Lesson Research Proposal for Transition Year: Topic Perimeter and Area

For the lesson on 25th January 2018
At Crana College, Buncrana, Co. Donegal
Taught by: Helena Doherty
Instructor: Lorraine Cunningham
Lesson plan developed by: Helena Doherty, Louise Duffy, Lorraine Cunningham

Title of the Lesson:
M.M.A- Mixed Mathematical Approaches to the 'Notorious' planning permission in Las Vegas.

1. Brief description of the lesson

In this lesson, students will try to formulate the area of the first floor (rectangle) of Conor Mc Gregor's holiday home in Las Vegas. They will have to find the perimeter of the rooms (all squares) in the inside of the rectangular plan to find the dimensions to subsequently calculate the area.

2. Research Theme

The main aspects that Crana College are focusing on this current school year for SSE are:

1. The delivery of the new Junior Cycle Curriculum
2. The use of Instructional Leadership in the school

In our teaching and learning of mathematics, we would like to implement such aspirations within our lesson study as we as teachers recognise the importance of adapting methodologies and incorporating the eight key skills and the twenty-four statements of learning from the new Junior Cycle programme to facilitate learning. Collaboration between teachers and departments has become ever more important in schools. With the introduction of the new Maths Course in 2018 teachers are exploring new methodologies to effectively deliver the new course. Structured problem solving permits the inclusion of all Key Skills and the applicable Statements of Learning in the Junior Cycle course.

Instructional Leadership encourages student engagement from modelling and practice. It also promotes the development of collegial networks as a means of support for teachers. This encourages teachers to modify the way they deliver lessons to maximise all student learning. As a result, teachers explore new tactics and approaches to deliver lessons. It fosters awareness how a teacher's actions impact on student learning as many of the methods encourage hands on experiential learning. Many of the methods used cater for the diverse learning styles and multiple intelligences of students. There are also benefits for classroom management as these approaches are often more active and engaging for students.
Structured problem solving provides an opportunity for specific task delivery, effective time allocation in lessons and too, the implementation of efficient Instructional Leadership when facilitating mathematics. Teacher collaboration is also paramount to create and deliver engaging lessons.

3. Background & Rationale:

This lesson is aimed at Transition Year students. It is important for students to learn about area and perimeter as this will give students a chance to use maths outside of school, in real life scenarios.

Area and perimeter are two important parts of mathematics, because they are the physical aspects of mathematics. They are the foundation for understanding other topics in mathematics, such as geometry, volume and mathematical theorems that help us understand algebra, trigonometry and calculus.

Students may see area and sometimes perimeter, as an application of formulae without understanding what area and perimeter are. Often, confusion arises between the concepts of area and perimeter, particularly in the following instances;
-They have difficulty developing an understanding of dimension.
-Failure to recognise that perimeter is a length, which is one-dimensional and measured in units of length such as metres, centimetres or inches, while area is measured in squares with bases of a certain length and hence is expressed in two-dimensional units such as m^2 (metres squared, or square metres).
-They may not link their everyday experiences and understanding of area and perimeter to what they learn in the mathematics classroom.
-Frequently, area and perimeter are intertwined with algebraic problems, such as expression creation, calculus, functions to name a few. Once variables are presented, students do not demonstrate confidence in their ability and fail to apply formulae or knowledge practiced in area and perimeter previously.

Additionally, we would like to shift our approach from traditional methodologies to a more interactive and cooperative facilitation of teaching and learning, where students will actively seek many solutions to a real-life problem, that is both relevant, highly challenging but also achievable.

4. Relationship of the Unit to the Syllabus

Related prior learning Outcomes	Learning outcomes for this unit	Related later learning outcomes
-Students will have covered Area and Perimeter at Junior Certificate level in the Strand Number, Section: Applied Measure. Students learned about: Measure and time. 2D shapes and 3D solids, including nets of solids (two-dimensional representations of three-dimensional objects). Using nets to analyze figures and to distinguish between surface area and volume. Problems involving perimeter, surface area and volume. Modelling real-world	-Calculate, interpret and apply units of measure. -Draw and interpret scaled diagrams -Select and use suitable strategies to find length of the perimeter and the area of the following plane figures: triangle, rectangle, square, and figures made from combinations of these. -Trigonometry Right-angled triangles: theorem of Pythagoras; Apply the result of the theorem of Pythagoras to solve right-angled triangle problems of a simple nature involving heights and	-This topic has cross-curricular links to other areas on the course, such as algebra, geometry, number, calculus and trigonometry. This recognition of the relationships will aid with future applications of problem solving for the remainder of Transition Year and the Leaving Certificate course. -Applied Measure is a significant part of the Leaving Certificate syllabus, both at higher and ordinary levels. Engaging with this content should promote future learning with the topic of Applied Measure. -Some proposed methods

situations and solve a variety of problems (including multi-step problems) involving surface areas, and volumes of cylinders and prisms.	distances. -Investigate the uses of algebra when formulating expressions relevant to Area and Perimeter. Synthesize and problem solve by exploring patterns, formulating conjectures, explain findings, justifying conclusions, communicating mathematics verbally and in written form, applying their knowledge and skills to solve problems in familiar and unfamiliar contexts. -Analyse information presented verbally and translate it into mathematical form − devise, select and use appropriate mathematical models, formulae or techniques to process information and to draw relevant conclusions.	involve making assumptions. Answers may be found without proof. The need for proof for all assumptions will be emphasized. This is relevant to the 'Proof by Induction' section of the Leaving Cert Higher Level course.

5. Goals of the Unit

-Students will understand that some types of problems may be multi-faceted in that there may be various solutions instead of simply one within the context of Applied Measure, thus proving that creativity in approaches is relevant to mathematics.
-Students will recognize the context and applications of Area and Perimeter by completing a contemporary and relevant problem that deals with real-life problems.
-Students will understand how to apply ideas to mathematical contexts as they arise. Additionally, they will be able to express ideas and communicate assertions to others during Structured Problem Solving.
-Students will recognize the relationships that Area and Perimeter has with other topics in the Mathematics course. Students will acknowledge that topics are not independent of other areas on the curriculum. This assertion will hopefully widen knowledge and hence enhance problem solving skills.
-Through increased mathematical expression among peers, students will become more familiar with communicating mathematical ideas and application because of the collaboration during the task and the

subsequent discussion of the solutions found.
-Many suggested solutions involve assumptions and estimation. Because of effective emphasis of methodologies during the Ceardaíocht, students will understand the need to prove their assumptions despite the likelihood of educated estimations or solutions.

6. Unit Plan

Lesson	Learning goal(s) and tasks
1 The Research Lesson	Applications and implementation of perimeter and area alongside other topics on the mathematics course. Use a suitable problem to: -that promotes an understanding of formulating algebraic expressions for area and perimeter and subsequent solving for an unknown. -help recognize common threads between trigonometry, geometry and area and perimeter. - integrate arithmetic methods when formulating area and perimeter strategies.
2	Practice formulating expressions and then solving variables when dealing with area and perimeter. Use targeted exercises to reinforce these practices and discuss any issues students may have with formulating algebraic statements and hence solving.
3	Implement tasks that show the connection between area and perimeter and trigonometry/geometry. Exercises should involve shape recognition when shapes are within another shape, just like the problem in the research lesson. Students should attempt problems with a variety of shapes such as triangles, circles and practice the application of suitable methodology and linkages.
4	Practice and continue to use targeted exercises to identify any issues regarding shape recognition and the correct application of suited methodologies.
5	Revisit exercises that require specifically arithmetic calculations within area and perimeter. For example, ratio and proportion, percentage error, to show how any given problem can be multifaceted and linked to other strands of the course.
6	Introduce a 3D plan of Conor Mc Gregor's house to introduce 3-D shapes, leading on to volume. This also provides opportunities to revisit some topics listed above such as trigonometry, geometry and arithmetic but in a 3D context.

7. Goals of the Research Lesson:

a) Mathematical Goals

Students will

- Understand the applications of perimeter and area in real-life contexts.
- Comprehend the need to utilise algebraic expressions for scenarios where there are unknown dimensions.
- Recognize the relationships between the various geometric shapes, associated angles and relevant processes involved.
- Be confident to express their own assertions based on their cognitive ability in a safe and positive environment.

b) Key Skills and Statements of Learning

In preparation for the introduction of the Junior Cycle for Mathematics, our maths department at Crana College are integrating the development of key skills into lessons.

This lesson will incorporate the following key skills:

1. Being Numerate: Students will engage with investigate possible solutions, formulated individually or in groups when attempting to solve the problem.
2. Staying Well: Problems are involved are suited to all needs of in a mainstream environment therefore confidence in ability will be promoted.
3. Managing Myself: Students will have to review and evaluate their workings when they are required to write a reflection at the end of the lesson.
4. Being Literate: Through Ceardaíocht, students will have to express their findings with precision and clarity.
5. Working With Others: Collaboration among students will result in co-operative learning after discussing ideas and approaches.
6. Managing Information and Thinking: Critical thinking and organization of ideas will be encouraged throughout the lesson.
7. Being Creative: As the solutions are multi-dimensional, students will be required to try as many methodologies as possible, thus creativity in approaches is required.

This lesson also meets the following JC statements of Learning:

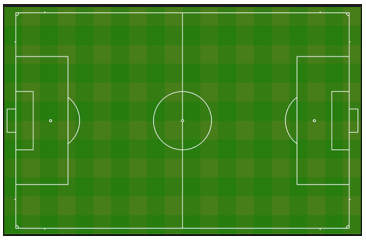
1. The student communicates effectively using a variety of means in a range of contexts.

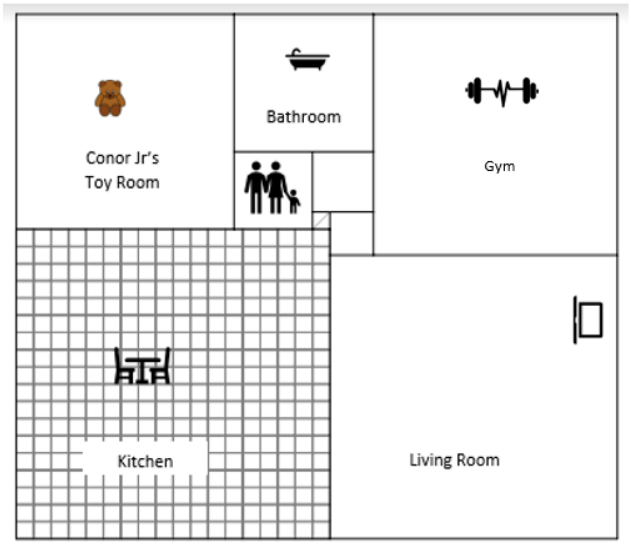
15. The student recognizes the potential uses of mathematical knowledge, skills and understanding in all areas of learning.

16. The students describes, illustrates, interprets, predicts and explains patterns and relationships.

17. The students devises and evaluates strategies for investigating and solving problems using mathematical knowledge, reasoning and skills.

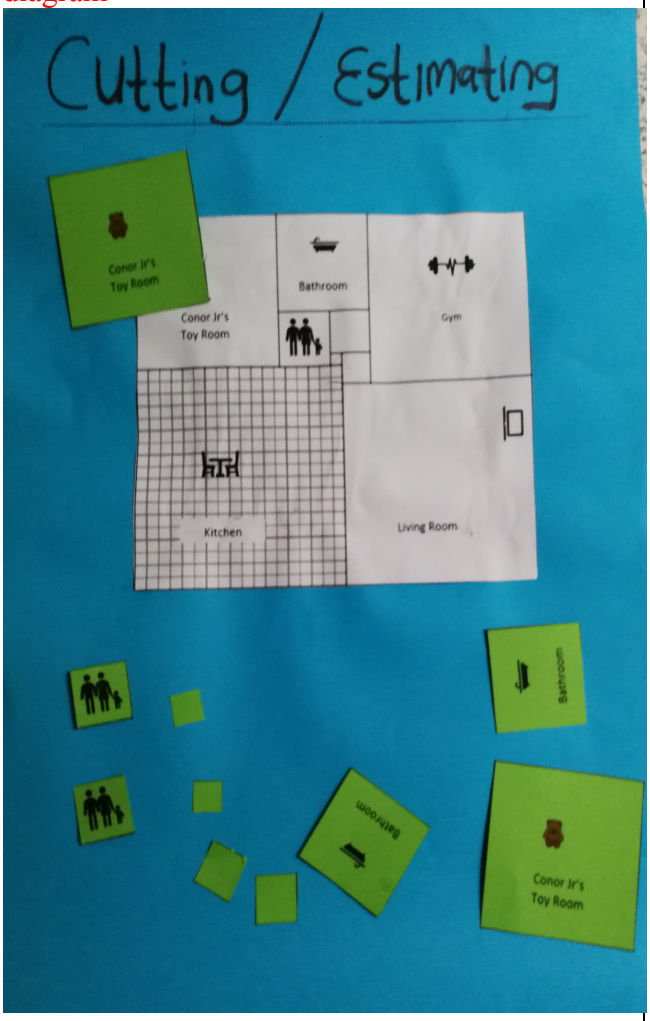
8. Flow of the Research Lesson:

Steps, Learning Activities Teacher's Questions and Expected Student Reactions	Teacher Support	Assessment
Introduction (5 mins) Before we start today's problem, I want to quickly review some maths we have learned previously. - Denotes student response(s) I want you all to tell me how you calculate; The perimeter The area of squares/rectangles. - Denotes student response(s) What would you do if you didn't know a dimension of the football field, could you still stay something about the football field? Could you create an expression for the perimeter or area? Are there any useful objects in the pitch that could help you? - Denotes student response(s).	This image will be to reactivate prior knowledge of perimeter and area.  Use the football pitch to create expressions for area and perimeter.	Can students identify how to calculate both area and perimeter? Can students recognize the useful nature of shapes within other shapes? Can students create expressions using variables if there are unknown dimensions?
Posing the Task (5 mins) Conor Mc Gregor has received planning permission to build his dream holiday in Las Vegas. However, in Nevada, there are restrictions due to over developments in large urban areas, therefore he was allocated a limited space. Below is a diagram of the plan of the ground floor, with some proposed room (all square)	Present an image of the problem on the board. Students will also be provided with and A3 sheet containing the problem Students will also be provided with rulers, extra paper and scissors	Do students understand the task?

positions.  Calculate the **area** of the ground floor (in as many ways as possible) given that diagonal of the smallest square above is equal to √8 metres. Hence find the planning permission that Conor was allocated. **Clarifying the problem 1 (5 mins)** What shape are we dealing with here? We know how to do it but what's different about this? Is there anything on the diagram that is useful? -Denotes the student responses(s)	Students will be guided to find a starting point of some sort before beginning. All groups will be provided with multiple copies of the problem, mathematical sets, scissors and extra paper.	Remind students that there are many ways to solve the problems. Highlight the importance of the variety of resources provided.

Student Individual Work

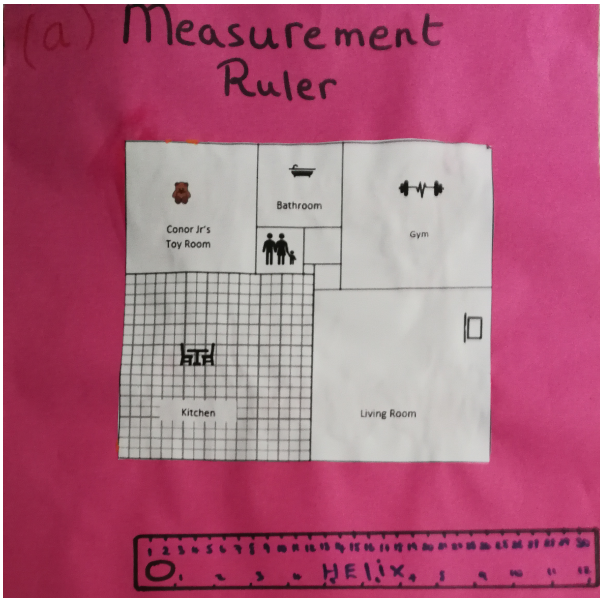
Method 1: cut out and place squares on the diagram



Students could be given two copies of the problem, one they can cut out the squares to establish the relationship and proportion between the squares.

i.e. 2.5 of the smallest squares is equal to the size of the next square and so on……

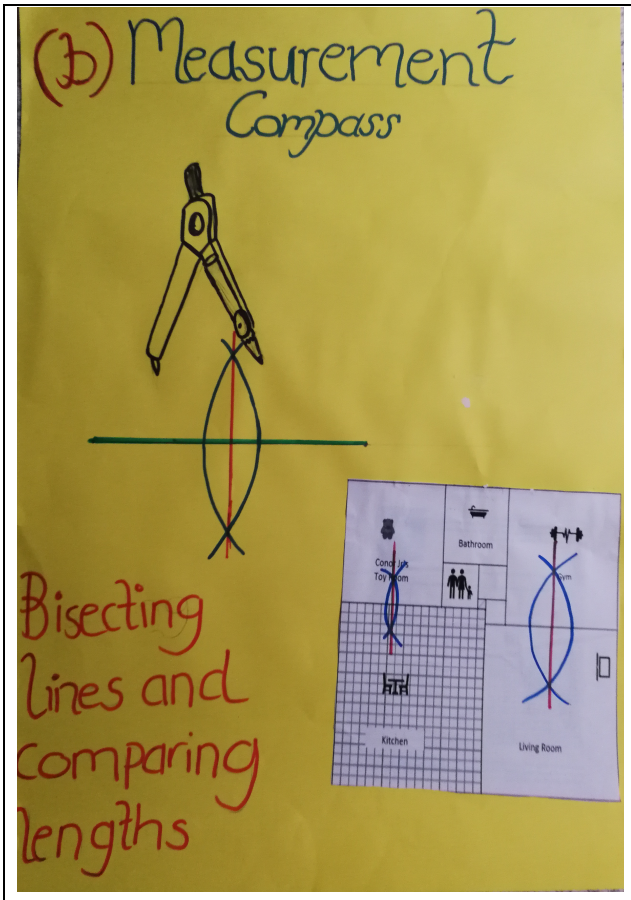
Method 2: Measurement (a)



