GIVING THEM WINGS – MIDDLE SCHOOL MATH LESSONS IN AVIATION

INTRODUCTION

Aviation themes excite students and help them become engaged in basic topics that are part of the focal points of the 7th Grade Math Common Core curriculum. This series of lessons reviews the properties and vocabulary of circles by showing how circles are used in aviation. By connecting these two topics students will see how to apply the properties of circles in real world applications. Specifically, this lesson uses the geometry of the circle and an aviation compass to teach fractions, decimals and percentages.

LEARNING OUTCOMES

- Students will become more fluent in converting fractions into decimals and percent by using the degrees of a circle.
- Students will know how the area formula of a circle is derived by cutting pieces of a circle and making a quadrilateral.
- Students will determine the area of a circle and a sector
- Students will determine the circumference and area of a circle as well as portions of the circle.

CURRICULUM ALIGNMENT

NORTH CAROLINA ESSENTIAL STANDARDS – SEVENTH GRADE MATH

7.NS.2.d. Convert a rational number to a decimal using long division; know that the decimal form of a rational number terminates in os or eventually repeats.

7.G.4. Know the formulas for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle.

NORTH CAROLINA ESSENTIAL STANDARDS – SEVENTH GRADE SOCIAL STUDIES

7.G.2.1 Construct maps, charts, and graphs to explain data about geographic phenomena (e.g. migration patterns and population and resource distribution patterns).

CLASSROOM TIME REQUIRED

4 class days (50 minute classes)

MATERIALS NEEDED

For each pair of students):

- Ruler or straight edge
- Protractor
- Paper Plates
- PowerPoint Presentation – "Giving Them Wings"
- Scissors
- Blank paper (8 ½ x 11)
- Copies of all handouts

TECHNOLOGY RESOURCES

- Computer with PowerPoint Software
- Projector
- Video camera

PRE-ACTIVITIES

Before doing the activities, students will need to know:

- Vocabulary associated with circles,
- How to find factor pairs of 360,
- Cardinal directions (North, South East and West) and how they relate to the degrees of a circle, and
- How to use a protractor.

ACTIVITIES

DAY 1

Lesson 1 Part 1 – Expert Interview 1: How Are Compasses Used in Aviation and How to Construct a Paper Compass?

Assign student pairs so that one person can be the Expert and the other the Interviewer. Give students time to read through the handout "Lesson 1 – Expert Interview: How Are Compasses Used in Aviation and How to Create Paper Compass?" Students will work in pairs with one student reading the Expert Portion and the other reading the Interview Portion. Once students have finished they can answer questions together as a group, or as a class, reviewing details about what they have read. The teacher will go over the answers with the class asking students to volunteer correct answers. The last portion of the interview gives students instructions on how to make a paper compass.

Lesson 1 Part 2 – Activity "Making a Paper Compass

View the full explanation of the process of how to construct a paper compass given in the PowerPoint "Lesson 1 Creating a Paper Compass" prior to the lesson. The teacher may want to use portions of the presentation with the students. Students will continue to work with the same partner and will need a ruler or straight edge, protractor and a paper plate. Students are to follow the instructions in the worksheet to make the Paper Compass.

Use one of the following questions as an Exit Ticket to assess students understanding of the key points of the lesson.

- What do circles have in common whether they are drawn on paper or in the cockpit of an airplane?
- What is unique about a compass on an airplane?
- How are directions marked on a compass?
- What was the learning objective of this lesson?

DAY 2

Lesson 2 - Practice with the Compass

Have the same students pair up and read "Expert Interview 2: How Runways and Landing Strips are Numbered". Once they have read the interview give students the Handout labeled "Cloz Passage Activity and Runway Numbering System" and have them work in partners to complete it. Once they have finished working on the Cloz Passage review the answers with the whole class. Give students the paper compasses that were made in Lesson 1 to help them visualize where the directions are and how they relate to the degrees of a circle. This will also help them work through the problems associated with how runways are labeled.

