

Lesson Details	Lesson Study Group
Name of lesson: Divide and Conquer Topic: Algebraic Long Division Year group: 2nd Years Level: Ordinary	School Name & address: Our Lady's Grove Secondary School Advisor: Marilyn O'Riordan Teachers: Richelle McDonald, Ursula Carley, Marc-Paul Lynn, Robbie Broughton, Jackie Donovan

Research Theme
One of the focuses of our School Self Evaluation Plan at Our Lady's Grove Secondary School for 2022-23 is our AEN (Additional Educational Needs) students. As a department we want to consider how we meet their needs in the Mathematics classroom through different teaching and learning strategies. While differentiation has been implemented across the department, through collaborative discussions in Lesson Study we want to discuss further how we can cater better for the needs of our students who need to be challenged more. While addressing the AEN focus, the Mathematics department also wants to contribute to the wellbeing goals that have been outlined in the SSE plan and have given consideration to this in the mathematics classroom through team teaching and scaffolding. Through our Lesson Study process we want to focus on: • using formative assessment approaches to develop mathematical skills that can be applied in a real world context. • moving to a common approach to develop understanding of more difficult concepts • developing collaborative relationships in the classroom through the use of 'I do, we do, you do' approach.

Background & Rationale

The *TIMSS Report (2019)* and *PISA reports* found that students experience difficulties with Geometry and Algebra in particular. The teachers at Our Lady's Grove found that 2nd year students have such a diversity in abilities and because of their lack of interest in Algebra, students find it difficult to make connections between skills that they have learned in class and real world problems that they have been presented with. In general, they are unable to make connections or extrapolate from previous knowledge. It was also found that because students are taught algebraic methods in many different ways in the junior years, teachers find themselves reteaching concepts in 5th year that should have been mastered by then.

As a result of this, the target of our research lesson is 2nd year higher students. We hope that by adopting a common approach to teaching the division of algebra, we can address some of the problems that students have with both algebra and fractions as a whole. We hope also that by applying formative assessment approaches we can challenge the more able students while still keeping everyone on task and remove some of the negative connotations associated with algebra and division in general.

Relationship of the Unit to the Syllabus

Prior Learning	Current Learning	Future Learning
p92 The child should be enabled to • identify simple prime and composite numbers • identify and explore square numbers $16 = 4 \times 4$ • explore and identify simple square roots construct diagrams record	AF 3c apply the properties of arithmetic operations and factorisation to generate equivalent expressions so that they can develop and use appropriate strategies to: divide quadratic and cubic expressions by linear expressions, where all	p37 4.1 - evaluate expressions given the value of the variables – expand and re-group expressions – factorise expressions of order 2 – perform the arithmetic operations of addition, subtraction, multiplication and division on

and relate to square numbers • identify common factors and multiples explore and record factors and multiples to identify common factors and multiples • write whole numbers in exponential form $1000 = 10^3$ $10^3 \cdot 10^3 \cdot 10 = 10^8$ $2^3 \cdot 2^3 \cdot 2 = 2^6$ p97 Equations The child should be enabled to • translate word problems with a variable into number sentences Peter cut a length of ribbon into five equal parts; each part was 30 cm long. How long was the ribbon before it was cut? $x \div 5 = 30$ • solve one-step number sentences and equations p96 Variables The child should be enabled to • explore the concept of a variable in the context of simple patterns, tables and simple formulae and	coefficients are integers and there is no remainder AF 5 generate quadratic equations given integer roots GT2c investigate 2D shapes and 3D solids so that they can: find the perimeter and area of plane figures made from combinations of discs, triangles, and rectangles, including relevant operations involving pi N1 investigate the representation of numbers and arithmetic operations so that they can: a represent the operations of addition, subtraction, multiplication, and division in N, Z, and Q using models including the number line, decomposition, and accumulating groups of equal size b perform the operations of addition, subtraction, multiplication, and division and understand the	polynomials and rational algebraic expressions paying attention to the use of brackets and surds – apply the binomial theorem p33 3.4 – use notation x – select and use suitable strategies (graphic, numeric, algebraic, mental) for finding solutions to inequalities of the form: • $g(x) \leq k$, $g(x) \geq k$; • $g(x) < k$, $g(x) > k$, with $g(x) = ax^2 + bx + c$ or $g(x) =$ and $a, b, c, d, k \in Q$, $x \in R$ • $x - a < b$, $x - a > b$ and combinations of these, with $a, b, \in Q$, $x \in R$ p39 4.2 – use the Factor Theorem for polynomials – select and use suitable strategies (graphic, numeric, algebraic and mental) for finding solutions to • cubic equations with at least one integer root
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substitute values for variables <i>identify and discuss simple formulae from other strands e.g. $d = 2\frac{3}{4}r$; $a = \frac{1}{3}w$ substitute values into formulae and into symbolic rules developed from number patterns.</i> p103 Area The child should be enabled to • recognise that the length of the perimeter of a rectangular shape does not determine the area of the shape • calculate the area of regular and irregular 2-D shapes • measure the surface area of specified 3-D shapes	relationship between these operations and the properties: commutative, associative and distributive in N, Z, and Q and in $R \setminus Q$, including operating on surds u5, 7-10,13	• simultaneous linear equations with three unknowns • one linear equation and one equation of order 2 with two unknowns and interpret the results p29 – consolidate their understanding of factors, multiples, prime numbers in N – express numbers in terms of their prime factors – appreciate the order of operations, including brackets p28 – generalise and articulate observations of arithmetic operations – investigate models to help think about the operations of addition, subtraction, multiplication and division of rational numbers.
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Goals of the Unit

