

Lesson Research Proposal for 1st Year Word-Algebraic Equations

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School name: Coláiste Pobail Setanta
Teacher giving lesson: Ronan Ludden
Associate: Mairéad O'Rourke
Lesson developed by: Frances Shannon, Damien Downey, Orna Mac Donough,
Ronan Ludden, Mairéad O'Rourke.

1. Title of the Lesson: Equating Fortnite-ly

2. Brief description of the lesson

Develop students' skills relating to forming mathematical equations by translating an English statement into algebraic equations. Develop students understanding that problems can be solved numerically, algebraically, visually and kinesthetically.

3. Research Theme

In line with the Quality Framework for Post Primary Schools our SSE Initiative for the Academic Year 2018-19 concentrates on Domain 3, Teachers Individual Practice. As a College we are focusing on Standard 2, The teacher selects and uses planning, preparation and assessment practices that progress students' learning.

At our school,

- We want to thoroughly prepare in advance resources tailored to match the specific learning intentions of each lesson, and individual students' learning needs.
- This year our SSE focus is on differentiation of learning intentions and learning activities, including personalised learning opportunities for our students.
- This year teachers will focus on differentiation using technology enhanced learning.
- As teachers we want our assessment practices include not only assessment of knowledge but also assessment of skills and dispositions.

As a Mathematics' department, we actively support the achievement of these SSE goals by doing the following:

- Being more varied in our approach to teaching and using TEL strategies to meet the needs all learning styles (differentiation).
- Implement more structured problem solving into lessons (independent/student led)
- As a department identify skills that we want students to work on and highlight this in our learning intentions every class.

4. Background & Rationale

The topic we've chosen is Introduction to Algebra for 1st years (Common Level). Our reasons for choosing this topic is because it is a new concept to most students.

As a Mathematics' department, we want to create a solid foundation for students' understanding of algebra which will be developed further through their study of Mathematics and build on their knowledge from primary school (patterns, variables, substitution).

From our group discussion we concluded that most students are not confident when answering algebra related questions, and students have most of their difficulties when translating word problems with a variable into number sentences. Other research findings that we found were from the chief examiners report. It was noted that students struggled noticeably with questions that involved substantial amounts of algebra. It was noted at lower levels candidates often left the algebra questions unanswered. Students struggled to carry out procedures accurately which indicated to us during our discussion, students lack understanding of a method or procedure but display a general idea of what to do. From the report it was noticeable for most candidates that if they didn't give the correct answer immediately, they showed little purpose in their future attempts. This was something we had noticed with our own students and wanted to change through this process.

5. Relationship of the Unit to the Syllabus

Describe how this unit relates to the syllabus/learning outcomes from prior years, for this year and for future learning.

Related prior learning Outcomes	Learning outcomes for this unit	Related later learning outcomes
Primary School-6 th Class <ul style="list-style-type: none"> • Students can identify relationships and record symbolic rules for number patterns. • Students should be able to explore the concept of a variable in the context of simple patterns, tables and simple formulae and substitute values for variables identify and discuss simple formulae from other strands e.g. $d = 2 \times r$; $a = l \times w$ • Students can substitute values into 	1 st Year Introduction to Algebra <ul style="list-style-type: none"> • Representing number or variables as letters. • Understanding how indices work in algebra. • Knowing and using proper vocabulary and key words like terms, coefficients and expressions. • Simplify problems by adding, subtracting and multiplying algebraic terms. • Revision of BIRDMAS to solve problems. 	JC (2 nd /3 rd Year) Course & LC Course <ul style="list-style-type: none"> • Simultaneous Equations • Linear Equations • Quadratic Equations • Cubic equations • Exponential Equation • Solving word problems • Algebraic fractions • Binomial theorem

<p>formulae and into symbolic rules developed from number patterns.</p> <ul style="list-style-type: none"> • Students should be able 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? $x \div 5 = 30$ • Students should be able to solve one-step number sentences and equations. 	<ul style="list-style-type: none"> • Solving problems with variables on either side of the equal sign. • Solving word problems by forming algebraic equations • Patterns 	
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6. Goals of the Unit

- Students should be able to investigate situations in which letters stand for quantities that are variable, so they can:
 - (a) Generate and interpret expressions in which letters stand for numbers
 - (b) Find the value of expressions given the value of the variables (Substitution)
- Students should be able to know when an expression contains more than one operation (BIDMAS).
- Students should understand the rules for multiplying or dividing integers applied to variables.
- Students should be able to multiply single brackets by a constant/variable.
- Students should be able to simplify an expression by grouping like terms together.
- Translate an expression into an English statement and vice versa.
- Students should understand the meaning of the words Variable, Term, Expression, Like, Unlike Terms, Constant, and Coefficient.

7. Unit Plan

How the research lesson fits into the larger unit plan, helping to show the bigger picture of the whole unit and the progression of learning. Clarify where the research lesson will be taught.

Lesson	Brief overview of lessons in unit
1.	Introducing variables. Using shapes to hide numbers (slowly bring in letters). Adding and subtracting algebraic terms.
2.	Adding and subtracting algebraic terms. Introduce multiplication and division (BIRDMAS). Making sure the letter is just hiding a number.
3.	Key Words (term, coefficient, constant, expression, equation, equivalent equation, like terms, unlike terms, substitution)
4.	Evaluating expressions by substituting in given numbers for letters.
5.	Understanding how to add or subtract like terms in algebra.
6.	Multiplication of algebraic terms. Making sure student know that only like terms can be added/subtracted but all terms can be multiplied by each other.
7.	Multiply number by number and variable by variable. (SNL)
8.	Multiplying expressions (Brackets) using methods (Array or distributive method) be able to multiply out one bracket.
9.	Use blocks to represent simple algebraic equations to solve for a variable.
10.	Solving linear equations with one variable and more than one operation.
11.	Research Lesson Using linear equations to solve word problems.
12.	Recap lesson on worded problems and converting from English to Maths and vice versa.

8. Goals of the Research Lesson:

- By the end of the lesson students should be able to represent unknown numbers using symbols or letters.
- By the end of the lesson students should be able carry out different operations to solve a problem (BIRDMAS).
- Translate an English statement into a mathematical statement.
- Develop skills relating to forming mathematical equations.
- Understand that problems can be solved numerically, algebraically and visually.
- The rules of multiplying or dividing integers applied to variables as well.

The Key Skills this lesson targets are: being literate, being numerate, managing information and thinking, being creative, communicating and working with others.

The Statements of Learning this lesson targets are: 3,10,15,16,17,18,21,22,23,24

9. Flow of the Research Lesson:

Steps, Learning Activities Teacher's Questions and Expected Student Reactions	Teacher Support	Assessment
<p>Introduction (10 minutes)</p> <p>Complete classroom routine as normal (check homework and keywords at the door) Previous homework task will link to the prior knowledge needed for today's lesson (defining operations involving algebra where students have to provide their own examples). Go through various students answers and have them explain their reasons for their choices.</p>	<p>While students are giving their answers are conscience of misconceptions. Make sure to correct these issues before proceeding.</p>	<p>Are students motivated?</p>
<p>Posing the Task (20 minutes)</p> <p>During a fortnite game, I have a certain amount of health. I find a health pack which adds 5 to my health. I meet up with 3 members of my squad, each whom have the exact same amount of health as me. We get stuck in the storm for a while, and we lose 12 points in total, which is equally split between the 4 of us. I check my own health, it is 9.</p> <p>What health did I start with?</p>	<p>Teacher explains the task question to students and informs them that they need to come up with as many solutions as possible.</p> <p>Question sheets are handed out to students.</p> <p>Teachers and observers move around the room designated to their located areas to identify students who have the predicted solutions.</p> <p>Watch for students with who have alternative solutions.</p>	<p>Ensure students have a minimum of one solution.</p> <p>If students need clarification explain the question to them, alternatively allow students to work in pairs.</p> <p>Ask students questions related to how they answered the question and why they chose that method and try pushing them to come up with others.</p>

Student Individual Work

1. Trial and error

2. Translating words to a formula

Breaking it down step by step:

Step 1: $health + 5$

Step 2: $health + 5 + (health + 5) + (health + 5) + (health + 5)$

Step 3: $4 health + 20$

Step 4: $4 health + 20 - 12$

Step 5: $4 health + 8$

Step 6: *divide by 4:* $1 health + 2$

Step 7: $1 health + 2 = 9$

Step 8: $health = 9 - 2$

Step 9: $health = 7$

3. Blocks (visual aid)



4. Order of operations (BIRDMAS) (follow order of steps by team)

Let $Health = x$

$$x + 5$$

$$4(x + 5)$$

$$4x + 20$$

$$4x + 20 - 12$$

$$4x + 8$$

$$\underline{4x + 8}$$

$$4$$

$$x + 2$$

$$x + 2 = 9$$

$$x = 9 - 2$$

$$x = 7$$

5. Order of operations (BIRDMAS)

(follow order of steps by player)

Let Health = x

$$x + 5$$

$$x + 5 - 3$$

$$x + 2$$

$$x + 2 = 9$$

$$x = 9 - 2$$

$$x = 7$$

6. Formulating the sum and equating to solve.

Creating a formula and then solving:

$$\frac{4(\text{Health} + 5) - 12}{4} = 9$$

$$\text{Health} = 7$$

$$\frac{(x + 5 + x + 5 + x + 5 + x + 5) - 12}{4} = 9$$

$$\frac{4x + 8}{4} = 9$$

$$4x + 8 = 36$$

$$4x = 36 - 8$$

$$4x = 28$$

$$x = 7$$

7. Reverse operations for a team

1.

$$9 \text{ health} \times 4 = 36 \text{ health}$$

$$36 \text{ health} + 12 = 48 \text{ health}$$

$$48 \div 4 = 12 \text{ health}$$

$$12 - 5 = 7 \text{ health}$$

2.

$$9 \text{ health} \times 4 = 36 \text{ health}$$

$$36 \text{ health} + 12 = 48 \text{ health}$$

$$48 - 20 = 28 \text{ health}$$

$$28 \div 4 = 7 \text{ health}$$

<p>8. Reverse operations for a player $9 \text{ health} + 3 = 12$ $12 - 5 = 7 \text{ health}$</p>		
<p>Ceardaíocht /Comparing and Discussing (20 minutes)</p> <p>Students come up to the board and display/explain their answers to the class in the preplanned sequence (1-8)</p> <p>Allow students time to compare and discuss their solutions (pair and share). Get students to identify the methods they didn't think of themselves but now have learnt from their peers in this lesson.</p>	<p>Using appropriate questions, question students on their solutions and have students see the similarities and links between solutions. Highlight and explain any misconceptions.</p>	<p>Misconceptions highlighted. Can the students see the links and progression with the various solutions? Pay close attention to group discussions.</p>
<p>Summing up & Reflection (8 minutes)</p> <p>Using mentimeter, have students determine the learning objectives for the lesson. Have students provide feedback on the lesson.</p> <ol style="list-style-type: none"> 1. One thing that they learned? 2. One thing they found difficult? 3. One thing they would like to learn more about? 4. Would you like to try a class like this again? <p>Praise the students for their amazing work.</p> <p>Homework Worksheet with question similar to the task question</p>	<p>The teacher will use the layout of the board work to help students make a summary of their learning and write their own version of what the learning objectives were for the lesson.</p> <p>Handout worksheet to students</p>	<p>Using mentimeter students will give their feedback on the lesson.</p>

10. Board Plan

TASK QUESTION
 During a fortnite game, I have a certain amount of health. I find a health pack which adds 5 to my health. I meet up with 3 members of my squad, each of whom have the same amount of health as me. We get stuck in the storm for a while, and we lose 12 points in total, which is equally split between the 4 of us. I check my own health, it is 9. What health did I start with?

① TRIAL and ERROR

② TRANSLATING WORDS INTO A FORMULA
 STEP ①: $h + 5$
 STEP ②: $h + 5 + (h + 5) + (h + 5) + (h + 5)$
 STEP ③: $4h + 20$
 STEP ④: $4h + 20 - 12$
 STEP ⑤: $4h + 8$
 STEP ⑥: DIVIDE BY 4:
 $1h + 2 = 9$
 STEP ⑦: $1h + 2 = 9$
 STEP ⑧: $h = 9 - 2$
 STEP ⑨: $h = 7$

③ BLOCKS (VISUAL AID)

④ ORDER of Operations (BIDMAS) (Follow order of Steps by Team)
 Let Health = x
 $x + 5$
 $4(x + 5)$
 $4x + 20$
 $4x + 20 - 12$
 $4x + 8$
 $\frac{4x + 8}{4} = 9$
 $x + 2 = 9$
 $x = 9 - 2$
 $x = 7$

⑤ ORDER of Operations (BIDMAS) (Follow order of Step by Player)
 Let Health = x
 $x + 5$
 $x + 5 = 3$
 $x + 2 = 9$
 $x = 9 - 2$
 $x = 7$

⑥ FORMULATING THE SUM AND EQUATING TO SOLVE.
 Creating a formula and then solving:
 $4(\text{Health} + 5) - 12 = 9$
 $\frac{4(\text{Health} + 5) - 12}{4} = \frac{9}{4}$
 $\frac{4x + 20 - 12}{4} = \frac{9}{4}$
 $\frac{4x + 8}{4} = 9$
 $4x + 8 = 36$
 $4x = 36 - 8$
 $4x = 28$
 $x = 7$

Reverse the steps for the player's health
 Looking at a player's health
 $9 \text{ health} + 3 = 12$
 $12 - 3 = 9 \text{ health}$

Reverse the steps for the teams total health
 Looking at the teams total health
 $9 \text{ health} \times 4 = 36$
 $36 \text{ health} + 12 = 48 \text{ health}$
 $48 \text{ health} - 4 = 44 \text{ health}$
 $44 - 5 = 39 \text{ health}$

Looking at the team total health
 $9 \text{ health} \times 4 = 36 \text{ health}$
 $36 \text{ health} + 12 = 48 \text{ health}$
 $48 - 20 = 28 \text{ health}$
 $28 \div 4 = 7 \text{ health}$

11. Evaluation

The lesson supported our research theme and it was successful in reiterated our school's SSE focus for the year which is on differentiation of learning intentions and learning activities, including personalised learning opportunities for our students.

The task question complemented our research theme very well as it provided students with a personalised learning opportunity where they could attempt them question using their own methods. The task was also differentiated as solutions ranged from easy to complex. From the students' work it was clear to see the different abilities of students by how they answered the question.

The lesson promoted more student discussion. This corroborated with what the team wanted from the research theme as they wanted students to develop important skills such as communication and discussion of their solutions. The discussions allowed the teachers to assess learning, students could demonstrate their understanding of the lesson goals and the task.

Students discussed their solutions amongst each other and compared their workings and some taught the other how they got their answer.

Through student discussion it was easy to identify some misconceptions and problems students had about the task question. These included, adding 5 instead of subtracting 5 from the word problem when solving the question in reverse and the wording of question threw students and they struggled to identify the key information.

The lesson effectively achieved the main research goals. During our post-lesson discussion, the team realised that six goals was too ambitious, but the three most important goals were achieved and it was evident from students' work and the discussion between students during the Ceardaíocht. The goals were:

- Translate an English statement into a mathematical statement.
 - Develop skills relating to forming mathematical equations.
 - Understand that problems can be solved numerically, algebraically and visually.
- Evidence of achieving these goals can be seen in the sample of students' work below.

Student work

What health did I start with?

ended up with $9 + 3 = 12$

Squad lost 12 in total $\div \frac{4}{3}$

4 Members in total

~~12~~
~~15~~

12
- 5
7

What health did I start with? ~~12~~ ~~15~~

Starting Health [?] 7

Health Pack [5]

Health Lost [3]

Out of the storm [9] = $12 - 5 = 7$

$a - 5 = 7$

Starting Health \downarrow ?

Health Pack \downarrow +5

Health Lost \downarrow -3

Health out of the storm \downarrow = 9

$? + 5 - 3 = 9$

$-5 + 3$

$9 - 5 + 3 = 7$

Translating English into an equation/ formula.
Using a variable to represent an unknown quantity.

