Lesson Research Proposal for Second Year Applied Arithmetic

1. Title of the Lesson: A Question of Money – Getting Value for Money

2. Brief description of the lesson
In this lesson students will try to solve a problem involving currency exchange set in a real life situation.

3. Research Theme
In Templemichael College, we want our students to
    (i)   engage purposefully in meaningful learning activities, and
    (ii)   grow as learners through respectful interaction and experiences that are challenging and supportive.
As a Maths Department, we actively support the achievement of these goals in the following ways:
    (i)   Collaboratively developing meaningful enriched tasks in which all students can engage with and achieve success.
    (ii)   Foster a positive respectful environment in our classrooms in which students feel at ease to participate fully.

4. Background & Rationale
This lesson is aimed at second year students. After discussion with colleagues it was decided that we would look at the area of Applied Arithmetic as it is a concrete life skill. It is also an area in which our students struggle. This topic fits in with our work plan for the year.

There are various methods employed to teach this topic including, beginning with the exchange rate on the board e.g. €1 - $1.18, students must know whether to multiply or divide to make the correct currency exchange. One teacher approaches this by placing the wanted currency underneath its corresponding currency e.g. Place €100 under €1 – in this case the students will multiply the number under the $ by 100. If the sum of money is in $ then students divide by 1.18 as it was placed under $ currency. Another teacher employs a similar method however gets students to predict whether the answer will be bigger or smaller (**Fig 1**). A third teacher implements a similar method, however places a ? under the wanted amount (**Fig 2**). As a group we felt that these methods were very procedural and did not promote understanding of the concept and did not fulfill the requirement of provided the students with a vital mathematical life skill.
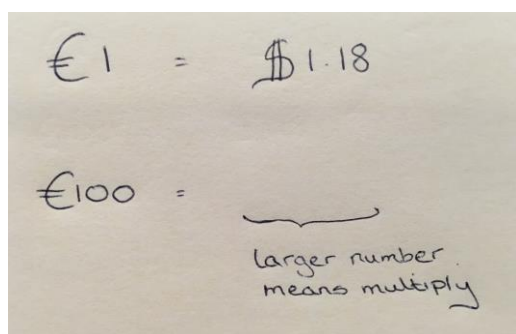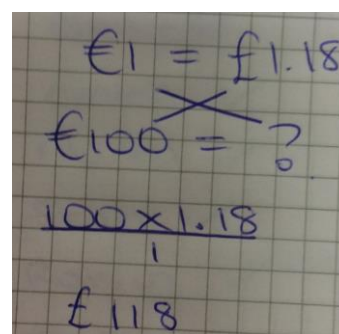

Fig. 1: *Currency Exchange Method 2*

Fig. 2: *Currency Exchange Method 3*

5. Relationship of the Unit to the Syllabus

Related prior learning Outcomes	Learning outcomes for this unit	Related later learning outcomes
In fifth class students should gain a greater understanding of money including topics such as pay per hour, shopping bills, comparing value for money. In sixth class students' progress to exploring value for money, VAT and discount, they should be able to identify and discuss exchange rates and convert sums of money between currencies. From primary school and first year students should be competent in multiplication, division, decimals, percentages and ratios.	In this section students will solve problems that involve finding profit or lost, % profit or loss (on the costs price), discount, % discount, selling price, compound interest for not more than three years, income tax (standard rate only), net pay (including other deductions of specified. amounts). In addition to this, students will solve problems involving mobile phone tariffs, currency transactions, shopping, VAT, ratio and meter readings.	In third year students at higher level will solve problems involving cost price, selling price, loss, discount, mark up, margin, compound interest, income tax, net pay and other deductions.

6. Goals of the Unit
- (a) Students will understand the concept of profit and loss.
- (b) Students will understand that profit/loss can be calculated as a percentage of cost price.
- (c) Students will apply their knowledge of percentages to calculate discounts.
- (d) Students will understand the importance of currency exchange in real life.
- (e) Students will use real life problems to gain an understanding of the concept of value for money.

7. Unit Plan

Lesson	Learning goal(s) and tasks
1	Percentage Profit and Loss, Selling Price • Gain an understanding of profit and loss • Differentiate between cost price and selling price • Find profit/loss by solving problems • Perform simple calculations involving percentage profit/loss
2	Percentage Profit and Loss, Selling Price • Build on previous knowledge and solve more complex problems involving percentage profit/loss. • Appropriate problem: o The student council decided to sell school jerseys for €40, they are making a profit of 25%. How much did each jersey cost the student council?