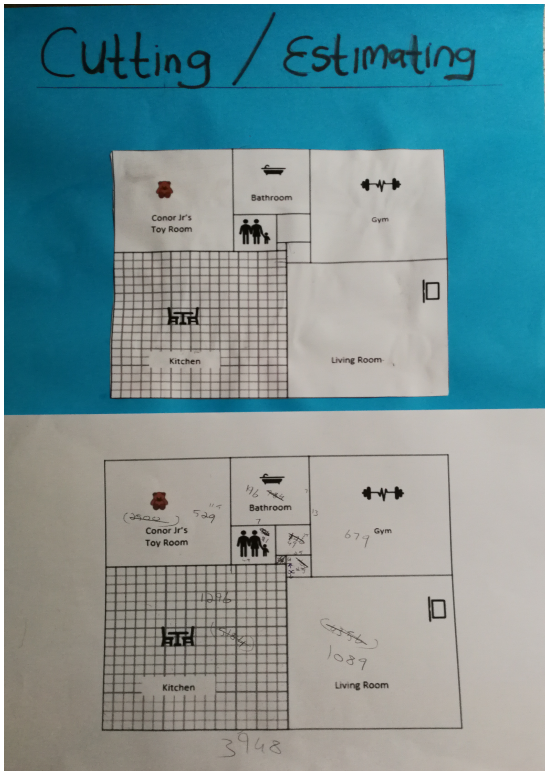
- Students could lift a ruler and simply measure the size of each of the squares
- They could measure the size of a tile in the kitchen and use this to determine the size of a side. E.g. each tile is 5mm 18 tiles so 5x18 =90 mm

Method (b): Compass Measurements.

Students could bisect one dimension of a square and compare this length to another bisection of a larger square and use such measurements to determine the dimensions of the length and width of the larger rectangle.



Method 3: Estimations



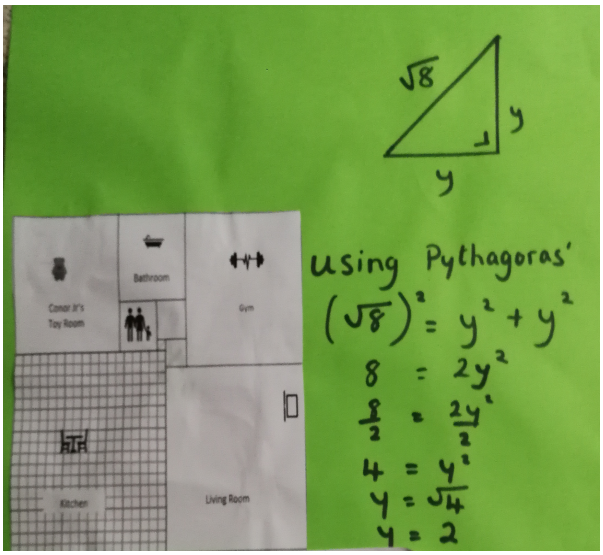
Students might estimate the size of the larger squares using the kitchen tiles which are the same size as the smallest square on the diagram.

Students could simply assume each square tile in the kitchen to be 1 unit in length and count the number of square to establish the length of a side e.g. 18 squares side is 18 units/metres. They could then use this to count the size of the other squares.