① #6

$12 \div 4 = 3$

$9 + 3 + 5 = 7$

②

$a + 5 - 3 = 9$

$-5 + 3$

$\frac{+3}{12}$

$\frac{-5}{7}$

③

$\square \square \square + \square - \square \square = \square \square \square$

④

$5 - 3 = 2$

$9 - 2 = 7$

#8

#3

#4

$14 \div 12 = 3$

storm took 3

1st way backwards

how many does it take to get from 9 to 12 = 3

2 way using 9

$9 + 9 = 12$

$3 + 9 = 12$

#8

at the end

7 health

#6

$12 - 5 = 7$

$3 + 9 - 5 = 7$

7 health

backwards

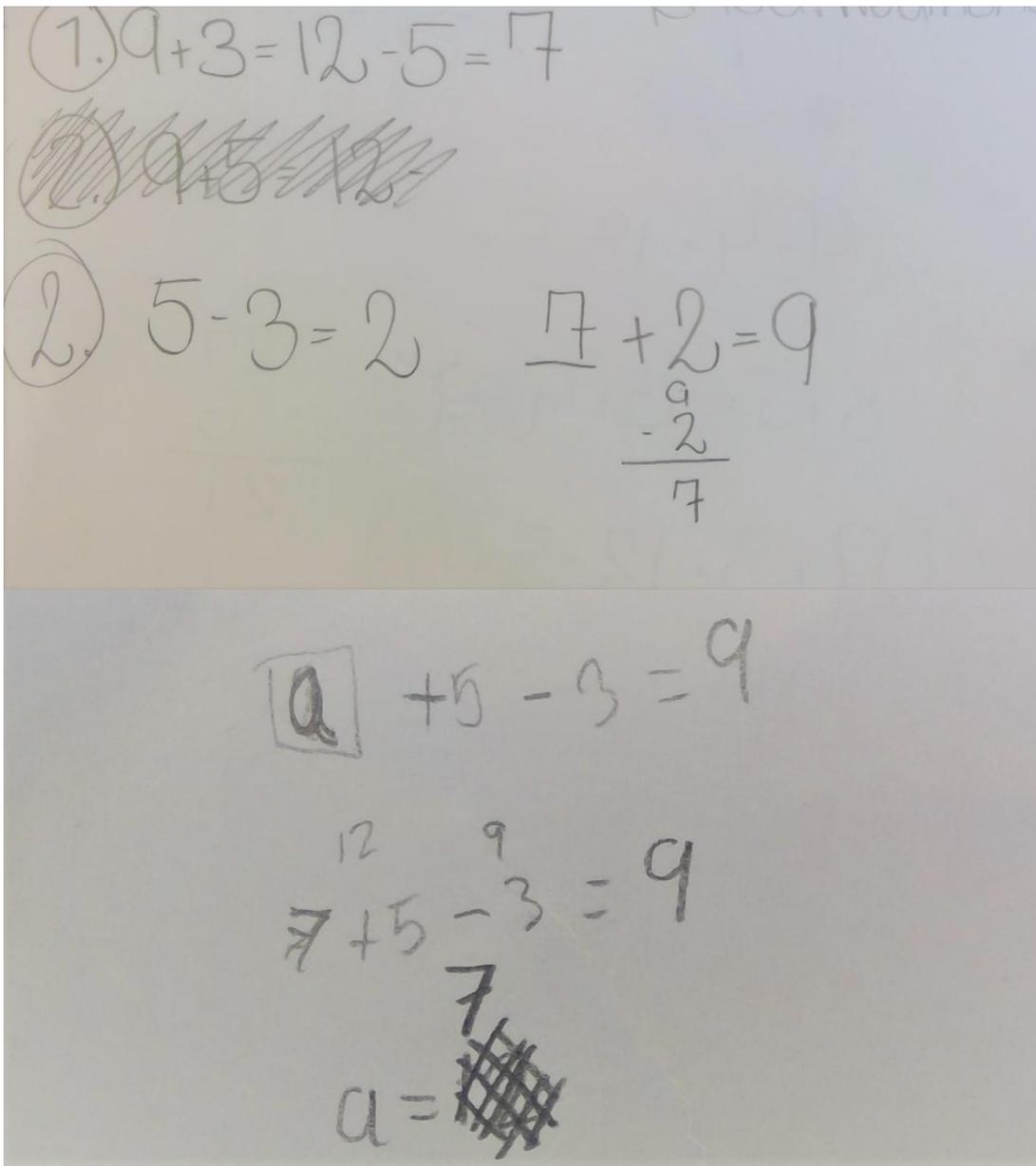
$9 + 3 = 12 - 5 = 7$

$7 + 5 = 12 - 3 =$

9

forwards

Students are developing skills relating to forming mathematical equations.