DAY 3

Lesson 3 – Conversions – Fractions, Decimals and Percent

Prior to starting Lesson 3 have the students practice the new vocabulary from the previous lessons by identifying the following parts of a circle:

1. Define and locate the center of the circle
2. Define and locate the radius
3. Look at the diameter. What do you notice about the directions at each end?
4. Define and locate the circumference of the circle
5. Define and locate the degrees in semicircle
6. Define and locate the sector of the compass. Measure the degrees between the coordinal directions.
7. Define and locate the arc of the compass (all or portions of the circumference)

On the Student Activity Sheet student will complete the following:

- List factor pairs of 360
- Identify sectors of each common pair fraction
- Identify the number of degrees in each sector
- Calculate a fraction and its simplest form for a factor pair
- Use long division to determine the fraction associated with each sector or fraction of the circle.
- Determine the percent associated with the fraction of a piece.

Lesson 4 – Slice the Paper Compass to study Area Formula of a Circle

View slides from the "Giving them Wings " PowerPoint for pictures of this activity.

Students will cut the compass into 16 pieces. They will then tape together the pieces into a parallelogram. The students should trace around the parallelogram onto another piece of paper and label the radius and the circumference that make up the 2 measurements of the parallelogram. Student will then be asked to determine how to find the area of the parallelograms.

Lesson 5 – Video Production of "How to Convert Fractions to Decimals and Percentages" or "How the Area of a Circle is Related to the Circumference of a Circle"

Students will prepare a script and create a video on either of the following topics.

1. Describe the Process that you used to find the factors of 360 and tell how this relates to a compass. Also, describe how to make fractions from the degrees of a circle and how to convert those fractions to decimals and percent. Be sure to use a visual aid in your presentation.
2. Describe how the area of a circle relates to the circumference of a circle.

Use the following guidelines:

- State the purpose
- Describe the vocabulary that you will need to use in your explanation.
- Describe the process that you use to find the factors of 360 and tell why and where the 360 are used (in the denominator or the numerator).
- Show how to use long division to change a fraction to a decimal.
- Show how to convert a decimal to a percent and why you chose this process.
- Give hints to help your viewer remember the steps you used.

The rubric will be used to assess the video.

ASSESSMENT

For Lessons 1 through 4, students will hand in the completed worksheets or products produced for each lesson that they complete. Grades should be based on worksheet completion, accuracy and quality.

For Lesson 5 Students will use the attached rubric for assessment.

MODIFICATIONS

Students that need modified assignments may use calculators instead of doing the fraction to decimal conversions by hand with long division or they may use the calculators to check their work. Also, partially completed paper compasses can be handed to students for them to complete and use.

ALTERNATIVE ASSESSMENTS

Students can turn in a group assignment each day that should be graded on correctness and completion.

CRITICAL VOCABULARY

Arc – a part of the circumference of a circle.

Area- the space inside the circle

Central angles- angles formed by any two radii in a circle.

Chord - a line segment that joins two points on the edge of the circle.

Circle - a shape with all points the same distance from its center.

Circumference-the perimeter of the circle, also it is the length around the circle.

Diameter - a straight line that runs through the center of a circle.

Radius- a line that goes from the center of the circle to the edge of the circle

Sector- an area of a circle enclosed by two radii and an arc. It looks like a slice of pizza

Tangent – a straight line that contacts the circumference of the circle at one point.

Segment- the area enclosed by a chord and an arc. It is made by slicing a circle straight across from one side to the other.

Semicircle: an arc whose endpoints are the endpoints of a diameter. It is named using three points. The first and third points are the endpoints of the diameter, and the middle point is any point of the arc between the endpoints.

Vertex-the center of the circle or angle

Minor arc: an arc that is less than a semicircle. A minor arc is named by using only the two endpoints of the arc.

