Lesson Research Proposal for linear patterns

Date of lesson: 22/1/19
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Associate: Emma Tormey
Lesson developed by: Sarah Scully, Catherine McGinley, Louise Corrigan, Anne Brosnan

1. Title of the Lesson: straight to the n^{th} game.

2. Brief description of the lesson

Using a problem question to develop the general formula for a pattern

3. Research Theme

The teaching and learning goals set for this year by our Mathematics Department is the improvement of our students' learning and our teaching are as follows:

- To select and use assessment practices that progress students' learning
- Value and engage in professional development and collaboration

On a regular basis to achieve the above as a Mathematics Department we are going to:

Focus on the family of techniques from Assessment for Learning by using more in-between desk work when students are at work to assess students learning in real time and as far as possible note student's strategies, misconceptions etc. as the class progresses. We feel that by doing this we will gain a greater understanding of the general misconceptions, strengths and weaknesses of our students and address these in the following way:

- Encouraging our students to present and explain to their peers in class their various ideas/solutions. By making time for this, students will not only present but grow familiar with presenting at the board by saying "First I did this because……", "Next I did because…."
- Encourage students to actively listen to each other and make relationships, comparisons and differences in various methods presented leading to greater collaboration
- Encourage students to make explicit preferred ways to tackle a problem and why? Pay particular attention to our Boardwork so that the flow of the lesson can be seen by all students
- Support students' reflections on the lesson
- Concentrate on effective questioning

As a Mathematics Dept. we value our professional development and have decided to engage in Lesson Study as a means of greater collaboration. Developing a research lesson over 6 evening meetings is the key to unlocking this collaboration. In addition, when the research lesson is conducted we will invite all Mathematics teachers and management into our classroom to engage in the classroom observation and post-lesson discussion. We hope to invite a knowledgeable other to the research lesson.

4. Background & Rationale

We chose this topic as it is a good lead into algebra. Students have an instinctive sense of what a pattern is. However, turning this innate ability into something concrete can be difficult for them. When they have a good solid grasp of these concepts, the lead and connection into algebra is smooth and seamless. Students think that algebra is a magic formula and you need

to know a new language to understand it, rather than the idea that algebra is a generalization of a pattern.

When students are introduced to algebra through patterns they think that the algebra is just an extension of the patterns section. They do not have a preconceived misconception of what algebra is.

When students are introduced to algebra in isolation, students do not understand that the variable represents a quantity. They do not understand that algebra can be a generalization of a pattern, and used to predict outcomes.

5. Relationship of the Unit to the Syllabus

Related prior learning Outcomes	Learning outcomes for this unit	Related later learning outcomes
In primary school students learned to: Collect, organize and represent data. Use data sets to solve problems. Explore and discuss simple properties and rules. Translate word problems with a variable into number sentences Explore the concept of a variable in the context of simple patterns, tables and simple formulae and substitute values for variables	Use tables to represent a repeating pattern Generalize and explain patterns and relationships in words and numbers Write arithmetic expressions for particular terms in a sequence Find the underlying formula, written in words, from which the data is derived (linear relations) Recognize features of linear, quadratic and exponential patterns.	Appreciate that patterns can generate sequences of numbers or objects Investigate patterns among these sequences Use patterns to continue a sequence Generalize and explain patterns and relationships in algebraic form. Recognize if a pattern is arithmetic or geometric. Find the sum to n terms of an arithmetic series

6. Goals of the Unit

- Develop and understand ideas accurately and express them accurately.
- Students will use language and numbers to express and develop ideas.
- Students will explore and develop their ideas in groups learning to listen to others and present ideas in a meaningful way.
- Students will explore options and alternative ways of developing the question, thus learning creatively.
- Students will gain confidence in their abilities by exploring and deepening understanding while expressing knowledge to their group and the class.
- Students will have an opportunity to reflect on and evaluate their learning at the end of the lesson.

7. Unit Plan

Lesson	Brief overview of lessons in unit
1	Preparation lesson.
2	Research lesson
3	Introduction to sequences
4	First term, common difference and next three terms of a linear pattern
5	General term of a linear pattern and find the value of a given term
6	Non-linear patterns. Identify quadratic and exponential patterns
7	Problem solving with patterns.

