

Lesson Research Proposal for 2017-Applied Arithmetic

For the lesson on 17-01-2018

At St Joseph's Community School, Charlestown Co. Mayo.

St Louis Community School, Kiltimagh, Co. Mayo

Ms Maggie Tighe's Third year higher level Maths

Associate: Lynn Anderson

Lesson plan developed by: Maggie Tighe, Sinead Mahon and Julie Ryan

Dining out! Who gets your money?

Brief description of Lesson:

In this lesson students will complete a problem to find out how much a meal costs before tax is added by finishing this question they will have identified the cost of the meal before tax and the cost of the meal inclusive of tax.

Research Theme

At St Joseph's Community School, Charlestown we want our Students to:

- grow as learners through respectful interactions and experiences that are challenging and supportive
- enjoy their learning, feel motivated to learn, and expect to achieve as learners.

Through discussion and from our teaching experience, we find that students have difficulty solving problems that require working backwards with percentages, especially when tax has been included.

The maths department in St Joseph's Community School, Charlestown use fractions and decimals to calculate percentages with varying approaches. Currently there is collaboration among all the subject departments to calculate exam percentages using fractions.

In our teaching we try to ensure that:

- Relationships and interactions in classrooms and learning areas create and sustain a cooperative, affirming and productive learning environment
- Students contribute their opinions and experiences to class discussion with confidence
- They ask questions and suggest possible solutions very confidently. They are willing to risk incorrect responses, and understand the value of making mistakes, using them as learning opportunities.
- They demonstrate a high level of motivation, and enjoy engaging and persisting with increasingly challenging work.

Background & Rationale

Based on our experience and according to the chief examiners report there are issues with student comprehension in this topic. We have decided to conduct research to seek a solution to this teaching/learning problem. We find that students do not link the problems posed in the classroom to real-life experiences. Sometimes students do not think logically about their answers and this is evident by the way the solutions given by students.

Relationship of the Unit to the Syllabus

Related prior learning Outcomes	Learning outcomes for this unit	Related later learning outcomes
<p>In fifth class, the child should be enabled to</p> <ul style="list-style-type: none"> • develop an understanding of simple percentages and relate them to fractions and decimals express percentages as fractions and as decimals, and vice versa calculate simple percentages, e.g. 50%, 25% 10% • compare and order fractions and decimals explore, compare and record using concrete materials and money order diagrammatically or on the number line • solve problems involving operations with whole numbers, fractions, decimals and simple percentages use diagrams; estimate and compute answers with a calculator include simple discount and increase examples 	<ul style="list-style-type: none"> – solve problems that involve finding profit or loss, % profit or loss (on the cost price), discount, % discount, selling price, compound interest for not more than 3 years, income tax (standard rate only), net pay (including other deductions of specified amounts) – solve problems that involve cost price, selling price, loss, discount, mark up (profit as a % of cost price), margin (profit as a % of selling price) compound interest, income tax and net pay (including other deductions) 	<ul style="list-style-type: none"> – check a result by considering whether it is of the right order of magnitude and by working the problem backwards; round off a result – accumulate error (by addition or subtraction only) – make and justify estimates and approximations of calculations; calculate percentage error and tolerance – calculate average rates of change (with respect to time) – solve problems that involve <ul style="list-style-type: none"> • calculating cost price, selling price, loss, discount, mark up (profit as a % of cost price), margin (profit as a % of selling price) • compound interest, depreciation (reducing balance method), income tax and net pay (including other deductions) • costing: materials, labour and wastage • metric system; change of units; everyday imperial units (conversion factors provided for imperial units) – make estimates of measures in the physical world around them <p>use present value when solving problems involving loan repayments and investments</p>

<p>10% off all jeans, 20% extra free.</p> <p>6th Class.</p> <p>The child should be enabled to</p> <ul style="list-style-type: none"> • use percentages and relate them to fractions and decimals <p>express quantities as percentages</p> <ul style="list-style-type: none"> • compare and order percentages of numbers • solve problems relating to profit and loss, discount, VAT, interest, increases, decreases. <p>In first year Students should be able to:</p> <ul style="list-style-type: none"> • convert between percentages, fractions and decimals • Express a quantity as a fraction of another • Increase/decrease by a given percentage 		
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Students will:

- Solve problems involving percentages
- Calculate solutions to problems and link the information to real-life situations
- Analyse their solution and determine that it is appropriate in the context of the question
- Understand VAT is a tax charged by the government to fund other services
- Understand the breakdown of a receipt of a meal
- Solve problems that involve finding the original cost before VAT has been included
- Critically analyse an incorrect solution to a problem and explain why the method used was incorrect

Goals of the Unit

The variety of ways to present percentages can cause a problem with student understanding and linking to prior knowledge.

Students will be able to apply their prior knowledge of percentages to solve real life problems

Students will be able to link the problems to real-life context

Students will be able to make realistic justifications with money calculations

Unit Plan

Lesson	Learning goal(s) and tasks
1	Students will be able to solve problems that involve percentages: <ul style="list-style-type: none">• VAT-finding the price including VAT• profit and loss
2 RESEARCH LESSON	Students will be able to solve problems that involve finding the original price before VAT has been included. Problem One: The price of a meal for eight people in a restaurant is €264 after VAT of 20% is included. Find the price of the meal before VAT is added. Problem Two: A meal in a restaurant costs Jerry €30.52. The price included VAT at 9% Jerry wanted to know the price of the meal before the VAT was included he calculated 9% of €30.52 and subtracted from the cost of the meal. Explain why Jerry will not get the correct answer using this method.
3	Students will be able to solve problems that involve cost price, selling price and discounts
4	Students will be able to solve problems that involve income tax and net pay including deductions.
5	Students will be able to solve problems that involve mark-up and margins
6	Students will be able to solve problems the involve compound interest

3. Goals of the Research Lesson:

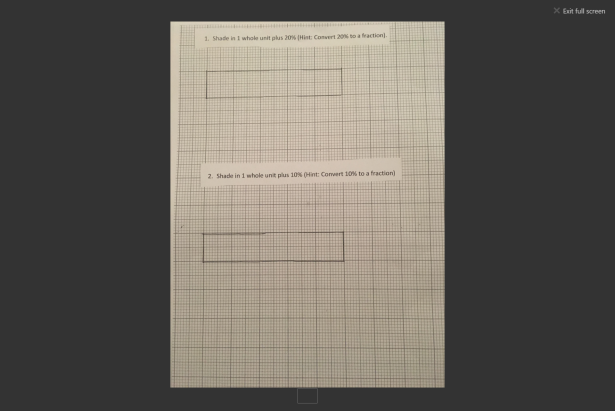
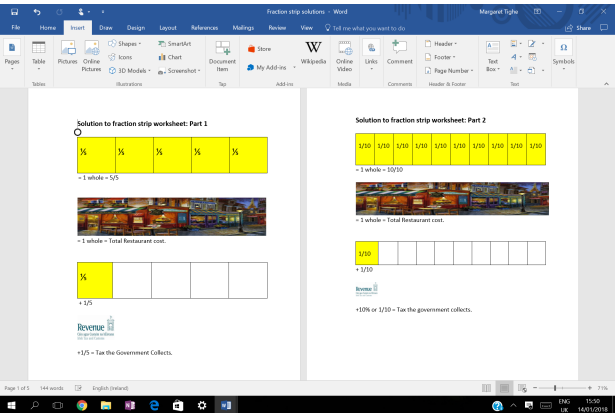
Students will be able to:

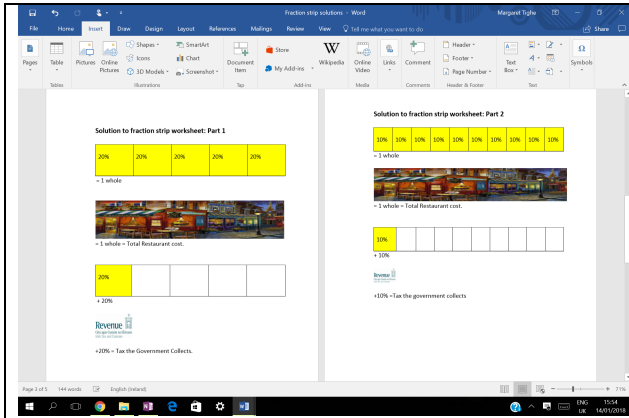
- Understand how to use percentages to solve more challenging VAT problems eg identifying the percentage of the bill given when VAT is included.
- Develop strategies for solving difficult VAT problems
- Reflect on their learning through problem number two

Key Skills to be developed during lesson:

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: Student's will have the opportunity to reflect on their own learning.
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. Reflecting on and evaluating their learning.
8. Managing information and thinking: Students will be encouraged to think creatively and critically.