Students can:

- Identify factors of an expression and apply their knowledge to calculate remaining factors of an expression.

- Solve long division problems with letters and numbers and be able to explain them to someone else.
- Use long division in algebra to solve problems that have more letters or minus in them
- Use long division to solve real world problems.

Key skills:

Being Numerate: By engaging in suitable tasks, students will develop a positive attitude towards investigating, reasoning and problem solving.

Working with Others: Students will use 'elbow buddies' to learn from each other by discussing different approaches to problem solving.

Communicating: Through effective questioning, students will communicate their findings, discuss their mathematical thinking and question for understanding.

Managing myself: Students will have the opportunity to reflect on their own learning throughout the lesson.

Managing Information and Thinking: Students will have to think critically when engaging with more difficult problems.

Unit Plan

Lesson	Brief overview of lessons in the unit
1	Inequalities and compound inequalities
2	Algebraic fractions
3	Algebraic fractions
4	Algebraic fractions
5	Algebraic Long Division
6	Algebra manipulation
7	Algebraic Formative Assessment tasks

Goals of the Lesson

Introduce the concept of long division in algebraic expressions
 Practice long division with algebraic fractions

Challenge high ability students with more complex problems moving towards polynomials.

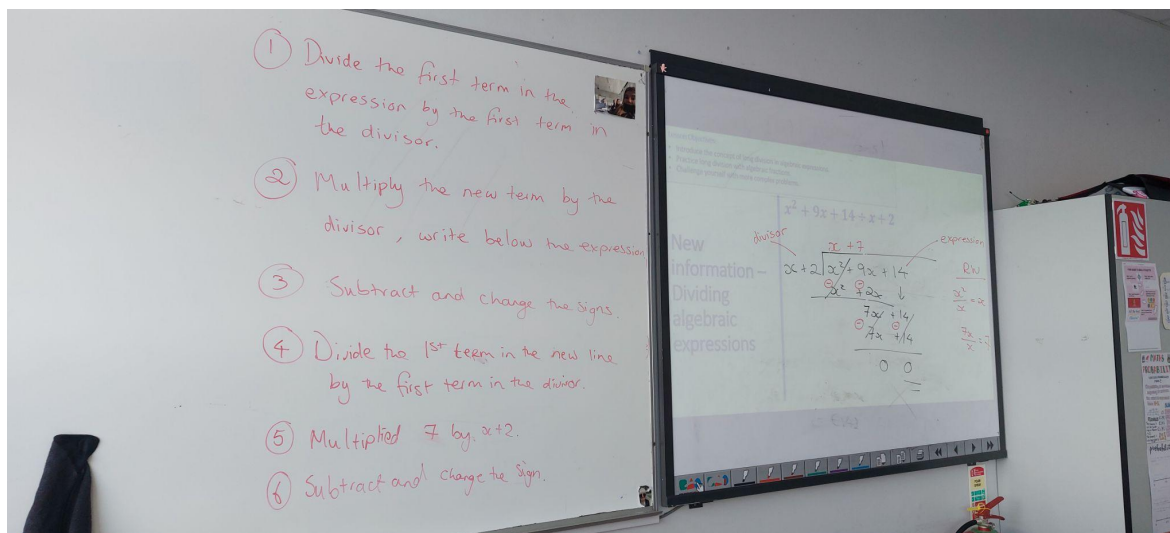
Flow of the Lesson

Timing, activities, steps, resources, problems	Teacher support, activity	Assessment, questions, comments, strategies
Introduction: (10 mins) Share Learning Intentions with the class and a stimulus to engage. A question that will recap factorising and division - 2 questions on the board. Introduce using division of a cubic expression $(2x^3 - 13x^2 + 25x - 12) \div (x - 3)$	By the end of the lesson the goal is to solve this question.	Are they able to factorise questions and cancel down? I do, we do, you do.
Posing the Task: I do, we do, you do. Complete 1 example: (5 mins) I do: one example slowly. $(x^2 + 9x + 14) \div (x + 2)$ Complete 2 examples: (12 mins) We do: $(6x^2 + 10x - 4) \div (2x + 4)$ and $(10x^2 - 7x - 12) \div (2x - 3)$	Students are strong so one example is enough. Go through steps step-by-step probing the students. Randomly select students to come and explain. Watch for change of sign.	Students are going to have difficulty with signs. Allow time to try and give feedback on the board.

Student individual/ group work: (12 mins) You do: Students will engage with a similar question but with different letters: $(6n^2 + 21n - 12) \div (n + 4)$ The task: This will consist of three parts: a basic quadratic equation A worded quadratic question A polynomial Extension Ceardaíocht: This will happen throughout. Use of whiteboards and show incorrect work in the we do section and let students find the mistake. Menti - exit ticket to evaluate their learning. Spot the difference and some questions on what did they learn? What did they enjoy?		
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Board Plan

Board work was carried out by students calling out what should be written and discussions were had as to why suggested answers were correct or incorrect.



Evaluation of Lesson