8. Goals of the Research Lesson:

Looking at the goals of the research lesson itself from two perspectives:

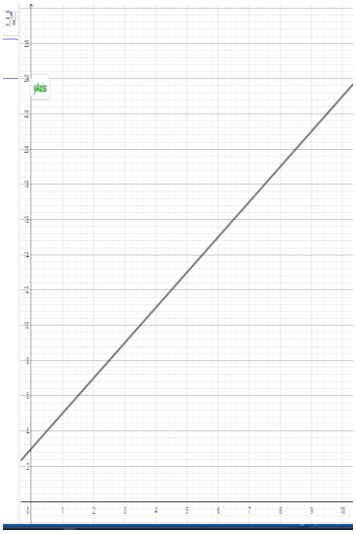
a. Identify a linear pattern, come up with a general term/ formula. Use this to predict future outcomes.
b. Recall and demonstrate understanding of the fundamental concepts and procedures of patterns
c. Apply appropriate procedures correctly and accurately.
d. Generate and evaluate mathematical arguments to support ideas.
e. Make connections between mathematics and the real world.
f. Make sense of a given problem and mathematise a situation.

9. Flow of the Preparation and Research Lessons:

Steps, Learning Activities Teacher's Questions and Expected Student Reactions	Teacher Support	Assessment
Take roll Students will be presented with the first part of the problem Johnny is 13 years of age and he wants to join an online gaming community because his friends say it's "cool". €3 is the joining fee for under 14's plus a subscription of €2 a month thereafter. His mother allows him to join on a trial basis for 10 months. Show how much this would cost in as many ways as you can. (5 minutes)	Students will be given a worksheet and allowed to work on the issue.	Students will be called to the board to explain what they have done
Student individual work	Method 1: €3+€2+€2+€2+€2+€2+€2+€2+€2+€2=€23 Method 2: €3+€2x10=€23 Method 3: Add on | total	

	€3	€3
	€2	€5
	€2	€7
	€2	€9
	€2	€11
	€2	€13
	€2	€15
	€2	€17
	€2	€19
	€2	€21
	€2	€23

Method 4:

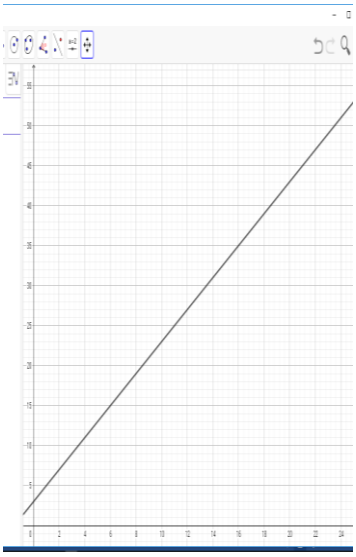
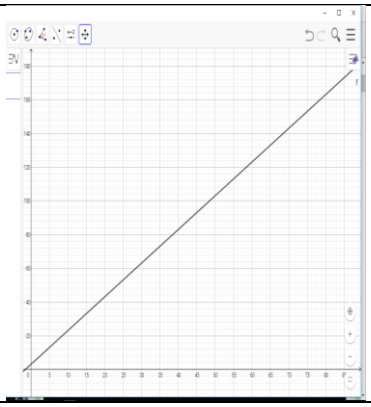


Ceardaíocht /Comparing and Discussing		Students will be called to the board to explain each of their methods. When one student explains a method a different student should be asked to reiterate the explanation. Students should be asked to explain things in their own words. For homework students will be asked to decide which is the most efficient way of doing the question, and why.

<table>
<tr><td>Second lesson</td><td></td><td></td></tr>
<tr><td>Take roll,
Check homework.

Students will be informed that teachers will not be available to assist with the problem, but no one will be called upon with an incorrect answer.
Explain that students can ignore the other teachers in the room.
(5 minutes)</td><td>Observing teachers will be spread out around the class room ready to watch.</td><td></td></tr>
<tr><td>Posing the task:
The teacher will explain that the question today is a continuation of the problem from yesterday.
Show how much this would cost, in as many ways as you can, if Johnny was to join for 2 years. This time you may not use arithmethic.