3	Discounts Allowed and Received
	• Gain an understanding of discount
	• Differentiate between discounts allowed and discounts received
	• Using real life examples, including different currencies, calculate a variety of discounts
4	Discounts Allowed and Received
	• By solving real life problems appreciate the concept of value for money
	• Appropriate problem:
	o SEC 2015 JCOL Paper 1: Question 3
5 The Research Lesson	*Introduce Currency Exchange*
	• Use a suitable problem to
	o Understand value for money calculations and judgments
	o Understand the concept of currency exchange
	o Apply currency exchange rates
6	Currency Exchange
	• Solve a variety of problems involving currency exchange

8. Goals of the Research Lesson:

The Goals of the lesson should refer to:

a) Mathematical Goals
- a) Understand value for money calculations and judgments
- b) Understand the concept of currency exchange
- c) Apply currency exchange rates

b) Key Skills and Statements of Learning

In the planning and design of this lesson the Junior Cycle Key Skills and Statements of Learning have been considered. This lesson will implement and promote JC Key Skills in the following ways:

1. Being Literate: Students will have the opportunity to express their ideas clearly and accurately.
2. Being Numerate: It will develop a positive disposition towards problem solving.
3. Managing Myself: Students will develop life skills in the form of recognizing and understanding value for money.
4. Staying Well: Students' confidence and positive disposition to learning will be promoted.
5. Communicating: Students will present and discuss their mathematical thinking.
6. Being Creative: Students' will explore options and alternatives as they actively participate in the construction of knowledge.
7. Working with Others: Students will learn with and from each other.
8. Managing information and thinking: Students will be encouraged to think creatively and critically.

This lesson is also designed to meet the following JC Statements of Learning in particular:

1. The student communicates effectively using a variety of means in a range of contexts.
9. The student understands the origins and impacts of social, economic, and environmental aspects of the world around him/her.
10. The student has the awareness, knowledge, skills, values and motivation to live sustainability.
14. The student makes informed financial decisions and develops good consumer skills.
15. The student recognises the potential uses of mathematical knowledge, skills and understanding in all areas of learning.
17. The students devises and evaluates strategies for investigating and solving problems using mathematical knowledge, reasoning and skills.

9. Flow of the Research Lesson:

Steps, Learning Activities Teacher's Questions and Expected Student Reactions	Teacher Support	Assessment
Introduction Learning Intention - Today we are going to work independently (on your own) to solve the following problem. - Remember that not all countries use the same currency.	*Possible Questions:* What currency do we use? What currency do they use in Poland? *(Polish Zloti)* What currency do they use in the UK?	To reaffirm previous knowledge.
Posing the Task 'George is buying a t-shirt for his uncle's birthday. The t-shirt costs €25 in Spirit Clothing. Before he buys it, he does an online search for the same t-shirt. He finds it on Asos (a UK website) for £20 including postage. George wants to get the best value for money, if €1 = £0.75 show the different ways that George can work it out.' **Clarifying the Problem** *Are there any words on the board that you don't understand?* *What are we trying to figure out?* *Which do you think will be better value?* *What is your prediction and why?* <u>*Don't forget to try to solve it as many ways as you can.*</u>	Problem to be projected onto board, also printed on handout for each student. 'George is buying a t-shirt for his uncle's birthday. The t-shirt costs €25 in Spirit Clothing. Before he buys it, he does an online search for the same t-shirt. He finds it on Asos (a UK website) for £20 including postage. George wants to get the best value for money, if €1 = £0.75 show the different ways that George can work it out.' Worksheets, Props (cash), Show Me (A3) Boards to be distributed to students.	Do students understand the task? Are students willing and eager to participate?
Student Individual Work *Response 1* - Currency Matching using coins provided with scaffolded worksheet for some students (students continue to match each €1 for £0.75. *Response 2* - Drawing a Table – up to €25 = or £20 *Response 3* - Currency Matching by Grouping – students let €2 = £1.50 and continue pattern *Response 4* - Students multiply £0.75 by 25	Worksheet – Two options (**Fig. 3 and 4**) Students will match each €1 to £0.75, 25 times and total the currencies. Matching currencies in table format. Students tabulate data. Encourage students who go straight to response 4 to come up with other ways of solving the problem.	Are all students able to make a step in the right direction? Are students looking at alternative ways of solving the problem?