Moving from prior knowledge to new knowledge for students with Additional Educational Needs can for the most part yield excitement at the challenge of learning new skills and acquiring new knowledge. In the case of this lesson, where students were moving from simplifying algebraic fractions to seeing the line as dividing, comments such as 'Can we not use the way we already know?' reflected the general consensus of students' thinking. However when presented with a fraction that had x^3 , students understood the need for new skills. Excitement and frustration alike were the feelings expressed when solving more difficult problems with students exclaiming 'I'm so confused', 'It's so fun when you actually know how to do it' and 'Aww, there are no more questions left'.

Effective questioning and feedback from the teacher kept students motivated throughout with praise such as 'you are so close, keep going' encouraging students not to give up. Through independent work students followed a process to complete long division but with the introduction of group work and discussion more concrete learning took place as students either tried to explain more difficult concepts to their peers or sought verification for their own work.

To generate a good post lesson discussion observing teachers focused on questions such as:

- Did students appreciate different ways of approaching problems?
- Did students critically compare approaches or evaluate appropriateness of their method?
- How and when did students start to understand change?
- Did students ask questions of their classmates?

Overall the main goals of the lesson were achieved with all students moving towards understanding of the more difficult polynomials and not just the AEN students. Through working with others on these more difficult concepts, concrete understanding of algebraic division will be embedded in students' understanding for longer.

Summary of Key Learning

Meeting 1	Spent time engaging with the Schools SSE. Identified a focus on AEN Discussions on how teaching practices in general differed and which year groups had most diversity Discussed topics that proved difficult - algebraic long division - area and fractions. Array model - no no no.
Meeting 2	Some discussion around the rationale - we want a common approach. Look at junior cycle curriculum for learner outcomes, followed by prior learning in primary and future learning from the LC specification
Meeting 3	Discussion was had around the title of the lesson, when it will happen, who will be present, who will teach the class and what room it will be taught in. Introduction discussed starting with fractional form and factorising, maybe some simple revision of numbers to remind them of long division. Create a small task eg rectangle one side length and find the other one and look at questions with no coefficient on x squared and positives.

	Discussion around how much can be covered, how do we check for understanding throughout the lesson? Whiteboards, different colours, roughwork column. Have a cheat sheet with tasks preprinted. Step by step as a remember key steps. What deems a step? They can be long – lead into success criteria....FA work individually, pairs etc... Considerations given to where the problem areas will be and how we're going to assess learning as we go along. Spent some time Looking at some examples that could be done. Texts and tests 2. Folens. Active maths 1....p500 linking anything creative?...WORDED PROBLEMS highlighted. Square or rectangle. Real life problems – camping extended task...how many people fit into a tent?
Meeting 4	Discussion was had around the flow of the lesson and the activities to be carried out to support learning.
Meeting 5	Observation sheet was shared. Flow of the lesson continued. and consideration given to the amount of work to be completed in class. Allow time for questions, elbow buddies etc. Language of the questions need to be considered. Layout of the room and time of class discussed. Board work discussed.