Major arc: an arc that is more than a semicircle. It is named by three points. The first and third are the endpoints, and the middle point is any point on the arc between the endpoints

WEBSITES

How to Read an Aircraft Compass: http://www.ehow.com/how_8658899_read-aircraft-compass.html#ixzz21HZMRzQ9

PilotFriend – General Aviation Portal: http://wwwlpilotfriend.com

AUTHOR

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KENAN FELLOWS PROGRAM

SMT
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Lesson 1

Expert Interview: How Are Compasses Used in Aviation and How to Construct a Paper Compass?

Expert information in this interview has been provided by:
Orestes Gooden, Professor of Aviation at Elizabeth City State University
Interviewer: **Mary Jackson, Kenan Fellow and Middle School Math Teacher**

***Interviewer**:* If you were teaching this lesson what guidance would you give to 7th grade students as they get ready to make their paper compasses and why this activity is important?

***Expert**:* Circles are everywhere in aviation. What circles all have in common is that they have 360 degrees and the ratio pi (π) which is the ratio of the circumference of the circle to its diameter. When I am flying an airplane or helicopter the compass is the only instrument on board that tells me what direction I am flying. Take a look at this pilot's cockpit and you will see that most of the items on the control panel are gauges that are circular. Being able to quickly glance at these gauges to make necessary adjustments is a skill that every pilot must be able to do.

In order to read these gauges many skills are needed. Focusing on the Compass portion of the Cockpit you notice that it is broken into 4 ninety degree sections representing the cardinal directions, North, South, East and West.

An airplane's magnetic compass is usually the only direction-seeking instrument on the aircraft.

Interviewer: The learning objective of this lesson is to review the vocabulary of circles and use the geometry of a circle to have students create their own paper compass. A circle is created by connecting all points' equal distances from the center of the circle. Follow each step on the next page.

Directions on How to Make a Paper Compass

1. Start with a paper plate and fold the plate in half and then in fourths.
2. Locate the center (also known as the vertex) of the circle, where all of the folds intersect, and place a dot there.
3. From the center of the circle to the opposite edge is another radius of the circle.
4. Two radii equal the diameter of the circle. Label the diameter of the circle.
5. With a marker outline the edge of the circle and label it the circumference.
6. The entire circle is composed of 360 degrees. Mark the edge of the circle at each 90 degree increment.
7. Label the cardinal directions (North, East, South, West)on the edge of the plate at points 0 degrees as N - North, 90 degrees as E- East, 180 degrees as S-South , 270 degrees as W-West, drawing a horizontal line through the circle intersecting the vertical line.
8. Label the Inter-cardinal points. These points are halfway between the cardinal points. Label them northeast, southeast, southwest and northwest on the circle.
9. Central Angles are angles formed by any two radii in a circle. Label the arc created by 90 degrees (North to East) as a minor arc= an arc less than 180 degrees.
10. A Semicircle is an arc whose endpoints are the endpoints of a diameter and is named by three points. The first and third points are on the circumference of the circle while the second point is the center of the circle. When these three points are connected they form the diameter of the circle and are composed of 180 degrees. Label the arc created by 180 degrees as a straight angle – above the words diameter.

Using the Paper Compass you have created fill in the table below:

Direction	Number of Degrees
North	
East	
South	
West	
Northeast	
Southeast	
Southwest	

What direction is shown by a compass reading of 360 degrees?

_____

What angle is exactly halfway between west and northeast?

_____

Lesson 2

Expert Interview 2: How Runways and Landing Strips are Numbered

Expert information in this interview has been provided by:
Orestes Gooden, Professor of Aviation at Elizabeth City State University
Interviewer: **Mary Jackson, Kenan Fellow and Middle School Math Teacher**

Interviewer: How is a runway numbered?

Expert: A runway's compass direction is indicated by a large number painted at the end of each runway. A runway's number is not written in degrees, but is given a shorthand format which leaves off the last zero of that heading. For example, a runway with a marking of "14" is actually close to (if not a direct heading of) 140 degrees. This is a southeast compass heading. A runway with a marking of "31" has a compass heading of 310 degrees, that is, a northwest direction. For simplicity, the precise heading is rounded off to the nearest tens. For example, runway 7 might have a precise heading of 68 degrees, but is rounded off to 70 degrees. It is still good practice to check your compass prior to take-off or landing as it has been known that the numbers have been painted on the wrong ends! Then ending direction is always 180 degrees opposite the beginning direction.

