Topic: Linear Patterns
Year Group: First Year

For the lesson 8th December 2016
At Colaiste na hInse: First year class
Teacher: Catriona McArdle
Lesson plan developed by: Catriona McArdle (Colaiste na hInse, Laytown),
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Title of the Lesson: The Great Hall at Hogwarts

Brief description of the lesson:

A first look at developing linear patterns. Students will be given the start of a pattern with tables and chairs and asked to continue the pattern. They will then be asked to calculate a higher number in the pattern.

Aims of the Lesson:

Short term aims:

- For my students to appreciate that mathematics can be used to solve real world problems
- For my students to try more approaches to problems even after they have a solution.
- For my students to understand how to calculate the general term in a sequence.
- For my students to communicate effectively their findings.

Long term aims:

- I'd like my students to develop their ability to discover and continue patterns.
- I'd like to foster my students to become independent learners.
- I'd like my students to become more creative when devising approaches and methods to solve problems.
- I'd like to emphasise to students that a problem can have several equally valid solutions.
- I'd like to support students in developing their literacy and numeracy skills through discussing ideas. [1]

Learning Outcomes:

As a result of studying this topic students will be able to:

- Calculate the next terms in a sequence
- Work out any particular term in a sequence
- Describe how to calculate the nth term in words

[1] This Lesson Proposal illustrates a number of strategies to support the implementation of Literacy and Numeracy for Learning and Life: the National Strategy to Improve Literacy and Numeracy among Children and Young People 2011-2020 (Department of Education & Skills 2011).

Background and Rationale

(a) What the students need to learn according to the syllabus;

4.1 Generating arithmetic expressions from repeating patterns.
Students should be able to:

- use tables to represent a repeating-pattern situation;
- generalise and explain patterns and relationships in words and numbers;
- write arithmetic expressions for particular terms in a sequence.

4.2 Representing situations with tables, diagrams and graphs.
Students should be able to:

- use tables, diagrams and graphs as tools for representing and analysing linear, quadratic and exponential patterns and relations (exponential relations limited to doubling and tripling);
- develop and use their own generalising strategies and ideas and consider those of others.

4.3 Finding formulae.
Students should be able to find the underlying formula written in words from which the data are derived (linear relations).

(b) Difficulties students have had in the past with the subject matter

Students struggle to reason algebraically. Often students' first introduction to algebra is in the application of skills e.g. a + a = 2a. By introducing algebra in such a way, without developing their ability to reason algebraically or understand the need for algebra, students resort to memorising rules without any understanding. This results in continued misapplication of these rules and disengagement throughout second-level algebra. We hope that by providing students with the opportunity to develop their algebraic reasoning skills, that they will see the need for algebra themselves, will be motivated to engage with it and will understand the rules of algebraic manipulation more deeply.

(c) The thematic focus of this lesson study, i.e. larger (see above in number 3 for ideas) goals the team will try to address, and why.

- I'd like to emphasise to students that a problem can have several equally valid solutions
- I'd like my students to appreciate that algebra is a tool for making sense of certain situations
- I'd like to foster my students to become independent learners

These were chosen as the thematic focus as they are all linked and direct towards students becoming successful learners. By our students appreciating that there are many ways to approach a problem they will be more motivated to attempt problems however they see fit with no apprehension. This lesson will help them to realise that algebra is just one more way to solve a mathematical problem. This can then lead to our students learning independently and having the confidence to do so.

Research
In preparation of this lesson plan the following materials have been used:

- www.ncca.ie National Council for Curriculum and Assessment (Maths Syllabus)
- Teejay Textbooks
- Textbooks for Junior Cycle

About the Unit and the Lesson

If a student can develop a firm understanding of linear patterns then they will be able to transfer the skills into many areas of the course. The applications of these skills are seen throughout algebra and co-ordinate geometry. The unit of work starts with basic number work, including types of numbers, moving to sequences and series before introducing the students to co-ordinate geometry and plotting lines.

This lesson was developed in line with the General Objectives as described in the Junior Certificate Syllabus:

A. They should have acquired relational understanding; that is, understanding of concepts and conceptual structures, so that they can:

• recognise patterns, relationships and structures.

B. They should be able to apply their knowledge of facts and skills; that is, when working in familiar types of context, they should be able to:

• translate information presented verbally into mathematical form;
• select and use appropriate mathematical formulae or techniques in order to process the information.

C. They should be able to analyse information, including information presented in cross curricular and unfamiliar contexts; hence, they should be able to:

• select appropriate strategies leading to the solution of problems;
• form simple mathematical models.