All samples of the students' work above demonstrate that they understand that problems can be solved numerically, algebraically and visually.

It can be seen from samples of students' work that most answered the question using more than one method. The samples of work allowed us to assess the different level of learning that took place. It helped us identify what students understood well which was that problems can be solved numerically, algebraically and visually. From our analysis and student feedback not, all students were able to develop a mathematical equation which carrying on from this lesson will be a key goal to achieve in future lessons. Representing unknown numbers using symbols or letters will need to be clarified further and solving an equation in a 'forward' order not just 'reverse' order.

Overall in our opinion the students enjoyed the lesson study approach and would like to use this process again. We feel that regular lesson study classes would hugely benefit students with their confidence in Maths and with forming problem solving techniques.

12. Reflection

The team hoped that all students would try several different methods to solve the question, and this was achieved by students.

Feedback from students included:

What I learned?
I tried different methods
I learned how to create a formula
I learned there are many ways to solve the same question x28
I learned to simplify word problems
I learned to use a visual aid

During the lesson the most common methods used were:

Trial and error
Reverse operations for a player
Reverse operations for a team
Blocks (visual aid)
Translating words to a formula
Formulating the sum and equating to solve

Most students reversed operations to solve the question. After discussion we identified this was most common as students were more familiar with answering questions using reverse operations.

The students who used variables when answering the question tended to use the letter 'a', we concluded that this was the case as the teacher had used the letter 'a' in class rather than the most predictable letter 'x'.

Something we noticed during the lesson was that a lot of students drew diagrams and used boxes which is a method used in primary school. We were surprised by this and after our discussion we spoke of how as teachers we forget what students remember from primary school and that we tend to teach using our teaching method rather than allowing a student to complete a question their way first. We were very impressed with how quick students found solutions especially dividing 12 by 4 immediately and working from 9 backwards. Students used the blocks more than we expected. Visually demonstrating what was happening showed that students understood the question and they could explain it to their peers. From the experience of using the blocks, it is something we would like to incorporate more often as students enjoyed using them and it makes the task more realistic and easier to assess student understanding. Instead of using different colours it was suggested by a notable other that different sized blocks rather than colour could be used to represent variables.

During the post lesson discussion, the teachers agreed to progress the learning further, more work on solving equations is needed. The procedure of working forward on a question is needed as all students tended to work in reverse and work more on the concept of a variable. For future lessons this feedback highlights the need for a problem-solving class to be incorporated in schemes of work to encourage students to evaluate their own learning. This is something the teachers plan to do.

Improvements:

Not all goals of the lesson were achieved, which after discussion the team believed it was too ambitious to try achieving six objectives, but the main three objectives were achieved.

When teaching the lesson again the teachers would spend more time on the Ceardaíocht by bring students up to the board. The teachers wished there was more time to bring students through the various solutions and have them identify the linking solutions.

In relation to the question some students familiar with the game 'fortnite' spent time discussing values of 'health packs' which was irrelevant to what we wanted them to think about. This could have caused difficulty, hence for this lesson it is important to remind students that this question doesn't use the value of the actual game.

The blocks potentially may cause distraction for students. The teacher must monitor use closely.

During the post-lesson discussion, we raised the question, could we be sure that the students understood what they had to do?

To consolidate the learning, we would get students to replicate solutions again to see could they do it themselves, have a think, pair, share activity or have them demonstrate to the class.

Task Question

During a fortnite game,
I have a certain amount of health.
I find a health pack which adds 5 to my health.
I meet up with 3 members of my squad, each whom have
the exact same amount of health as me.
We get stuck in the storm for a while, and we lose 12
points in total, which is equally split between the 4 of us.
I check my own health, it is 9.

What health did I start with?

Homework

Q1 Answer the following in as many ways as possible. Include new methods learnt today.

A number is multiplied by 5 and then
6 is added to the result. The result is
36. Find the number.