Ceardaíocht/Comparing and Discussing

- *Response 1 – Match Up*
- Currency Matching using coins provided with scaffolded worksheet for some students (students continue to match each €1 for £0.75.
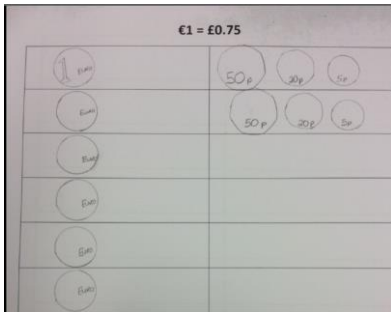
€1 = £0.75

- *Response 2 – Draw a Table*
- Drawing a Table – up to €25 = or £20

€1 = £0.75	
€1	£0.75
€2	£1.50
€3	£2.25
€4	£3.00
€5	£3.75
€6	£4.50
€7	£5.25
€8	£6.00
€9	£6.75
€10	£7.50
€11	£8.25
€12	£9.00
€13	£9.75
€14	£10.50
€15	£11.25
€16	£12.00
€17	£12.75
€18	£13.50
€19	£14.25
€20	£15.00
€21	£15.75
€22	£16.50
€23	£17.25
€24	£18.00
€25	£18.75

- *Response 3 - Grouping*
- Currency Matching by Grouping – students let €2 = £1.50 and continue pattern

€1 = £0.75	
€2	£1.50
€4	£3
€6	£4.50
€8	£6
€10	£7.50
€12	£9
€14	£10.50
€16	£12
€18	£13.50
€20	£15
€22	£16.50
€24	£18
€25	£18.75

Students will come to the board in order with responses and give their reasoning.
Ensure that when a student comes to the board to present work that their name is attached to it.

Possible Questions for each Response:
Did anybody else use this approach?
Did this match your prediction?

Discussion for each Response (after Boardwork is complete):
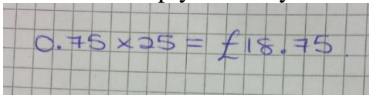
Why does this work?
Do you think this the most effective way of solving the problem? Why?

Can students explain their approach and why it works?

Can students follow the approaches being presented?

Do students recognise similarities/differences between their approach and the approach presented on the board?

Are students confident in their presentations?

• *Response 4 - Multiplication* • Students multiply £0.75 by 25 0.75 × 25 = £18.75	Discussion of Response 4: *Can someone explain what multiplication is?* *Why does it work here?* *Is multiplication the most effective way of solving the problem? Why?* <u>Possible further discussion:</u> *The answer in £ is a smaller number than the answer in € - even when we multiplied, did you expect that?* *Why is the number smaller?*	*If a student cannot explain why Response 4 works, get them to revisit Response 2 and examine the similarities.*
Summing up & Reflection Extension Task 'If the t-shirt was reduced from €25 to €22.50 in Spirit and reduced to £17 on Asos, use one of the methods on the board to decide which would be better value for money?' **Summing Up** Today we demonstrated that there are many ways to solve a mathematical problem, problem solving is a key skill in our maths tool box. Some solutions can be long, some may be short. You must also remember to revisit problems and check if you are using the most efficient method. Homework Task 'The following week George goes into Spirit Clothing to buy the t-shirt but they are all sold out. He now decides to buy the top from Asos at £20. If the exchange rate stays the same €1 = £0.75 how much in euro will be taken from his bank account?'	<u>*Extension Task:*</u> *What method did you use?* *Why did you use this method?* *What was the most efficient method?* <u>*Homework*</u> *We multiplied to solve the first problem, if we had to solve this problem by converting Sterling to Euro using the same exchange rate is there any way I could do this?*	

€1 = £0.75	

Fig. 3: *Scaffolded Worksheet*

€1 = £0.75	

Fig. 4: *Non-scaffolded Worksheet*

10. Board Plan

'George is buying a t-shirt for his uncle's birthday. The t-shirt costs €25 in Spirit Clothing. Before he buys it, he does an online search for the same t-shirt. He finds it on Asos (a UK website) for £20 including postage. George wants to get the best value for money, if €1 = £0.75 show the different ways that George can work it out.'

- Response 1
- Match Up

- Response 2
- Draw a Table

- Response 3
- Grouping

€1 = £0.75

- Response 4
- Multiplication

0.75×25 = £18.75

- Extension Task
- 'If the t-shirt was reduced from €25 to €22.50 in Spirit and reduced to £17 on Asos, use one of the methods on the board to decide which would be better value for money?'

Homework Task

'The following week George goes into Spirit Clothing to buy the t-shirt but they are all sold out. He now decides to buy the top from Asos at £20. If the exchange rate stays the same €1 = £0.75 how much in euro will be taken from his bank account?'

11. Evaluation

The lesson was evaluated using the following question and with the Research Theme and Goals of the Lesson in mind:

'Did the students engage and achieve success in the lesson, by participating fully in a respectful manner?'

