**DAY ONE**

**TOPIC:** Introduction of Circles/Discovering Pi

**CONTEXT OF LESSON:** Last week, we spent time reviewing the formulas for finding the perimeter and area of triangles, rectangles, squares, and parallelograms. We also discussed situations in which it would be necessary to find the perimeter and situations when it would be necessary to find the area. In this lesson, we will discuss vocabulary associated with circles (radius, diameter, circumference), which most students should be familiar with, and discuss why the formulas similar to what we used with polygons for area and perimeter won’t work with circles (circles don’t have sides, aren’t polygons). Once that discussion is over, I will introduce Pi and ask if any students have heard of it (not the kind you eat!) and tell them it’s the “magic” number when it comes to circles. We will then do the activity, which is the main part of today’s class.

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| Learning Objective | Bloom | Assessment (Formative/Summative) |
| Students will define and then in their own words explain the following terms: radius, diameter, circumference. | R | Vocabulary packets where students define in their own words the key terms and also where students write the more precise definitions discussed in class will be collected at the end of the class period.  Each term discussed will be checked for certain key words. |
| Students will measure the circumference and diameter of various circular objects. | App. | As students are measuring the circumference and diameter of circular objects, they will be recording their results in a chart provided. Once they are finished and they calculate the ratio of the circular object’s circumference to its diameter, I will be able to see how accurate their measurements were by comparing the ratio to Pi (3.14). I will push students to examine any ratios that seem to be irregular in comparison with the others and if necessary, go back and re-measure the object. |
| Students will discover the formula for circumference of a circle. | Ana. | After students have used their calculators to find the ratio of the circumference to the diameter, as a class, we will discuss the results. Hopefully students will see on their own that their results are all close to the same number. This number is the “magic” number I referred to earlier as pi. Pi is calculated when you divide a circle’s circumference by its diameter. If students don’t discover it on their own, I will push them in the direction of seeing that, if we know pi=c÷d, then using our knowledge of fact families, we can arrive at the conclusion that c=pi x d. |

**SOL:** 6.10 – The student will

1. Define pi as the ratio of the circumference of a circle to its diameter

**MATERIALS:**

15 pieces of pre-cut yarn (36 inches)

Apple Pi Worksheet (<http://illuminations.nctm.org/LessonDetail.aspx?ID=L573>)

Various circular objects

Yard sticks

**PROCEDURE for Reviewing/Introducing Key Terms Associated with a Circle (20 minutes):**

1. I will show a picture of a circle and square on the rectangle. Underneath each picture, I will have students add description words and/or words they have heard of associated with either shape.
2. Once students have run out of words to add, I will lead a brief discussion asking students what differences there are between a circle and a square. I will ask questions such as, “What if I have two bulletin boards, one of each of these shapes and I want to put a border around it. What would I need to calculate to do that?” Hopefully, the students will recall their knowledge of the perimeter of polygons to tell me how put a border around the square but will question how to calculate the distance around a circle.
3. I will hold up a yard stick and ask, using this, how could I find the perimeter of that square? Why wouldn’t it work for the circle? What could I use to measure around the circle? If they don’t come up with the answer, I’ll give them a hint by holding up the piece of yarn.
4. Once I have steered them in the direction of telling me to use the yarn to measure around the circle, I will tell them that before we start the activity, we have some key words that I need to make sure they know first.
5. On their own, they will use their textbook to look up the definitions of radius, diameter, and circumference. They will write the definitions in their vocab packets and then with their partner, come up with a definition for each word in their own words.
6. Once the key terms have been defined and some students have shared their own definitions of each word, I will tell them that we are going to use yarn to measure the circumference and diameter of different circular objects. Once we finish doing that, we are going to examine our results and find a formula for calculating circumference, which will we will do by using a “magic” number that is related to EVERY circle.

**ACTIVITY PROCEDURE (20 minutes):**

1. Students will work in their groups of 4 (some may only have 3). Each group member will have a task. One student will measure diameter, one will measure circumference, one will use a calculator to divide circumference by diameter, and one will record the results on the apple pi worksheet.
2. Each group should get 1 piece of pre-cut yarn, 1 yard stick and an apple pi worksheet for recording their results. Some circular objects will be on the back table (cups of varying circumferences, EXPO cleaner, etc.) and the rest will be in the normal spots in the room. Students can measure anything they can find in the room that is circular. They must measure at least 5 different objects. As they are doing their measuring, I will be looking over their shoulders and pointing out any results that might be odd and encourage those groups to go back and re-measure that particular object.
3. I will do an example using my stool. To measure the stool, I will have a student hold one end of the yarn in place and I will wrap the other end around the stool. I will pinch the yarn where the two ends meet and the student will let go. I will then take the yarn and line it up on a yard stick so one end is at the 0 inch mark on the yard stick and the other end of the yarn is on the yard stick where I’m pinching it. I will record the results, including what I get when I divide circumference by diameter, in the apple pi chart that I have on the smart board. Students will not be allowed to use the stool as one of their objects.
4. By the time directions are explained, students will have about 15 minutes to measure their 5 objects. When they are finished, they should go back to their seats and in the last column of their apple pi worksheet, they are going to

**POST ACTIVITY PROCEDURE/DISCUSSION (20 mintues):**

1. When it seems that all of the groups have finished up and are back in their seats, we will start the discussion of pi. I will begin by asking if anyone has ever heard of pi (not the kind you eat!) and if they have, do they know what it means. Most will probably be familiar and some might even be able to tell me pi is equal to about 3.14 (it’s on their formula sheets) but no one will probably be able to tell me that pi is the ratio of a circle’s circumference to its diameter.
2. I will have each group share with me one of their circular objects that they think they measure correctly and give me each part of the chart (description of object, diameter, circumference, circumference divided by diameter) so that I can fill it in on the chart that’s on the smart board.
3. Once each group has given me an object, I will ask the class what they notice similar about all of their results. If they don’t see that the results when circumference was divided by diameter are all pretty close, then I will steer them in that direction by just asking what they notice about that particular column on the chart.
4. I will then tell them that the magic number I referred to earlier that is related to every circle is called pi and it is derived by dividing ANY circle’s circumference by its diameter. I will reiterate the fact that it doesn’t matter how big the object is (point out biggest object on chart) or small an object is (point out smallest object), the result when you divide those two measurements will always result in that “magic” number called pi.
5. I will quickly ask the students why, if EVERY circle’s circumference divided by its diameter is pi which is equal to 3.14, did our not work out perfectly. If necessary, I will push them toward what I’m looking for which is the fact that we used string which is not the most precise form of measurement.
6. I will then ask the students if they think that mathematicians use string and a yard stick every time they want to measure the distance around a circle. When they say no, I will tell them that just like the polygons we talked about, there is a formula that can be used to calculate the circumference of every circle. AND since it’s on their formula sheet, they don’t have to memorize it.
7. I will write what we have just determined ∏ = circumference ÷ diameter. Then I will write a fact family on the board (8x5=40, 5x8=40, 40÷8=5, 40÷5=9) and ask if anyone can come up with any ways we rearrange our pi formula. I will write their ideas on the board and eventually circle the formula that’s correct (c=pi x d). If no one comes up with it, I will say, how about this and write what I’m looking for on the smart board.
8. Once we have determined the formula for circumference, I will end the lesson by having students add the definition of pi to their vocab packets. I will tell that tomorrow, we’re going to measure circumference again but instead of using the long way (yarn and yard sticks), we’re going to use the formula.

**MEETING THE NEEDS OF ALL STUDENTS:**

Since this is an inclusion class, many students have IEP’s. One accommodation that many of the students have in their IEP is that notes will be provided. When given their vocab packets at the beginning of the advisory, those students packets differed from the other students packets. Instead of having to write out the whole book definition, students were given the definition with the blanks that they have to fill in. Also, for the “in your own words” part of the vocab, students with certain accommodations were given the main parts of the definition and only had to fill in the words that they were key from the book definition. Another way to meet the needs of visual learners was done during the activity. After I told students how to measure the circumference and diameter of the circular objects, I showed them exactly what should be done.

**POTENTIAL PROBLEMS AND SOLUTIONS:**

One potential problem is that some students may not have their vocab packets. If that’s the case, they will simply be told to write the information on a piece of paper and when they do have their packets, to copy it into the appropriate place. Vocab packets are collected at the end of the advisory and are counted as a quiz grade. Missing definitions result in points taken off. Since the students have to measure at least 5 objects, another problem is that some groups may say they can’t find anything else to measure. If that happens, I will just go around pointing out various circular objects until I come across one they haven’t measured. A third problem might be that when students are measuring the objects, their measurements may be way off, which means that pi will not come close to 3.14. If that happens, I will encourage them to recognize that something must be wrong with that measurement and assist them in measuring that object again.

**CONNECTION TO CTA:**

CTA stressed the importance of getting the students involved and not having them sitting the entire period, listening to the teacher speaker. The activity that goes with this lesson is very hands on and for over half the class, students are moving around and everyone is very much a part of what’s going on. Also, I found this activity in two different places within the resources I received from CTA. One was in Colleen Watson’s packet of info in the CTA binder and the other was on the Illuminations website <http://illuminations.nctm.org/LessonDetail.aspx?ID=L573>).

**DAY TWO**

**TOPIC:** Applying the circumference formula

**CONTEXT OF LESSON:** Yesterday, student’s defined key terms associated with a circle and discovered through a measuring activity that pi is the ratio of a circle’s circumference to its diameter. They were also introduced to the formula for finding circumference. In today’s lesson, students will practice applying the circumference formula to solve various problems. The lesson will begin with a word problem in which I will solve on the smart board with the help of the students. I will then have students solve 4-5 problems individually but each one will be checked before the student moves on. Finally, we will use the RDC strategy that Strebe introduced to solve some MORE circumference problems. Although the lesson isn’t as hands on as yesterday’s activity, most students will stay involved with the lesson. They enjoy using their white boards and when we do RDC and they know they are working for points for their team, it will provide them with a little motivation.

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| Learning Objective | Bloom | Assessment (Formative/Summative) |
| Students will apply the circumference formula to solve various types of problems. | App. | To start the lesson, students will be assessing each other. Students who have not grasped the concept will be provided assistance by students who have. By observing to see which students quickly get their paper checked by their peers and which students are having their peers spend a little more time with them, I will be able to tell which students need additional help. Also, at the end of RDC, I will be collecting each student’s worksheet. |
| Students will determine which formula should be applied to solve various word problems. | App. | When we do RDC, the worksheet students will be working on will include other types of problems that we have gone over before such as finding the area of a square. Before they solve each problem, they will highlight the key words in the problem and write down beside the problem A (for area) and a picture of square to show me they know which formula is needed to solve the problem. The worksheet will be collected. |

**SOL:** 6.10 – The student will

b.) solve practical problems involving the circumference and area of a circle, given the diameter or the radius

c.) solve practical problems involving area and perimeter

**MATERIALS:**

White board supplies (boards, markers, erasers)

Perimeter, area, circumference worksheet

Calculators

Box paper

5 word problems for smart board

**PROCEDURE FOR APPLYING CIRCUMFERENCE FORMULA TOGETHER (25 minutes):**

1. I will begin the lesson by asking students to write down what we discovered yesterday about pi. Students should write their answers on their white boards. I will be looking for students to write ∏ = c/d or pi is the ratio of circumference to diameter. I will provide motivation for the students to answer quickly by choosing a name from the popsicle sticks and awarding that student’s group a point if they have the correct answer.
2. The next question I will have students answer the same way and provide the same motivation. The question this time will be, since it took so long to measure the circumference of a circle with a piece of yarn and a yardstick, we came up with a formula that could be used instead. Who can remember the formula?
3. Then, I will draw a picture of circle on the smart board with the diameter given. Students will WATCH and we will discuss how the process of how to use the formula to find circumference. Just like when we did perimeter and area of polygons, even though students get to use a calculator, they will be required to write down the steps for using the formula. There are three steps. Step 1: Write the formula. Step 2: Changes letters and symbols to numbers (plug it in!). Step 3: Write your answer.
4. After that problem, they will WATCH and help me through another one. This time I will draw a circle but will label its radius. I will repeat LOTS of times that radius does NOT fit into the formula we are using (C= pi x d). We will talk about the definitions of radius and diameter and come up with the diameter of the circle.
5. Next I will put the five problems that students are going to work out on their own on the smart board but will cover it up so they can only see one at a time. I will also hand out a piece of box paper to each student.
6. I will show the first problem and ask students to solve it in the first box on their box paper using the 3 steps. When they have finished, they will raise their hand. I will check the first 4 students who raise their hands’ work. If their work is correct, I will use a crayon to mark a “C” in that box and will give them the crayon to go check someone else’s paper. If I get to a student who has the wrong answer, I will first give out the crayons I have left to students who have the problem correct and then I will go back and assist the students who missed it. Students who get crayons will carry their paper around and check another student with their hand up. If that student has the problem correct, the student with the crayon will mark a “C” in that box, give the crayon to that student who will go check someone else’s paper, and sit in the students seat who they gave the crayon to. If the student with the crayon finds that a person with their hand up has the problem wrong, they will GUIDE them to finding their mistake and help them fix it. That student will not give up their crayon, they will move on to someone else.
7. We will do 4 more problems the same way. After each one, I will choose one student using the popsicle sticks to solve it on the white board. If they do it correctly showing each of the 3 steps, they will receive a point for their team.

**PROCEDURE FOR RDC 30 minutes**:

1. Students will be given a worksheet and will be told we are going to use the RDC strategy on it (we’ve used it often so they are familiar with it). They will highlight key words and write the formula they need to solve the problem on the actual worksheet but will show their work (the 3 steps from before) on box paper.
2. Students will be instructed to first go through each of the 5 problems and highlight key terms and write the formula they’re going to use. 3 of the problems will be the circumference formula, 1 will be area of a triangle, and 1 will be the perimeter of a square. Once they have done that, they will be given time to work out the problems. This should be done on their own. If they have questions, they may raise their hand for help from me.
3. When students have finished the five problems, they will be given 2-3 minutes to check their answers with their partners. If they disagree on one, they should compare their work and see where the mistake may have been made. If they can’t come to an agreement, they should raise their hands and I will assist them.
4. After they have checked their work with their partner, one group member will come up and get from me a blank copy of the same worksheet they just did. As a group, they will discuss their answers and agree on a group answer to write down on their group paper.
5. Once they have done all three steps of RDC, they will trade papers with another group and we will go over answers. Each group will be rewarded one point for each correct answer.

**MEETING THE NEEDS OF ALL STUDENTS:**

Before students begin working out problems on their own, they I will demonstrate exactly what should be done to solve circumference problems. While students are working on their own, I will leave the examples up for reference. Students will also have the assistance of a calculator and will be allowed to use their formula sheet which provides every formula that will be needed for today’s lesson.

**POTENTIAL PROBLEMS AND SOLUTIONS:**

One potential problem when we are doing circumference problems is that when given the radius, students may forget that it doesn’t fit in our formula. For students who are struggling with that, I will just keep reminding them to look at what’s given (r or d), look at the formula they have written down, and decide if what’s given fits or it has to be doubled. Another potential problem is that some students may not work to solve the problems we do as a class. If I see that happening, one solution would be to call on that student when the time comes to award a team point, and have that student’s group take care of the problem!

**CONNECTION TO CTA:**

In this lesson, we will be using Stebe’s RDC method.

**DAY THREE**

**TOPIC:** Creating your own word problems!

**CONTEXT OF LESSON:** The last two days have been spent discovering pi and applying the circumference formula to solve various problems. Previous to that, a week plus was spent on solving problems involving the perimeter and area of polygons. Today, student’s will use any resource they have (old quizzes, homework, warm-ups) to create their own word problems. The word problems will later be solved by some of their classmates and some of the word problems will be chosen for use on the upcoming quiz. We did this earlier in the year with ratios and although some students basically just changed the numbers in an example they had in their notebooks (which I told them was ok to do), a lot of them got very creative and really enjoyed doing it.