Practice

Runways are numbered and referred to after their compass headings. A special short hand is used so that you always have to add one zero to the number that is painted on the runway. For example if you see 09 the compass landing is actually 90 degrees. If you see 18 the actual compass heading is 180 degrees. Also, each actual compass reading is rounded to the nearest ten. For instance, if the actual compass heading is 92 it is rounded to 90 and would be painted on the runway as 09. The reciprocal heading is also marked on the same runway.

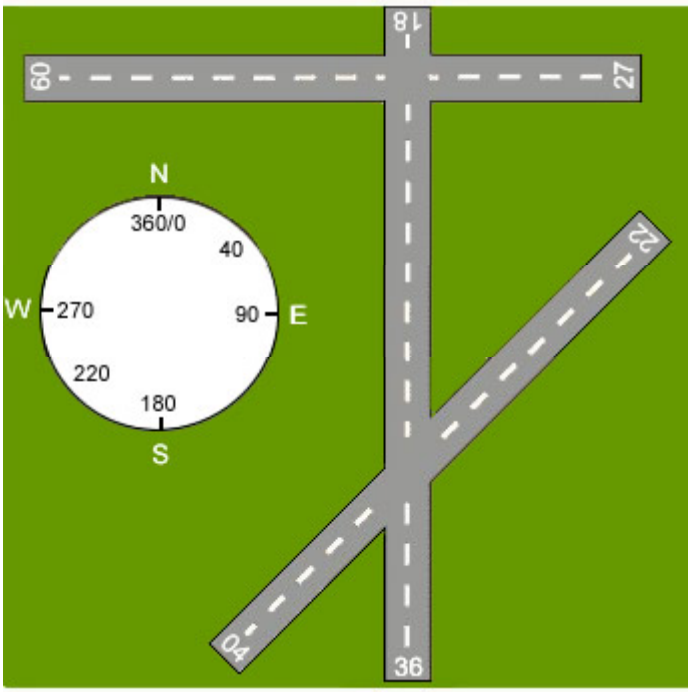
Example from your worksheet: If you compass aboard the airplane reads 42 degrees the shorthand written on the Runway would be 04, the direction listed on the beginning of the runway would be northeast and the direction at the end of the runway would be 220 degrees, southwest.

Lesson 2

Cloz Passage Activity: Runway Numbering System Data

Name _____ **Partner Name** _____

A runway's _____ direction is indicated by a large _____ painted at the end of each runway. A runway's number is not written in _____, but is given a shorthand format. For example, a runway with a marking of "14" is actually close to (if not a direct heading of) _____ degrees. This is a _____ compass heading. A runway with a marking of "31" has a compass heading of _____ degrees, that is, a _____ direction. For simplicity, the precise heading is rounded off to the nearest _____. For example, runway 7 might have a precise heading of _____ degrees, but is rounded off to 70 degrees. It is still good practice to check your compass prior to take-off or landing as it has been known that the numbers have been painted on the wrong ends! Then ending direction is always _____ degrees opposite the beginning direction.



Take turns with your partner giving the runway number and having them tell you the direction you must be headed in. Remember the short hand for degrees as well as the fact that you round to the nearest 10 to get the heading marked on the runway.

Degrees	Short Hand Written on Runway	Direction Beginning	Direction Ending
42 degrees	04	Northeast	220 Southwest

Runway Numbering System (KEY)

A runway's compass direction is indicated by a large number painted at the end of each runway. A runway's number is not written in degrees, but is given a shorthand format. For example, a runway with a marking of "14" is actually close to (if not a direct heading of) 140 degrees. This is a southeast compass heading. A runway with a marking of "31" has a compass heading of 310 degrees, that is, a northwest direction. For simplicity, the precise heading is rounded off to the nearest tens. For example, runway 7 might have a precise heading of 68 degrees, but is rounded off to 70 degrees. It is still good practice to check your compass prior to take-off or landing as it has been known that the numbers have been painted on the wrong ends! Then ending direction is always 180 degrees opposite the beginning direction.