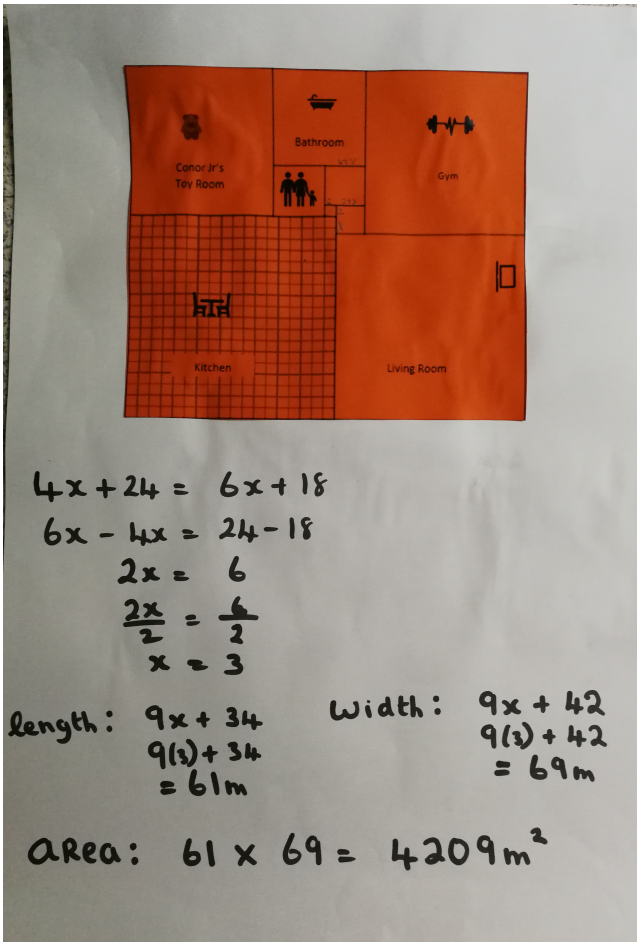
Students could use the information given on the diagram $\sqrt{8}$ for the diagonal of the smallest square and using Pythagoras to determine the side of the square to be 2 units. Then using this information, they could multiply the number of tiles by 2
E.g. 18 tiles x 2 units side of the square =36 units/metre

Method 4:

Students could use Pythagoras to find the length of the square when given $\sqrt{8}$ on the diagonal.



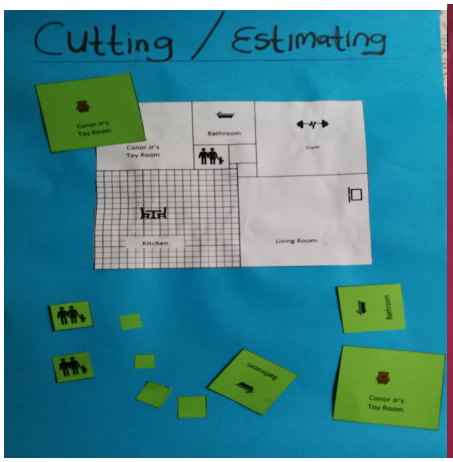
Using this value, 2, they can extend the length with an unknown variable, say x, to find a new length of the next square (x + 2).

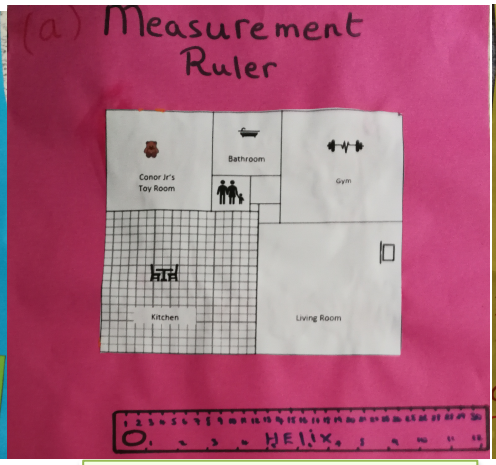
Using the length of the smallest square (2) and the length of the next square, they will then get the length of the 3rd biggest square. $x + 2 + x = 2x + 2$ This method will continue to be used to get an expression for the length of each square. Equate the length of one square with an equivalent length of a combination of squares to solve for x.  		
Ceardaíocht /Comparing and Discussing (20 mins) **Discuss Method 1:** Cutting and Estimations.	Provide generic solution and praise students who	Could you be 100% certain that this is

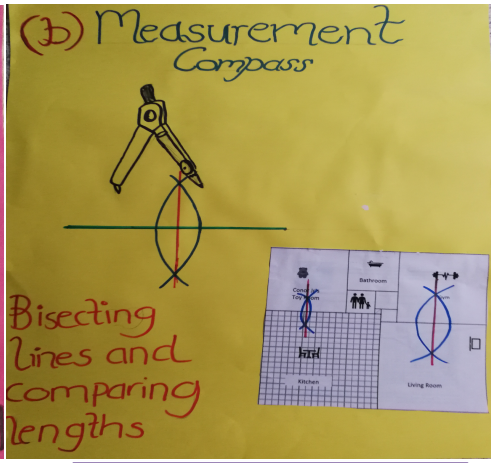
Bring student up to the board to discuss findings.	chose such methodology.	the correct answer?
Discuss Method 2: Simple measurements Show how students who measured with a ruler worked out the area.	Praise and acknowledge the relative validity of solution.	Are there any implications of carrying out such methodology? What about scale?
Discuss Method 3: Estimations and Assumptions Demonstrate how students assumed lengths and measured smaller shapes within larger shapes to arrive at a conclusion.	Praise and acknowledge the relative validity of solution.	Highlight the importance of using shapes within larger shapes. Question validity of assumptions. How can you prove it?
Discuss Method 4: Compass measurement Show how students who measured with a compass and subsequently worked out the area.	Praise and acknowledge the relative validity of solution	Are there any implications of carrying out such methodology? What about scale?
Discuss Method 5: Expression Creation and Equating expressions accordingly. Represent algebraic findings and show how algebraic statements can be equated to find an unknown variable.	Discuss how expressions were created and used to find missing variables leading to a final answer in many contexts such as area and perimeter.	Emphasize the certainty and validity of this approach in comparison to the methods discussed previously. All assumptions need proof in mathematics.
Student Reflection (5 mins) After all methods are discussed, students must be allocated sufficient time to reflect on learning		

during the lesson. The first four solutions discussed will be that of estimations and assumptions. The discussion will lead to realizing the need more concrete mathematics to find out answers such as algebra. Additionally, students will see that there are many ways to solve one single problem and that creativity in approaches has an important place in mathematics.		What new ideas have been generated?

9. Board Plan







Relevant student work including names

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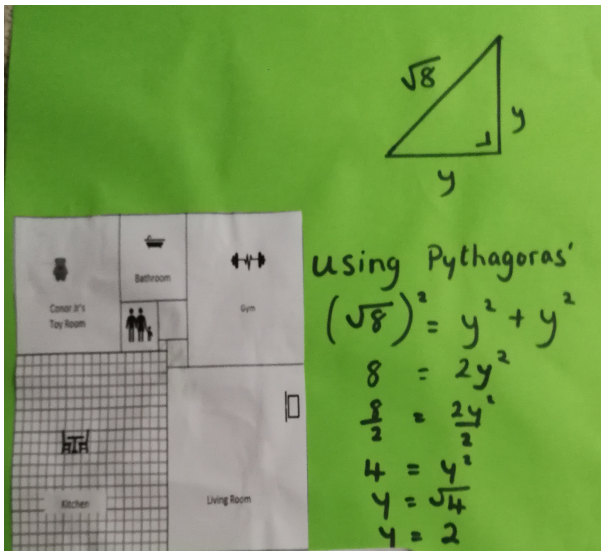
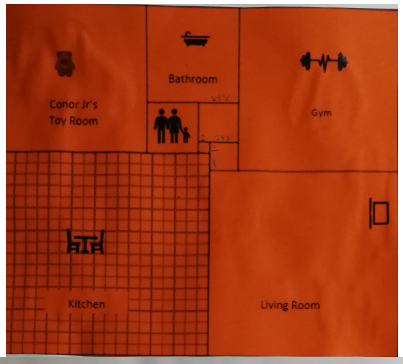
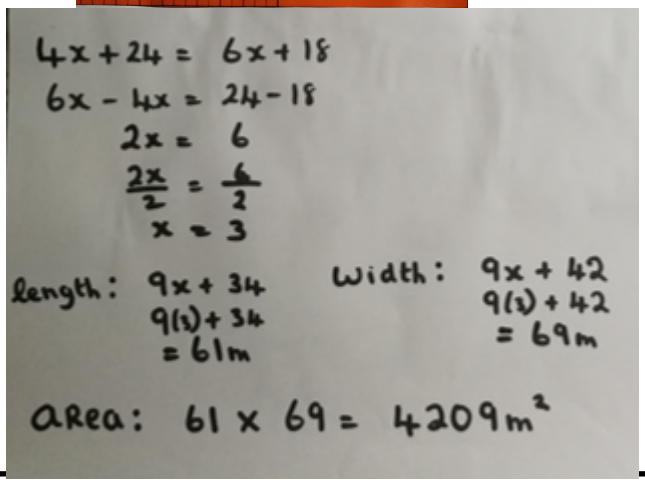


Algebra





10. Evaluation:

Research Theme

Structured problem solving provided an opportunity for specific task delivery, effective time allocation in lessons and too, the implementation of efficient Instructional Leadership when facilitating mathematics. Students were engaged and shared mathematical ideas through discussion and cooperative learning. Many statements of learning were intertwined into the lesson design, therefore a new approach to facilitating the teaching and learning of mathematics was implemented.

Goals of Lesson

Initially students were focusing on achieving one solution and often when a problem was solved, students felt satisfied with their work. Many failed to try to attempt another method. Two groups did however manage to attempt 3 solutions each.

