Lesson Title:	Folding Circles
Length of Lesson	1 Days
Created By	Michael Andre Hamilton
Subject	Geometry
Grade Level	10^{th}-12^{th} grade
State Standards	Geometry 2a
DOK Level	DOK 2
DOK Application	Graph, Compare, Estimate Infer, Predict, Interpret, Make Observation, Summarize
National Standards	Geometry for 9 – 12^{th} Math Standards
Graduate Research Element	Human Factors and Work Physiology

Student Learning Goal:

National Standards for Geometry for 9-12^{th}

A: analyze properties and determine attributes of two- and three-dimensional objects;
B: explore relationships (including congruence and similarity) among classes of two- and three-dimensional geometric objects, make and test conjectures about them, and solve problems involving them;
C: establish the validity of geometric conjectures using deduction, prove theorems, and critique arguments made by others;
D: use trigonometric relationships to determine lengths and angle measures.

State Standards for 9 – 12^{th} Geometry

A: Apply problem solving skills to solve and verify the solutions for unknown measures in similar polygons.

Materials Needed (supplies, hand-outs, resources):

A paper circle that is 7 to 10 inches in diameters Inspiring Minds;

Lesson Performance Task/Assessment:

The students will use fold paper to create different types of polygons

Lesson Relevance to Performance Task and Students:

The relevance of this lesson is to get the student to identify characteristics of different types of polygons.

Anticipatory Set/Capture Interest:

At the beginning of class, I will ask the class how many polygons they think I can make using a circle. The student will be asked to list at least 4 properties of figures such as circles, triangles, octagons. Then, I will talk about how great circles are because of the many shapes they can be.

Guided Practice:

The student will create polygons and shapes using a paper circle. The following is the procedure that should be used when guiding the students.

1. Ask the students to write down four properties of the figures they have been given. Make sure they understand what "property" means ("the way something is, or how you can describe a thing"). Circulate as the students work on this.

2. Have students present their answers until you have heard about all of the properties that the students came up with.

3. Tell the students that a circle is a wonderful shape, because you can make so many things with it. Have them fold their circles in half, and what they notice. Guide them to the realization that the halves match, and that this is "symmetry."

4. Ask what the name is for half a circle. Ensure that the class understands the term "semicircle."

5. Ask if they have seen anything that looks like a semi-circle, leading them to the realization that a protractor is a semicircle, that it contains 180 degrees, and a circle therefore contains 360 degrees.

6. Have the students fold their circles into fourths, then unfold them and mark the centers. Then have them draw a line from one edge of their circles through the center to the other edge. Through discussion, ensure that the class understands the term "diameter."

7. Repeat this with a line drawn from the center of the circle to one edge ("radius").

8. Have the students fold the edge of the circle down so that it meets the center, then draw a line on the resulting fold. Ensure that the class understands that such a line is called a "chord" ("a line from one point on the edge of a circle to another point on the edge"). Ask if a diameter is a kind of chord, and ensure that the class understands that all diameters are chords, but all chords are not diameters.

9. Have students fold down another edge to the center, so that the resulting shape looks like an ice-cream cone. Then have them fold down the final edge. Ask what

shape they have made and ask them what they can tell you about that shape. Discuss the properties of a triangle and of this triangle in particular (all three sides are equal).
10. Have students work out a few ways to prove that the triangle is equilateral without using a ruler.

11. Have the students fold one vertex of the triangle down so that it touches the center of the opposite side. Have them describe the resulting shape and through discussion ensure that they understand the terms “parallel” and “quadrilateral” (and, optionally, “trapezoid”, and “isosceles trapezoid”).

12. Have students fold one of the acute vertices of the trapezoid over so that it meets one of the obtuse vertices. Use this action as an opportunity to discuss the terms “acute” and “obtuse”.

13. Ask students to describe the resulting shape. Write down the words they come up with to describe the shape, and ensure that they include “quadrilateral, “parallelogram”, and “rhombus” and that students understand why each of those terms applies to the shape. Then discuss the relationship between these classes. Ask questions such as, “and so on, until it’s clear that the set of all rhombuses is a subset of the set of all parallelograms, which is a subset of the set of all quadrilaterals.

14. Ask students to fold one of the acute vertices of the rhombus so that it touches the other acute vertex. Have half of the students unfold that shape back to the original triangle, and then ask the students to compare the two shapes they now have (small and large equilateral triangle). Review the concept of “similarity” and “congruence”, and ensure that students can explain why these two shapes are similar but not congruent.

15. Have all students unfold their shapes back to the original large triangle, and then fold the three vertices of that triangle in so that each is in contact with the center point. Ask students to describe the resulting shape and in the ensuing discussion ensure that they understand the terms "hexagon” and “regular hexagon”. Ask students how they would prove that this hexagon is regular.

16. Unfold the shape back to the original triangle, and then refold to make a triangular pyramid. Ask students to describe this shape, and in the resulting discussion ensure that students understand the concepts “polyhedron”, “pyramid”, and “triangular pyramid”.

17. Fold the top halves of the triangles down across each other to make a truncated triangular pyramid. Ask students to describe this shape as completely as possible.

Independent Practice:

None, the student will perform each step with the instructor.

Remediation and/or Enrichment:

Remediation
Individual IEP; partner help throughout lesson; shorten parts of assignment; focus on few process

Enrichment:
None

Check(s) for Understanding:
Day 1:

1. Are all parallelograms also quadrilaterals?
2. Are all quadrilaterals also parallelograms?
3. What else you think we could do with circles

Closure:
Have a end of the class discussion about the activity and how many polygon shapes could be used with triangles.

Possible Alternate Subject Integrations:
*None.

Teacher Notes: