

## **Lesson Research Proposal for Discovery of Pi with 1<sup>st</sup> year mixed ability**

**Date of lesson:** 29th January 2019

**School name:** Our Lady of Mercy College, Beaumont

**Teacher giving lesson:** Ms. Jennifer Keegan

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**Lesson plan developed by:** Joanna Caffrey (St. David's CBS), Chloe McGarry (St. David's CBS), Peter Keaney (Our Lady of Mercy Beaumont), Jennifer Keegan (Our Lady of Mercy Beaumont) & Conall Kelly (St. David's CBS).

**1. Title of the Lesson:** How big is the Pi?

**2. Brief description of the lesson:**

Students will discover pi. They will do this by using active teaching methodologies. The lesson is broken into two tasks. The first task asks students to discover the numerical value of pi and the circumference of a circle formula. The second task asks students to list and explain different methods that could be used to find the circumference of the same given Circle.

**3. Research Theme**

**The SSE priorities guiding the teaching of mathematics are:**

- Ensure that all subject departments follow approaches to teaching Mathematical Concepts that are consistent with the Maths Plan.
- Endeavour to ensure that the timing of the introduction of new Mathematical Concepts in other relevant subject areas takes account of the Maths Programme.
- Value is placed on all calculations across all subject areas - encourage the correct use of the calculator.
- Continued engagement with aims of Project Maths.
- Common approaches /use of language in delivering the Maths programme by all Maths teachers.
- The above priorities will be further enhanced through the use of Maths Competitions and running of maths week.

- Promote the use of active teaching and learning methodologies in the teaching and learning of Mathematics.

**The broad teaching and learning goals identified as a priority to improve teaching and learning and the practical steps taken by teachers are:**

**1. As maths teachers, we want our students to:**

- Actively participate and take a sense of ownership in their work, take pride in it and take responsibility for improving their learning.
- Grow as learners through respectful interaction and experiences that are challenging and supportive.
- Relate concepts learnt in the classroom to real life situations.
- Develop and identify links between different mathematical concepts.
- Apply the strategies that they have learnt in other problem solving situations.

**2. As maths teachers, we want to:**

- Respond to individual learning needs and differentiate teaching and learning activities as necessary.
- Use a variety of methodologies that will give students the opportunity to engage with the work individually and as a group.
- Collaborative lesson planning, we will endeavour to create a problem-solving lesson, where the problem chosen is meaningful to the students and will encourage them to engage in the problem-solving process to the best of their ability.

**4. Background and Rationale**

This lesson is aimed at a first year mixed ability class and focuses on shape and specifically circles. We chose this topic as there are common misconceptions when students first meet pi. They struggle to understand what pi is or where it comes from. Subsequently, using pi in a formula can lead to misconceptions and students simply learn off that they have to use a formula for. This lesson aims to enable students to discover pi themselves and create the formula for the circumference of a circle.

As a group we have discussed how over the past few years in both house exams and specific shape chapter tests our students in Our Lady of Mercy College Beaumont and St. David's CBS, Artane have not scored well with applications of the circle questions and do not appear to understand why they are substituting into the formula to find the circumference. Some students simply learn that when they see the word circumference it means to substitute into the formula. Students are at a disadvantage doing this as the word circumference rarely comes up in actual Junior Cert exam questions. Therefore, it is important that they understand that they are finding the length around the circle or the perimeter of the circle. Students also struggle to see the link between the circles and coordinate geometry. In the new Junior Cycle we are trying to move away from teaching specific stand-alone chapters and instead teach units that gel different topics together. It is hoped this lesson will merge together topics from coordinate geometry and shape.

### 5. Relationship of the Unit to the Syllabus

Related prior learning Outcomes	Learning outcomes for this unit	Related later learning outcomes
<p><b>Primary School Mathematics Syllabus</b></p> <ul style="list-style-type: none"> <li>Shape and Space (2D and 3D Shapes).</li> </ul> <p>Understand the properties of a circle including the relationship between the diameter and the radius and the relationship of the circumference and the diameter.</p>	<p><b>Junior Cycle Mathematics Specification</b></p> <p>Investigate 2D shapes so that they can find the perimeter and area of plane figures such as squares, rectangles, triangles and circles. (GT2(b)).</p> <p>Represent mathematical situation in a variety of ways (U4)</p> <p>Make sense of a problem and mathematise the problem (U7).</p>	<p><b>Junior Cycle Specification</b></p> <p>Find the volume of a rectangular solids, cylinders and a combination of these. (GT 2(c))</p> <p>Finding the surface areas and curved surface area of rectangular solids, cylinders, spheres and</p>

<p>Measure the circumference of circles and everyday items containing circles such as a rolling pin.</p> <p>Construct a circle given the diameter or radius of a circle.</p> <p>Use the properties of 2D shapes to solve problems.</p> <p>Identify and understand 3D shapes and explore and examine the relationships in 3D shapes.</p> <ul style="list-style-type: none"> <li>• Measures (Length).</li> </ul> <p>Ability to use appropriate instruments to take measurements such as ruler for short objects, meter stick for longer objects and trundle wheel for long distances.</p> <p>Estimate and measure the perimeter of regular and irregular shapes.</p> <p>Using metric units and converting units.</p>	<p>Communicate mathematics effectively (U13).</p> <ul style="list-style-type: none"> <li>• Geometry and Trigonometry</li> </ul> <p>Calculate, interpret and apply the units of measure (length).</p> <p>Investigating 2D shapes so that students can draw and interpret scaled diagrams.</p> <p>Calculate the area and perimeter of squares, rectangles and triangles.</p> <p>Investigate properties of points, lines and line segments in a co-ordinate plane.</p>	<p>a combination of these. (GT 2(d)).</p>
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Interpret and use scales.		
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## 6. Goals of the Unit

- Students will explore the properties of a circle.
- Students will understand that some types of problems do not have a single approach rather there are many sets of approaches to solve the problem.
- Students will recall basic facts related to shape and space of 2D and 3D shapes.
- Students will be confident in their own abilities to select the correct formula/approach to solve the problem.
- Student will have the opportunity to interpret information presented to them.
- Students will apply a variety of approaches to locate the formula of a circumference.
- Students will recall basic 2D and 3D, coordinate geometry such as distance and midpoint and circle properties (diameter, radius, and perimeter/circumference).
- Students will engage in a task where the solution is not immediately obvious.
- Students will discuss the problem in pairs and break it down into manageable steps.

## 7. Unit Plan

Lesson	Brief overview of lessons in unit
1	Introduction of regular polygon shapes (Squares, rectangles and triangles). Introduce the properties of these.
2	Calculate the area and perimeter of squares and rectangles. Using the formulae $A = l \times w$ and $P = 2l + 2w$ .

3	Introduction to the circle as a shape. Using area of rectangle and square from prior learning show that the formula for their perimeter and area will not work for a circle.
4	Properties of a circle - Diameter of the circle is the distance through the centre point, radius is half the diameter, circumference is the distance around the outside of the circle (link to perimeter of polygon shapes).
5	<b>Research Lesson</b>
6	Extend the learning to semi circles and arcs
7	Word problems using real world problems.

## 8. Goals of the Research Lesson:

### a. Mathematical Goals

#### Students will know/understand:

- What pi is
- What circumference means
- What is the formula for the circumference of a circle is and how to use it
- That there are many different ways to find the circumference of a circle including using coordinate geometry

### b. Key Skills

- Being literate: expressing ideas clearly and accurately - students will be to verbalise the meaning of pi and the circumference of a circle formula.
- Managing myself: being able to reflect on my own learning - students will be able to reflect on the strategies they used in this lesson to support future learning.
- Staying well: being confident, being positive about learning - there is an opportunity for all students to succeed and experience success. The

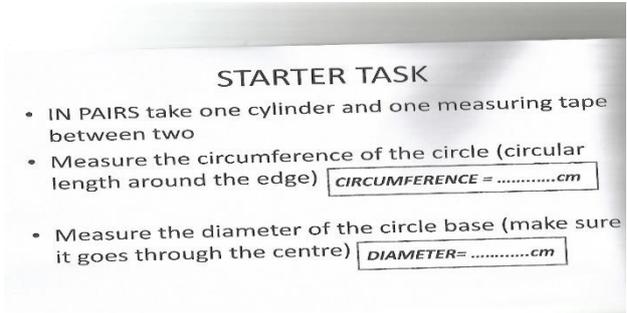
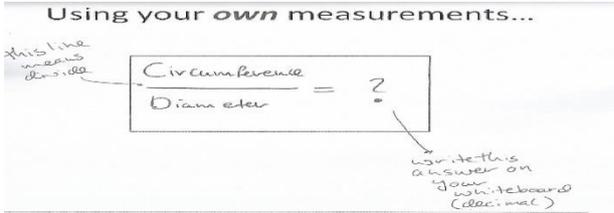
employment of differentiation throughout the lesson will provide an opportunity for all students to experience success.

- Managing information and thinking: being curious; thinking creatively and critically; reflecting on and evaluating my learning - this will be achieved through the use of active learning methodologies.
- Being numerate: expressing ideas mathematically; estimating, predicting and calculating; developing a positive disposition towards investigating, reasoning and problem solving; seeing patterns, trends and relationships -
- Being creative: exploring options and alternatives; implementing ideas and taking actions; learning creatively this will be achieved through the use of active learning methodologies.
- Working with others: cooperating; learning with others
- Communications: using language; using number; listening and expressing myself; performing and presenting; discussing and debating.

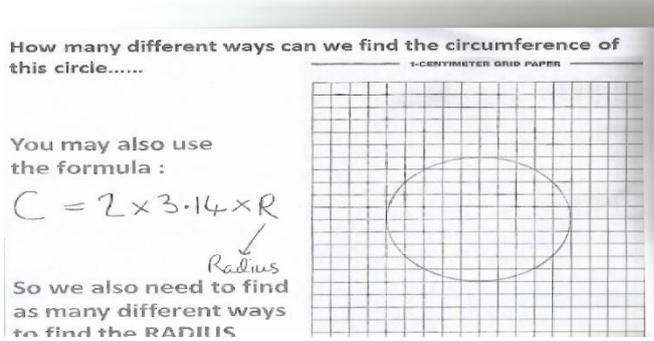
### **c. Statements of Learning**

- SOL 15 recognises the potential uses of mathematical knowledge, skills and understanding in all areas of learning
- SOL 16 describes, illustrates, interprets, predicts and explains patterns and relationships
- SOL 17 devises and evaluates strategies for investigating and solving problems using mathematical knowledge, reasoning and skills
- SOL 23 brings an idea from conception to realisation

9. Flow of the Research Lesson:

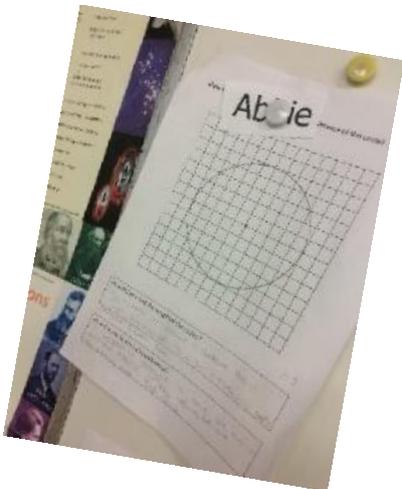
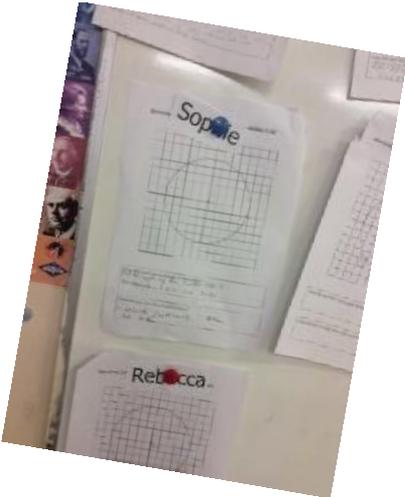
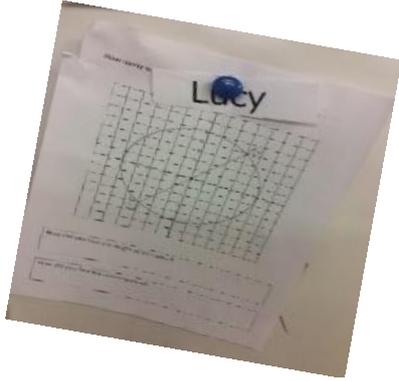
<p><b>Learning Activities</b>  <b>Teacher's Questions and Expected Student Reactions</b></p>	<p><b>Teacher Support</b></p>	<p><b>Assessment</b></p>
<p><b>Introduction</b></p> <p>Students will be shown the starter sheet on their desk.</p>  <p>They will be instructed to measure the circumference of the cylinder and then the diameter.</p>		
<p>“Now using your own measurements, divide the circumference by the diameter, and write your answer as a decimal onto your mini whiteboards”.</p>  <p>“Now hold up your whiteboards, look around the room.”</p>		

<p>“Everyone used a different cylinder/circular base but all of your got an answer very close to.....”</p> <p>“10 divided by 2 is equal to 5, so what operation do I fill into the box to make this work?”. Students should say “multiply”.</p> <p>“6 divided by 3 is equal to 2, so what operation do I fill into the box to make this work?”. Students should say “multiply”.</p> <p>“Circumference divided by diameter is equal to 3.14, so what operation do I fill into the box to make this work?”. Students should say “multiply”.</p> <p>“We know that the diameter is 2 times the radius and 3.14 is pi, so can we create a formula using 2, r and pi for the circumference?” So the circumference is equal to 2 times pi times r, which is equal to <math>2\pi r</math>.</p>		
<p><b>Posing the Task</b></p>	<p>“Try to think of all the different chapters we have studied so far and think if any of those might help us solve the problems in</p>	<p>Students will all get around 3.14 for their answer.</p> <p>Students will identify the correct operation to complete the equation.</p>

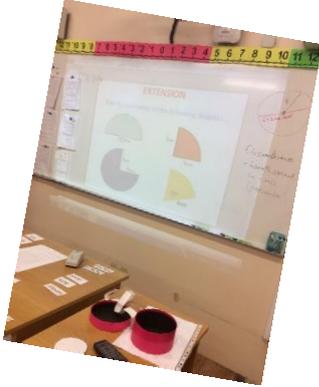
	today's lesson"	
<p>"Now we are handing out 1 cm grid paper with a circle drawn on it". "How many different ways can we find the circumference of this circle?"</p> <p>"You may also use the formula, <math>c = 2 (3.14) (r)</math> where <math>r</math> is the radius." "We may also need to find as many different ways to find the length of the radius. This task is to be done individually".</p> 		
<p><b>Student Individual Work</b></p>	<p>"You may use as many different methods as you wish. You may use scissors, string, the formula, your calculator or methods you have</p>	<p>Students should look like they are understanding the task set for them. Through nodding their heads and becoming engaged with the activity.</p>

	learned in other units”	
Students will find the circumference of the given circle using a variety of methods. They may need to find the length of the radius using different approaches.		
	Teacher will walk around the classroom supporting students in their individual work	Students should be able to achieve at least one of the possible approaches to solving the problem.

<p><b>Ceardaíocht /Comparing and Discussing</b></p> <p>Students will be invited to the board to display their solution to the problem. “Put your name and your workings on the board and explain how you got your solutions”. This will be repeated for each student invited to the board.</p> <p><b>**List of possible student solutions below and explained after the board plan**</b></p>	<p>“Why did you pick that method?”</p> <p>“How did you come up with that method?”</p> <p>“Can you explain how</p>	<p>Students will be assessed on their ability to explain their method.</p> <p>Students will be assessed by their ability to get the correct answer.</p>
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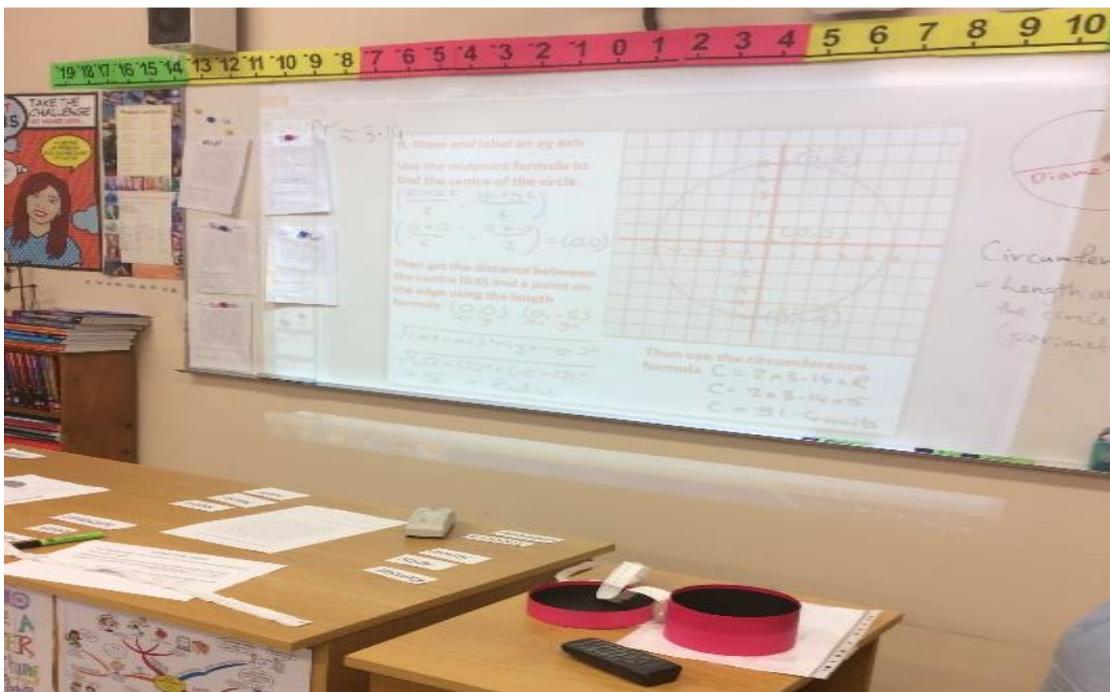
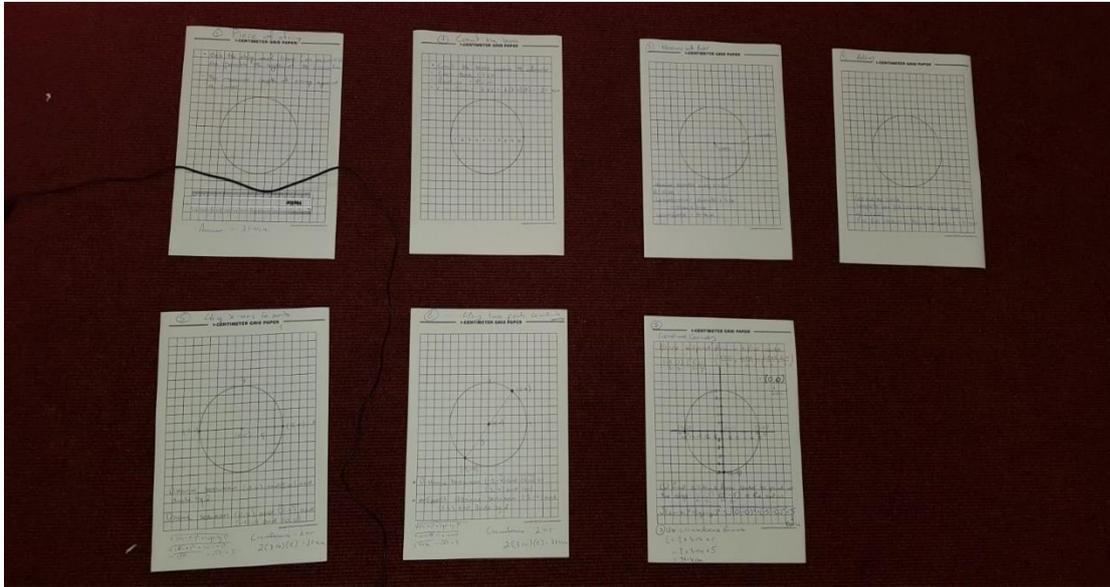


you got to that point?"

		
<p><b>Summing up &amp; Reflection</b></p> <p>“For future circles, which method would be the easiest to use and give the most accurate answer?” “And if we were to be given a circle with no grid or co-ordinate diagram we would need to be given the radius or diameter”.</p>	<p>Reinforcing the learning through repeating the statement.</p>	<p>Students will use the formula for the circumference of a circle to calculate the perimeter of a variety of sectors of circles.</p> 

## 10. Board Plan

### Possible Student Responses



## Possible Student Responses

1. String- using a string to physically measure out the circumference of a circle. Place the string on the circumference of the circle then straighten out the piece of string on a ruler.
2. Count the boxes - that go from outside edges across the centre. Then using the fact that the boxes are 1cm wide use this figure to multiply  $Pi \times d$  or  $half\ d \times Pi$ .
3. Measure with ruler for diameter- multiply the diameter by 3.14
4. Rolling - cut out the circle using the scissors provided. Complete one full rotation of the circle along the edge of a ruler. One rotation is the circumference of the circle.
5. Coordinate geometry - distance from two outside points on the axis - using either x or y axis to identify the distance between the two outside points.
6. Coordinate geometry - using any two points on the outside edges.
7. Coordinate geometry - Midpoint to find centre then distance - draw an x and y axis on the grid provided. Label points on both axes. Mark two points on opposite sides of the circle. Using the midpoint formula from co-ordinate geometry, find the centre point. Then find the length of the radius using a point on the circle to the centre point. Use the radius then to find the circumference

## 11. Evaluation

### Question for Discussion

**a. Did the lesson successfully promote student-to-student discussion?**

Yes. Students worked in pairs. They consulted with each other. They shared materials. They supported each other's feedback.

**b. Did students achieve the goals of the lesson i.e.**

- What pi is
- What circumference means
- What is the formula for the circumference of a circle is and how to use it

- That there are many different ways to find the circumference of a circle including using coordinate geometry.

Yes.

## 12. Reflection

### Teachers' Reflections on their Lesson Study

- **What did you find useful about participating in a Lesson Study?**

The lesson study process is dependent on the close collaboration of a group of teachers. By engaging in the lesson study process I experienced the benefits of such collaboration including, shared experiences – problems and possible solutions, leading to increased motivation and eagerness to try new things.

- **Has participating in a Lesson Study caused you to think about your teaching in a different way?**

Yes.

- **Having participated in one Lesson-Study cycle - can you see the difference between doing a Lesson Study for your professional development versus participating in a workshop? Consider the benefits of doing so, and the associated challenges and possible solutions.**

Yes. Time management is a point worthy of consideration in this area. Key too is the support of management in the development of the lesson study cycle. The lesson study process provided greater opportunities for learning than our traditional workshops, owing primarily to the steps involved in the lesson study cycle. Engagement in each step provided greater opportunity for reinforcement of learning as well as opportunities for consultation with colleagues.

- **Does Lesson Study have a role in supporting other curriculum reforms e.g. junior cycle? If so, how?**

Yes. Through our engagement in the lesson study process we came to the realisation that the lesson study process 'ticks all of the boxes' outlined in key policy documents as laid down by the DES.