In order to effectively observe the lesson each observer was assigned a group of students to observe in the pre lesson meeting. The classroom was divided into different zones and observers were allocated to each zone. Positions of the observers were allocated based on ease of access to the students and for minimal distraction to students. There were five observers in the room.

All observers had a copy of the seating plan, clipboard, paper, copy of the research lesson and an iPad. Some observers opted to use the LessonNote app while most relied on pen and paper to record the data.

Students were observed and notes were taken on approaches to solving the problem, questions asked, any misconceptions students had, student/student, teacher/student and student/teacher interactions. Photographs were taken of students' work on the iPads.

During the post lesson discussion, data collected during the lesson allowed for discussion on the following areas:
- methods used to solve the problem;
- comments/questions and answers the students had;
- common misconceptions; how and when in the lesson were these dealt with;
- when and how did the understanding change;
- did the activities in the lesson support the goals of the lesson?

12. Reflection

Throughout the lesson the students fully participated in a respectful manner, they engaged with all tasks posed to them and all students achieved some level of success.

In addition to this, observers used the Mathematical Goals of the lesson and the demonstration of the Junior Certificate Award Key Skills in the evaluation of this lesson.
By the end of the lesson students had a better understanding of value for money calculations and judgments and also the process of currency exchange. Throughout the lesson students demonstrated their literacy and numeracy skills, they managed their time, communicated and worked well with others and were also creative with their solutions.

During the introduction of the lesson students clearly demonstrated knowledge of value for money, different currencies and also internet purchasing. The original group observed are known to be able to work independently but prefer to work in groups.

Most of the Higher Level students initially gravitated to Response 4 immediately (Multiplication) **(Fig.8)**, while some students opted for Response 2 (Draw a Table – Repeated Addition) **(Fig. 6)**. Students were refocused during their Individual Work, this was beneficial as it encouraged and reminded students to focus on solving the problem in multiple ways. Originally students who multiplied first were reluctant to attempt other methods prior to this. One student noted within his group that because 0.75 was less than 1, then, online was better value, but didn't voice his opinion to

the whole class. Students who struggled initially used Response 2 once students were refocused. There were various methods of Grouping employed **(Fig 7)**. Some students who employed Grouping as a method made 3 groups of €8, and then added €1, as they viewed it as easier. Some students did use a trial and improvement method – multiplication and division, and used the exchange rate to decide which solution was correct, this response had not been anticipated by the group. During a period of discussion where one student was using repeated addition another student pointed out to him that it was *'just a long way of multiplying'*. During Ceardaíocht students did point out that Response 1 **(Fig 5),** in particular, and Response 2 *'took too long'*. It was noted in our discussion that while most students achieved at least one mathematical answer to the problem, no student stated in their work that Asos was the better value.
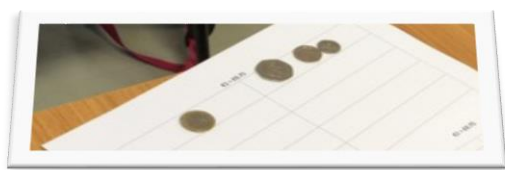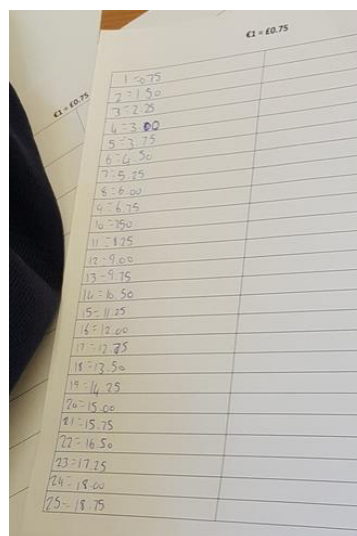

Fig 5: *Response 1 – Currency Matching*

Fig 6: *Response 2 – Draw a Table (Repeated Addition)*
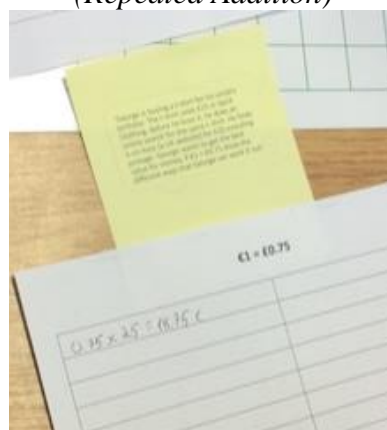

Fig 7: *Response 3 – Grouping*

Fig 10: *Response 4 - Multiplication*

Student learning was evident throughout the lesson, in particular during Ceardaíocht. Evidence of this was provided by their completion of the Extension Task. All except one student opted to use multiplication to solve the problem. Another student went further and converted the sterling to euro by division to find the 17 in Euro.