Degrees	Short Hand Written on Runway	Direction Beginning	Direction Ending
42 degrees	04	Northeast	220 Southwest
52 degrees	05	Northeast	230 Southwest
62 degrees	06	Northeast	240 Southwest
72 degrees	07	Northeast	250 Southwest
82 degrees	08	Northeast	260 Southwest
92 degrees	09	South	270 North
102 degrees	10	Southwest	280 Northeast
112 degrees	11	Southwest	290

Worksheet for Lesson 3

Warm Up: Locate the following on your Paper Compass and fill in the blanks:

1. Center
2. Radius
3. Diameter – What do you notice about the directions at each end?_____
4. Circumference of the circle
5. Degrees in Semicircle _____
6. Sector of the Compass- measure the degrees between the coordinal directions._____
7. Arc of the Compass (all or portions of the circumference) _____

List all of the factor pairs of 36. _____

Data Collection for "Slicing the Compass"

Total Number of Pieces	Number of Degrees in Each Slice	Angle type of one slice*	Fraction	Decimal each Piece Represents	Percent of each Piece
1					
2					
3					
4					
5					
6					
8					
9					
10					
12					
15					
18					

* use Acute (minor arc), Obtuse (major arc) or Straight

What do you notice about the number of degrees in each slice and the fraction, decimal and percent equivalent?

Worksheet for Lesson 3 KEY

Warm Up: Locate the following on your Paper Compass and fill in the blanks:

1. Center
2. Radius – from the center of the circle to the edge (circumference)
3. Diameter – What do you notice about the directions at each end? West to East, North to South
4. Circumference of the circle –The outside of the circle
5. Degrees in Semicircle – 180 degrees
6. Sector of the Compass- measure the degrees between the coordinal directions. – 90 degrees
7. Arc of the Compass (all or portions of the circumference) 360 degrees
8. List all of the factor pairs of 36. 1,36 2,18 3,12 4,9 6,6

Total Number of Pieces	Number of Degrees in Each Slice	Angle type of one slice*	Fraction	Decimal each Piece Represents	Percent of each Piece
1	360	Major	360/360	1.0	100%
2	180	Major	180/360	.5	50%
3	120	Major	120/360	.33	33%
4	90	Minor	90/360	¼	25%
5	72	Minor	72/360	.2	20%
6	60	Minor	60/360	.167	16.7%
8	45	Minor	45/360	.125	12.5%
9	40	Minor	40/360	.111	11%
10	36	Minor	36/360	.1	10%
12	60	Minor	60/360	.167	16.7%
15	24	Minor	24/360	.067	6.7%
18	20	Minor	20/360	.056	5.6%

What do you notice about the number of degrees in each slice and the fraction, decimal and percent equivalent? – When you multiply the number of degrees by the number of slices you get 360. When you multiply the decimal by the number of slices you get a product of 1. When you multiply the percent of each slice by the number of slices you get 100%.

Worksheet for Lesson 4

Materials Needed: Scissors, Paper Compass, Paper (8 ½ x 11)

1. Use your protractor to evenly divide the Paper Compass into 8 equal pieces. This may be done by drawing lines from the circumference (edge) of the paper compass from the Intercardinal marks through the center of the circle to the intercardinal position 180 degrees away from the initial position.

2. Use your protractor to evenly divide the Paper Compass into 16 equal pieces by marking off or by cutting the paper compass into 16 pieces.

3. Tape together the pieces into a parallelogram.

4. Trace around the parallelogram onto another piece of paper and label the radius and the circumference that make up the 2 measurements of the parallelogram.

5. How can you find the area of the parallelogram?