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| Learning Objective | Bloom | Assessment (Formative/Summative) |
| Students will create and solve their own perimeter, area, and circumference word problems. | C | Students will be writing and solving 3 word problems of their own. When they are finished, I will be collecting the word problems and using the best (creative and makes sense!) 5 problems on the upcoming quiz. |
| Students will apply their knowledge of perimeter, area, and circumference to solve each other’s word problems. | App. | Once word problems are written, students will be given time to solve at least 3 other students word problems. The students problem who they solve will check their work. If it’s correct, they will put a “C” and their name in box. If it’s wrong, they will come to me and the three of us will work it out together. Papers will be collected at the end of the period. |

**SOL:** 6.10 – The student will

b.) solve practical problems involving the circumference and area of a circle, given the diameter or the radius

c.) solve practical problems involving area and perimeter

**MATERIALS:**

Box paper

**PROCEDURE FOR STUDENTS CREATING THEIR OWN WORD PROBLEM (35 minutes):**

1. Students will be told that since they are pro’s at finding the perimeter and area of polygons AND the circumference of circles, they will now write their problems. I will remind them that we did the same type of thing a while back with ratios and tell them the best written, most creative problems will be used on the upcoming quiz.
2. Before they start writing their own, I will tell them the directions and will show them how I would write a word problem.
3. Students should be told they are to write 3 word problems. One involving perimeter of a polygon, one the area of a polygon, and one the circumference of a circle. After they write the problem, they must also show the three steps and solve the problem.
4. Next, I will demonstrate how I would go about writing a word problem. I’ll take out the worksheet from yesterday and tell the students that I’m using that as my guide. I’ll choose one of the problems and tell them that I’m going to focus on that particular one. As I’m writing it, I’ll be reading the problem on the worksheet but I’ll change the numbers, names (to teacher and/or names of students in the classroom) and maybe even modify the question so that students can see how to make the question more creative.
5. I’ll leave my example on the smart board and let students know that they can use any old homework assignment, warm-up, or quiz to get ideas for word problems. They should be working on their own but if they have questions, they can first ask group members and then me.

**PROCEDURE FOR STUDENTS WORKING OUT EACH OTHER’S PROBLEMS(25 minutes):**

1. Once students have written their 3 problems, students will be given time to go around and do two things; one, have at least 1 person solve each of their 3 problems, and two, solve at least 3 problems from 3 different people.
2. Students will check each other’s work. If the problem is solved correctly, the student who wrote it will mark a “C” and put their name on the student’s paper who solved it correctly. If the student who is solving their problem gets a different answer than the student who wrote it, they will both come see me and we will work it out together.
3. When students have gotten each of their problems solved by someone else and have also solved 3 other student’s problems, they will go back to their seats. With the time remaining, I will use the popsicle sticks to call on students to share one of their problem’s. If someone else in their group can tell me which formulas should be used to solve that problem, I will award that group a point.

**MEETING THE NEEDS OF ALL STUDENTS:**

There are some students in the class who will have really good ideas for word problems but will struggle to get those ideas down on paper. Since we’ve done something similar to this before, I know who those students are. Even though I don’t like to single anyone out, I will have to for this lesson. The students who I know will struggle, I will have come to the back table and work with me in writing their problems. Also, some students who have certain accommodations in their IEP’s will be given permission to type their word problems on the computer.

**POTENTIAL PROBLEMS AND SOLUTIONS:**

One problem that might arise is that some students will struggle to get their ideas down on paper. To solve that, I will have the students I know that will happen to work with me when writing their problems. Also, some students may claim they don’t have any ideas. If that’s the case, I will have them get out an old assignment that has area or perimeter on it and show them how they can use one of the problems and just change the numbers.

**CONNECTION TO CTA**:

CTA stressed the importance of getting students involved in learning. By creating their own problems to solve, students will be involved in every aspect of today’s lesson. They will also be working on their own and with other students for most of the lesson rather than having me just lecture them.