properties they intentionally created as their design.

In light of the blueprint check along the way, the teacher's role at the end for presentations will be to evaluate accuracy and thoroughness of the properties that make the circle and polygons being presented correct. In addition, the teacher will be looking for vocabulary words that show mastery of the content. This will provide an opportunity for reviewing misunderstandings in concepts that arise.

Giving peers a chance to respond after presentations will be a platform for connecting shapes and assessing the similarities and differences. The teacher can attempt to build rules/generalizations based on the evidence provided and allow students to determine if more information would be needed or if another example could exist that isn't being displayed.

The driving question provides a purpose for the students and gives them a direction with a goal in mind. The blueprint check and constant observation of discourse that takes place within teams, will provide the needed assessments for empowering students. Those highlight moments that take place can be shared within or at closing to reinforce the learning that takes place.

ASSESSMENT

Observe:
The teacher's role is in large part a listener. Visiting and conferencing with teams as they make progress on the driving question will bring about meaningful conversations that can correct student paths as well as reinforce the learning being explored.

The teacher must be looking for vocabulary connected to the topic (angles, degrees, length, diameter, radius, parallel, etc.) in correct context. This can also be done at the end during presentations to measure student mastery.

Ask:
Tell me about the circle/polygon you are creating?
What is the objective/driving question that you are working towards?
How do you know this polygon is _____?
Can the angles/sides be of any other measurements and still fit the polygon type?
Is there a range of angles/sides that would still make this true?
Do the angles/sides have any relationship with one another?
How does the property of parallel sides, or lack of, influence the polygon's design?
Is there any connection between the angles and sides?
Can you use the information from one or more angles/sides to tell you another? Based on the polygon type?