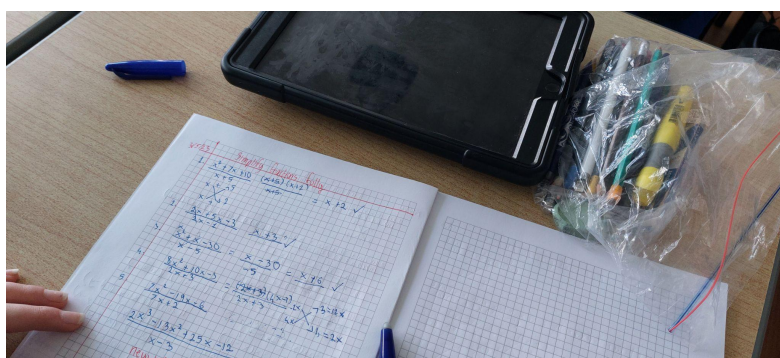
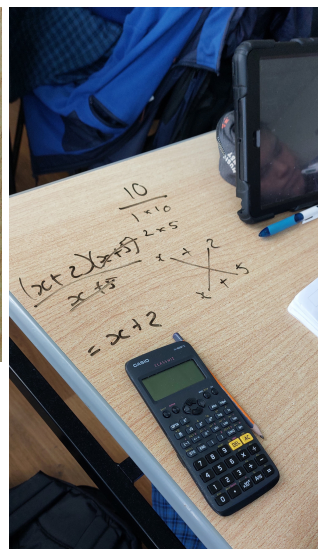
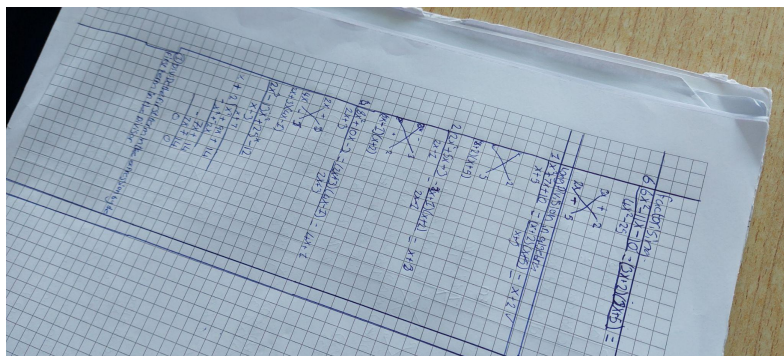
Final Reflection

Post lesson discussions began by addressing the question of whether the goals and the research theme of the lesson had been met. Through collaboration in Lesson Study the Mathematics teachers at Our Lady's Grove, Goatstown teachers wanted to adopt a more common approach to long division to prevent reteaching the topic in 5th year.

Lesson observations:

Having observed this lesson it was felt by teachers that the long division method could be taught by all teachers to all students with a view to more scaffolding for weaker students. Although it was planned to have one 'I do', two 'we do' and one 'you do' questions, students understood the process of long division much sooner than was expected. One student had completed the 'we do' questions before others had even completed the 'I do' question. Students' written communication

was excellent which may be contributed to the fact that students are encouraged to use their desks as whiteboards for roughwork as they work their way through problems.



Use of mathematical language when discussing long division was of a high quality and this contributed to good expression of thought processes orally. Peer discussions led to increased understanding of long division as in cases the explainer became the listener when the expertise changed hands.

Future Study:

It was suggested that a nice closure exercise for this class in future would be to verify solutions by multiplying out the divisor and the factor to find the original expression. And to extend learning further, students could make up their own division problems for their neighbour. As the ability of classes can change a bank of scaffolding questions will be created to allow for the lesson to be used again. And more opportunities will be created for students to share their learning more as independent learning was of high priority for AEN students in this class.



Lesson Study Process:

Teachers at Our Lady's Grove Secondary school really valued the opportunities that Lesson Study provided for collaborative discussions. They found that by observing the live lesson they could appreciate different teaching methodologies and use these to improve and develop their own teaching strategies depending on the class group. Teachers felt that to sit in and observe their students in other subjects would also be beneficial to both teaching and learning and management were very receptive to making this happen. Overall, the teaching and learning of algebraic long division was enhanced by Lesson Study and teachers are looking forward to taking part again next year.