There was evidence of misconceptions in the lesson:
- If €1 = £0.75 then £1.25 = €1.
  - The teacher prompted her individually to use the Grouping response to see if her method worked.

- Use of Division
  - The teacher also prompted the use of Response 3 to these students.
- Things are always cheaper online.
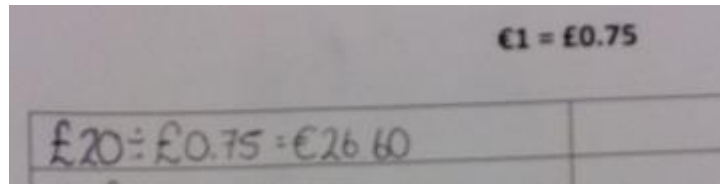 - This was clarified during the Extension Task.

Fig 11: *Common Misconception – Use of Division*

In future, with a strong group, the students could be prompted by encouraging them to think about how someone else (e.g. in primary school) might solve the problem. It was felt that the A3 Show Me Boards were problematic as students were tempted to erase their answer if they felt it was incorrect or if it didn't match their neighbours, if this lesson was repeated they could be omitted from the resources. For Currency Matching/Match Up, especially with a weaker group, one set of coins would not be enough, the students may need enough coins (or print outs) to complete the currency exchange.

In the next class, the students will need to revisit Response 3 in order to convert Sterling to Euro.

This lesson would be better suited to a 60 minute lesson, to allow for the Ceardaíocht of the Extension Task. A longer lesson would allow for a deeper discussion and also allow in depth analysis of questions such as '*The answer in £ is a smaller number than the answer in € - even when we multiplied, did you expect that? Why is the number smaller?*' A student had used that as his reasoning for his correct answer after completing the problem by trial and improvement, but there was no chance to explore if he understood why this was the case. With a shorter class (40 minutes) the extension task could be given as the Homework Task.
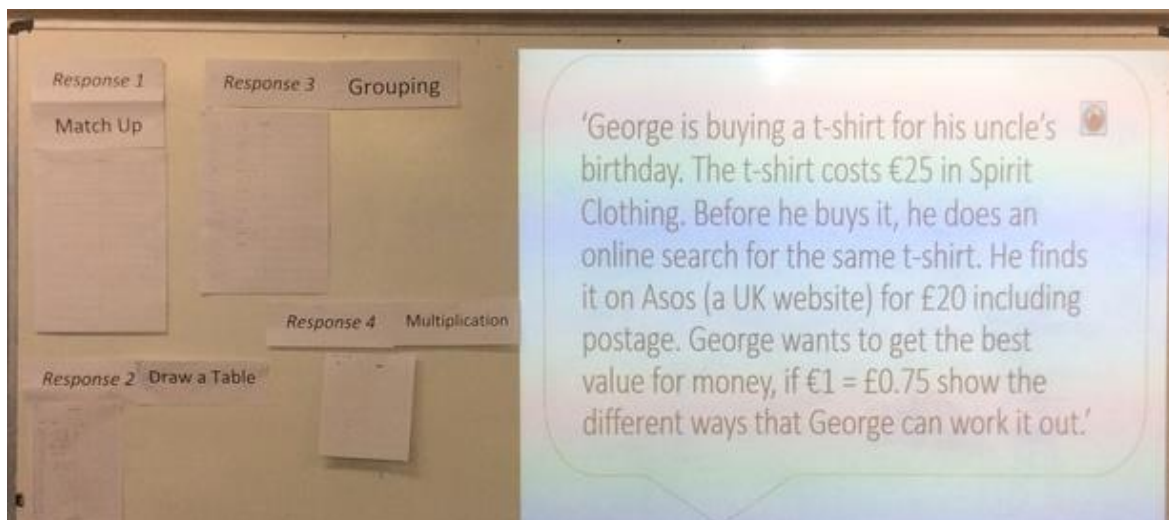

Fig. 12: *Final Boardwork*

We felt that there were many benefits to participating in Lesson Study. Firstly it enabled us to gain a better insight into methods of incorporating problem solving into our lessons. It allowed us to work collaboratively and delve deeper into the thought process our students have, when tasked with a problem. It allowed us to experiment with problem solving in our classrooms in a focused environment. It delivered excellent positive results with a high level of teacher satisfaction after seeing the lesson come into fruition.