D. They should be able to create mathematics for themselves; that is, they should be able to:

• explore patterns;
• formulate conjectures;
• support, communicate and explain findings.

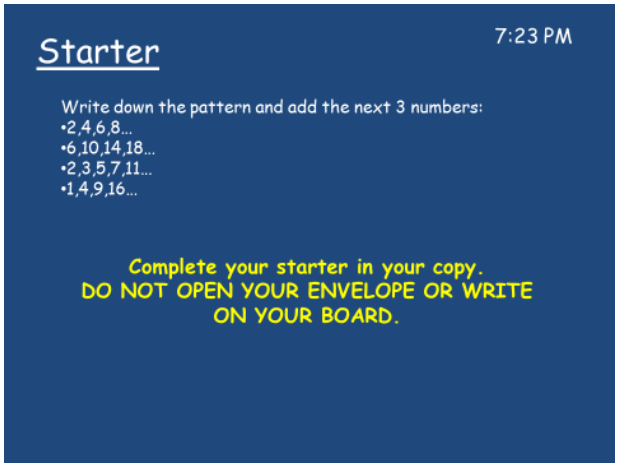
E. They should be able to communicate mathematics, both verbally and in written form; that is, they should be able to:

• describe and explain the mathematical procedures they undertake;
• explain findings and justify conclusions.

Flow of the Unit:

Lesson		# of lesson periods
1	Number systems: students learn about different types of numbers (inc. odd, even, square, prime, natural, integer, rational) and can add the next three terms to a sequence of numbers.	3 x 60 min.
2	The Great Hall: students continue patterns by considering input and output patterns. They continue the pattern using a variety of techniques and find ways to find larger outputs in the system.	1 x 60 min. **(research lesson)**
3	Linear patterns: students learn to find general term and practice constructing equations to describe patterns. They will use the equations to find the, e.g. 20^{th} term and also to find the input when given an output.	2 x 60 min.

Flow of the Lesson

Teaching Activity	Points of Consideration
1. Introduction Starter on patterns. Students will be given 4 patterns and asked to write down the next 3 numbers in each.  Students will be asked to explain how they were able to predict the next terms in each pattern.	By the end of this activity, students should appreciate that by understanding a pattern they are able to predict additional terms.
2. Posing the Task Hogwarts has bought new tables for the Great Hall. How many students can sit around 30 tables?	Students will start by making the next table using their props. When they have made the next table they can start attempting the main problem.

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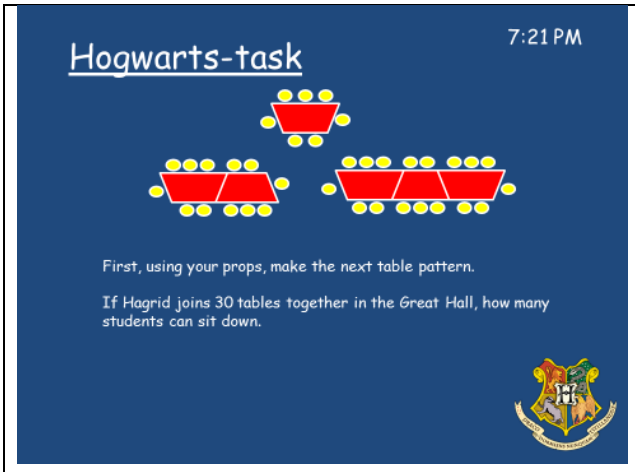
<tr>
<td> 
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<tr>
<td>3. Anticipated Student Responses

Multiply the first table by 30 (incorrect)
Use the props to build the entire structure
Draw out the 30 tables & count the number of students
Sum each table individually
Make a linear table & extend it
Draw a graph and extend it
Understand the pattern and use this to count the number of students (algebra)</td>
<td>Any student who makes an incorrect attempt will, most likely, have misunderstood that the tables must all join together and will have the problem re-explained.

Any student who finishes will be encouraged to find another method for solving the problem.</td>
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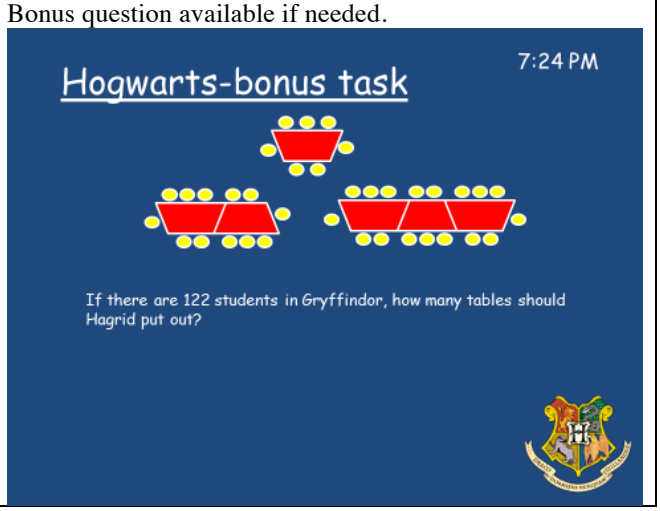
<tr>
<td>4. Comparing and Discussing
Bring one student up for each response (in order above).</td>
<td>During the discussion we will focus on the idea that there are many ways to solve a problem and all give the same answer. Students will benefit from explaining their methods to the class. We will spend most time considering the algebraic solutions as ultimately this is what we want</td>
</tr>
<tr>
<td>5. Summing up

There are many approaches to solving problems. All approaches are valid in that they all give us the same correct answer. The approach based on understanding the pattern is really useful as it allows us to predict any term in the pattern.</td>
<td>Bonus question available if needed.
 
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Evaluation

- What is your plan for observing students?

A seating plan for every teacher.
One teacher plus three observers (around 6/8 students per observer).

- Discuss logistical issues such as who will observe, what will be observed, how to record data, etc.

Room will be quartered to split the students among the observers.
A table will be provided for observers to fill in for each heading.

- What observational strategies will you use (e.g., notes related to lesson plan, questions they ask,)?

Names of students who approached the problem in each way will be written into the table.
Any questions from students to be recorded on the seating plan beside their name.

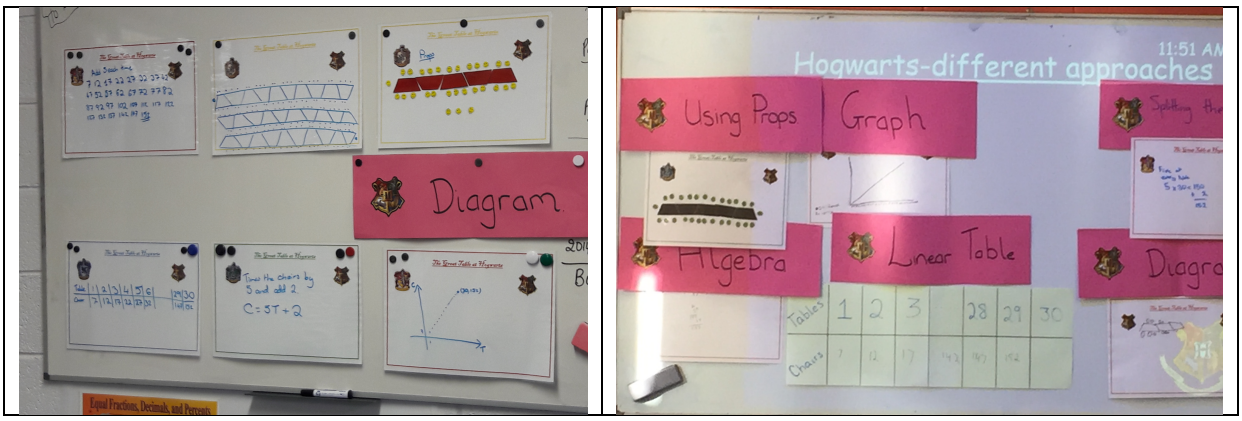
- What types of student thinking and behaviour will observers focus on?

Observers will look for all approaches from students, with a focus on any unusual methods.
Observers will look for common mistakes, common misunderstandings and common approaches.

- What additional kinds of evidence will be collected (e.g., student work and performance related to the learning goal)?

Photos will be taken of student work as they attempt problems. Photos will also be taken of the board at the end to record students' work.

Board Plan



The first board shows a mock-up of what we expected to see. The second board is from my lesson.

Post-lesson reflection

- What are the major patterns and tendencies in the evidence? Discuss

Students tended to use all the resources given to them (despite not needing to for the first part of the task).
Students tended to start by using an algebraic method (multiplying and adding) which was unexpected.
Once students had an answer they tried to create ways to come up with that number rather than come up with different ways to solve the original problem.

- What are the key observations or representative examples of student learning and thinking?

Asking students to continue the pattern caused many of them problems and they tended to struggle with this. Most of them found it easier to jump straight into the problem.
We expected more of the students to draw/count than we observed.
The theme of the lesson seemed to help the flow and engaged the students more than a non-contextualised problem.

The second time the lesson was observed I spent more time explaining the two questions and there were no problems differentiating the two.

- What does the evidence suggest about student thinking such as their misconceptions, difficulties, confusion, insights, surprising ideas, etc.?

Some of the students needed some positive reinforcement in order to get started but were happy to continue their work after this.
Some of the students multiplied by 7 (the number of chairs around the first table) showing a misunderstanding of the problem.
We were both very surprised that one of the students used a graph to show his working.
Some students came up with a method involving counting the end tables as having 6 seating around them and the middle tables having 5 chairs.

- In what ways did students achieve or not achieve the learning goals?

The learning goals were achieved as all students appreciated that mathematics can be used to solve real world problems. They also learned how to use various methods to solve the same problem many times. The students were able to articulate their answers when asked to come to the board and demonstrated their learning through answering the ‘bonus question’ at the end.

- Based on your analysis, how would you change or revise the lesson?

Based on our analysis we would firstly miss out the next pattern problem and go straight to the main problem. We would also add in the new heading (Split the tables). I would

also spend longer explaining the ‘many methods’ in more detail or not mention it at all.

The second time the lesson was observed I spent more time explaining how to make the next pattern, added the new heading for splitting the tables and explained the ‘many methods’ in more detail.

- What are the implications for teaching in your field?

Through the process of planning the lesson we experienced how important it is to formulate a clear meaningful problem that allows students the opportunity to extend their knowledge and give an account of their work within a single lesson. We understand that problem solving involves engaging in a task for which the solution method is not known beforehand, getting stuck and unstuck and communicating methods/ solutions. During our lesson we were giving the students ownership of their own learning. They had the confidence to try strategies despite not knowing if they would work. We hope they can continue this.

The context has helped the students who are ‘predisposed’ to dislike algebra. It gave them the opportunity to access the problem through the Harry Potter context and engaged every student from the start of the lesson.

It remains to be seen if the experience of this lesson will help retain information regarding algebraic patterns and make dealing with abstract problems less daunting. However, we believe that this lesson gave students the chance to explore algebra and deepen their understanding of the process behind linear patterns. It also provided them with an opportunity to present their own methods in a positive and safe learning environment.

Appendix

In this appendix we are attaching some of the resources we used in the lesson.

a) The Sorting Hat

The Sorting Hat

Slytherin
Slytherin
Slytherin
Slytherin
Slytherin
Slytherin
Slytherin
Gryffindor
Gryffindor
Gryffindor
Gryffindor
Gryffindor
Gryffindor
Gryffindor
Hufflepuff
Hufflepuff
Hufflepuff
Hufflepuff
Hufflepuff
Hufflepuff
Hufflepuff
Ravenclaw

Ravenclaw
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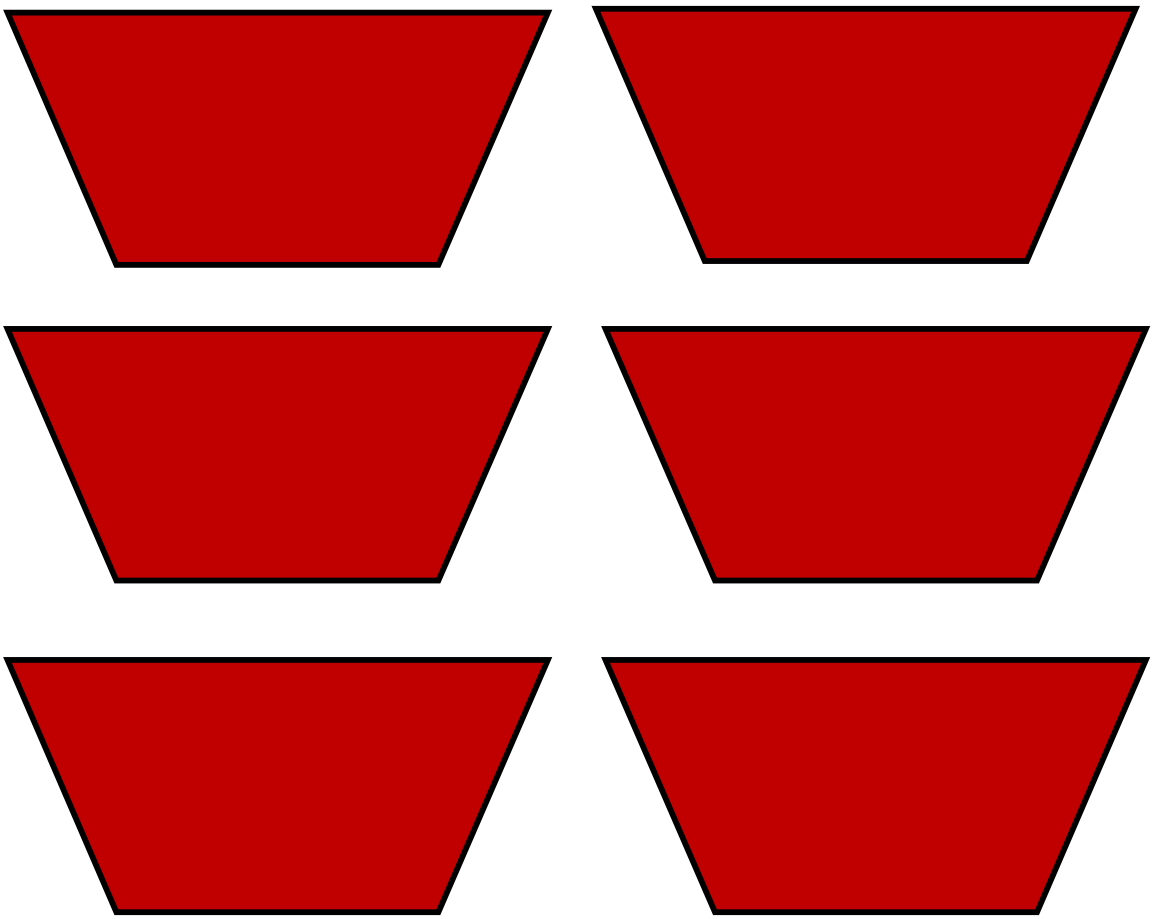
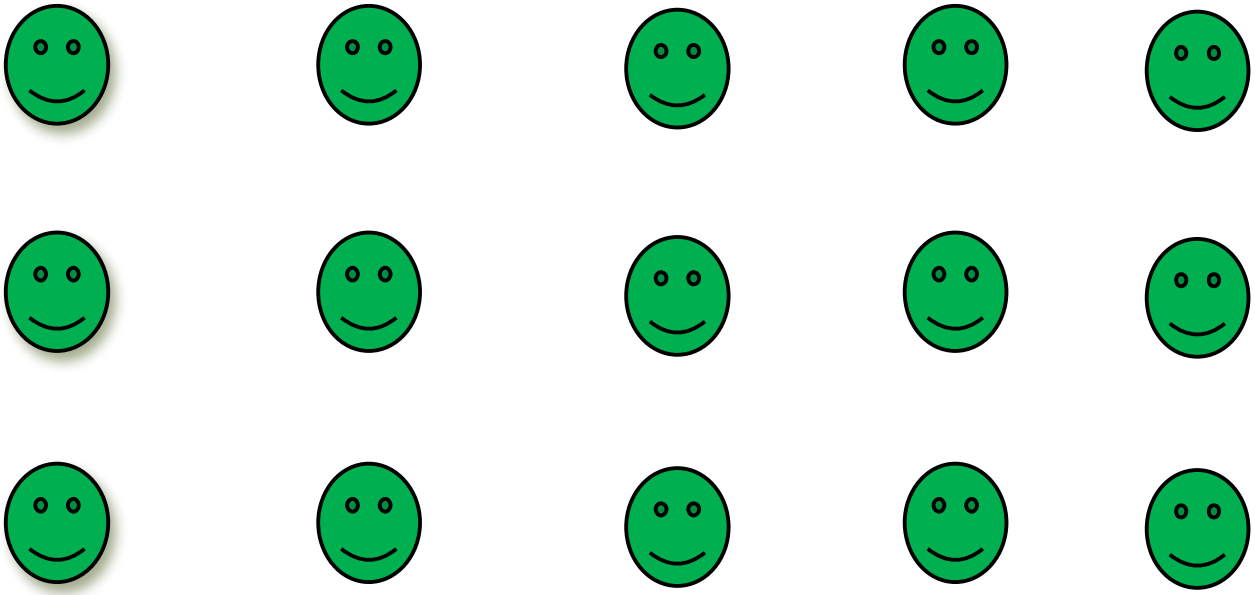
b) The Tables (red)



c) Smiley faces (green)



d) Whiteboards