Ruler measurements were attempted by almost all groups as a starting point. Students were very certain that this method was not reliable due to the issue of scale and sizing. Two groups tried to bisect lines of the dimensions of the smaller squares using compasses to find out information of the larger squares. However, they found this quite difficult due to the small size of such squares on the problem presented. Surprisingly, no group attempted to cut out squares to try to establish the relationship and proportion between the smaller and larger squares.
Estimations were used by all groups. Students assumed the length of the next bigger square based on knowledge found using Pythagoras' Theorem or otherwise. Such approximations were probably easily found since the required length was a whole number. Algebraic approaches were very obscure.

11. Reflection

Overall, we as a team, hoped that students would recognise that problem-solving need not be confined to one solution only, cross-curricular relationships would become apparent, confidence would be increased through effective collaboration and the need for concrete solutions as opposed to assumptions would be highlighted. All goals were achieved to some extent, except for instilling confidence when attempting math problems. Many students presented as apprehensive initially. Therefore, it was very difficult as teachers not to prompt or guide them. With that said, we admitted that perhaps more prior knowledge should have been reactivated at the beginning to help scaffold problem-solving process. Many students outlined during their reflection that they understood the need for proving assumptions but maintained that it is difficult to do so using algebra. Many were unsure about generating algebraic expressions. Reiterating the point from section 10, assumptions were easily made because the value for x was a whole number. Perhaps if the probable variables to be found first were decimals, this may lead to assumptions being more difficult to make thus encouraging the use of other methodologies. Furthermore, a larger print-out of the problem would be presented to promote more effective use of geometry sets.

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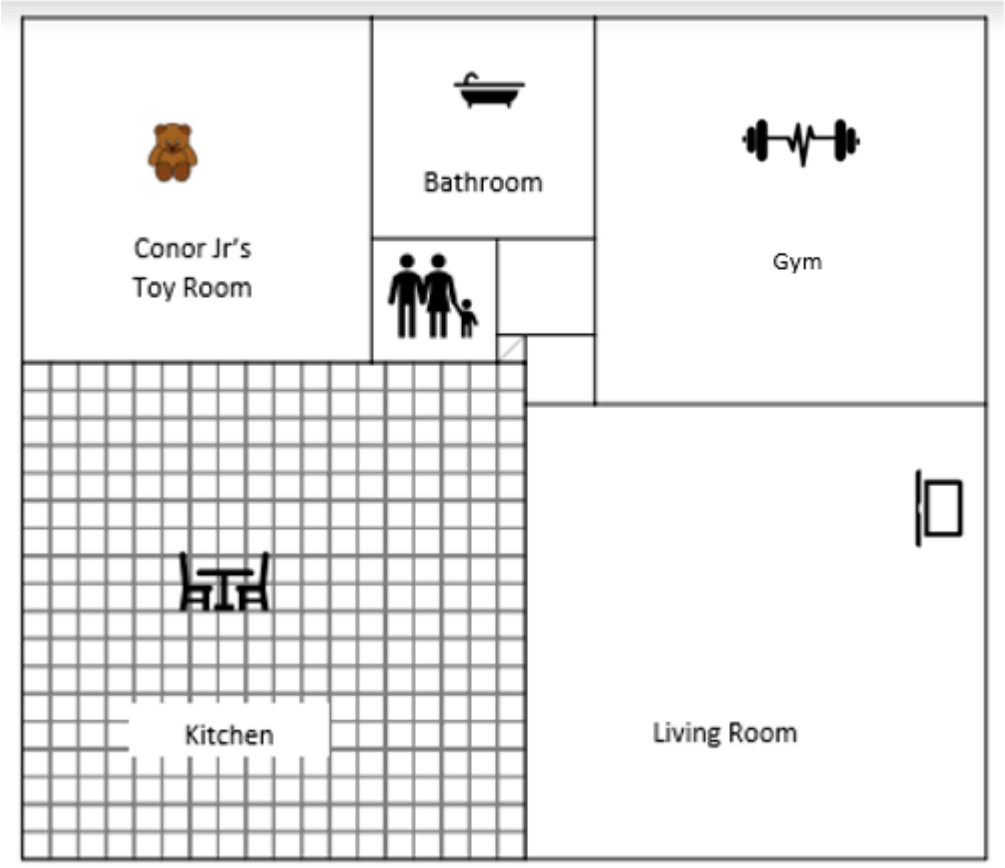
Below is a diagram of the plan of the ground floor, with some proposed room (all square) positions.



Calculate the **area** of the ground floor (in as many ways as possible) given that diagonal of the smallest square above is equal to $\sqrt{8}$ metres. Hence find the planning permission that Conor was allocated.