(5 minutes)</td><td>Students will be given the worksheets prepared.</td><td></td></tr>
<tr><td></td><td>Method 1:<table><tr><td>Add on</td><td>total</td></tr><tr><td>€3</td><td>€3</td></tr><tr><td>€2</td><td>€5</td></tr><tr><td>€2</td><td>€7</td></tr><tr><td>€2</td><td>€9</td></tr><tr><td>€2</td><td>€11</td></tr><tr><td>€2</td><td>€13</td></tr><tr><td>€2</td><td>€15</td></tr><tr><td>€2</td><td>€17</td></tr><tr><td>€2</td><td>€19</td></tr><tr><td>€2</td><td>€21</td></tr><tr><td>€2</td><td>€23</td></tr><tr><td>€2</td><td>€25</td></tr><tr><td>€2</td><td>€27</td></tr><tr><td>€2</td><td>€29</td></tr><tr><td>€2</td><td>€31</td></tr><tr><td>€2</td><td>€33</td></tr><tr><td>€2</td><td>€35</td></tr><tr><td>€2</td><td>€37</td></tr><tr><td>€2</td><td>€39</td></tr><tr><td>€2</td><td>€41</td></tr><tr><td>€2</td><td>€43</td></tr><tr><td>€2</td><td>€45</td></tr><tr><td>€2</td><td>€47</td></tr><tr><td>€2</td><td>€49</td></tr><tr><td>€2</td><td>€51</td></tr></table></td><td>While students are working on their answers the boardwork from yesterday’s class will be attached to the whiteboard, sot eh teacher can use this to illicit answers from the class.</td></tr>
</table>

	Method 2: 	
Ceardaíocht /Comparing and Discussing	Students are asked questions to lead them to explaining the relationships. If possible get a students to explain the relationship in a sentence and write it on the board.	The objective is to get students to identify: • The start number • The change and the value of the change Without feeding them the words.
Students will now be introduced to the third part of the question and shown the corresponding graph. If he remained a member until he is 21? How much would this cost overall?		This is done to illustrate to students that writing a table or drawing a graph may be too labourious .
Ceardaíocht	Going back to the previous work studetns will use only words to describe the relationships. Their sentences will be	

	written up and students should justify why they identify incorrect sentences as incorrect. Vocabulary for patterns will be introduced and show how to change the sentence into an algebraic expression.	
Summing up & Reflection	Students will be asked to fill in the student reflection sheets.	

10. Board Plan

Carefully plan the board work before the lesson takes place to decide on the order of the solutions and the links that will be made at the board. Put an image or a diagram of the pre-prepared board work here.

Board Plan

11. Evaluation

The lesson successfully promoted much student to student discussion. Throughout the whole class all groups involved themselves in discussions about how to successfully approach the problem. They discussed different starting points and results and how to achieve this.

The class was successfully lead to the understanding that they were working with a linear pattern. Students had an innate understanding of the constant difference and the end result, the teacher skillfully lead them to an explicit formal understanding of what they were doing, how to do it and the usefulness of the process.

Questioning in the Ceardaíocht showed how a class can be devised to include all students, allowing each to make a valid contribution to the learning process. Through continued patient repetition of questions, the teacher brought each one to a place where they know and understand a concept, without feeling that the process was difficult.

Student reflections showed that the class were eager and willing participants in the process.

They all enjoyed the class and felt that they had learned and were happy with the class. Student communication at desks and the board was clear and generally well explained.

12. Reflection

While lesson study allows students to approach and learn in a very deep way, the incredible benefit to participating teachers should not be overlooked. Working on the lesson development, particularly the Ceardaíocht, facilitates a change in teaching that has lasting benefits for all participants. We have the opportunity at each stage to reflect on different ways of achieving a successful lesson. Different approaches are analysed so that group discussion brings us to better understand our actions so that we can improve what we do.

Many hours were spent on choosing the wording of our question to illicit the desired responses from students. This continued right up to the week before the lesson until we were completely satisfied that students could understand and complete the work. We also considered how well this would allow for Ceardaíocht to further the learning so that the benefits of the lesson were continued even after the research lesson was completed.

Including a student reflection gives the students a voice in the process, other than just studied examples. Examining their reflections showed us how they felt about the work and process. Many students reported positive feelings about learning in this manner. They left the room confident in their abilities and achievements. They were all able to say something they had learned from a peer. The one thing we would change is that we would allow more time for the student reflection so that they could give us more feedback.