4. Flow of the Research Lesson:

Steps, Learning Activities Teacher's Questions and Expected Student Reactions	Teacher Support	Assessment
<p>Introduction</p> <p>Students will enter class at the start of the lesson and immediately complete a worksheet that is already on their desk. This worksheet will be based on fraction strips (2 min)</p>  <p>Class discussion on solutions to the worksheet and VAT (3 min)</p> 		<p>This introduction will allow the teacher to formatively assess what students may need clarification on prior to the posing of the task.</p> <p>It is also the opportunity to revisit number and reinforce previous topic.</p>



Posing the Task

Students will work on the problem individually
On task: (10 min)

Problem One:

The price of a meal for eight people in a restaurant is €264 after VAT of 20% is included. Find the price of the meal before VAT is added.

Problem will be handed out to students on a handout.
All students will be encouraged to solve this problem using a number of different approaches.

Student Individual Work

Method One:

Fraction Strips

44	20%	44	20%	44	20%	44	20%	44	20%
44	20%								

$$120\% = 100\% + 20\%$$

6 equal parts

$$\text{Bill before VAT} = 44 + 44 + 44 + 44 + 44 = 220\text{euro}$$

Method Two:

Fractions

$$100\% + 20\% = 120\%$$

$$120\% = 6/5$$

$$\Rightarrow 6/5 = 264 \text{ euro} \dots \text{Divide by } 5$$

$$\Rightarrow 1/5 = 44 \text{ euro} \dots \text{multiply by } 5$$

$$\Rightarrow \text{Bill before VAT} = 5 \times 44 = 220 \text{ euro}$$

Method Three:

Fractions Strips Advanced

44	44	44	44	44	44
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-----COST----- *****VAT**

-----220euro ----- *****44euro**

Method Four:

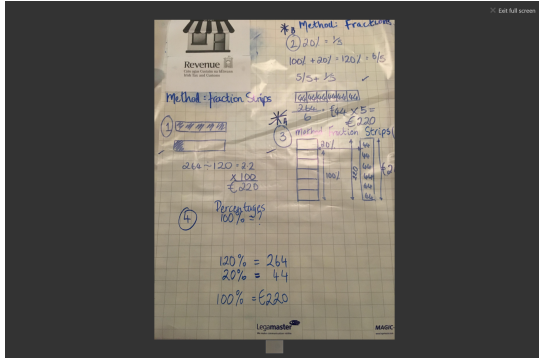
Percentages Method One

$$100\% = ?$$

Expected student responses:

- If a student is struggling to make a start on the task: Teacher will make reference to fraction strips as used in the activity earlier in the lesson.
- If a student has completed the task early: Teacher will instruct the student to try an alternative method.
- Reference will be made to any incorrect solutions in the Ceardaíocht
- If any student should use method five, Percentages Advanced, teacher will address this in the next lesson

120% = 264 euros
 20% = 44 euros
 100% = 220 euros



Method Five:

(i) Percentages Method Two

100% = ?
 120% = 264 euros
 $1\% = 264/120 = 2.20$ euros
 100% = 220 euros

(ii) Percentages Advanced

This approach is used by many Business Studies teachers and maybe used by students who are taking this subject.

$1.2 \Rightarrow 264$ euros
 $1 \Rightarrow 264/1.2 = 220$ euros

This approach will not be used if no students work lends itself to its development, as it is a more challenging approach for this group but it is very useful as it does link to Compound Interest and further areas of Arithmetic.

<p>Ceardaíocht /Comparing and Discussing(15 mins)</p> <p>The Ceardaíocht is based on all the possible solutions and will lead all learning toward the percentage approach of calculating 1% and then finding the appropriate amount. It was decided to take this direction as this method can be applied to the calculation of any percentage, therefore it is useful for other problems. Also the group like the efficiency of the method and the fact that it reinforces the idea of equal parts.</p> <p>Drawing from the methods in the previous section,</p> <ul style="list-style-type: none"> • Method One: Fraction Strips • Method Two: Fractions • Method Three: Fractions Strips Advanced • Method Four: Percentages Method One • Method Five: <p>(i) Percentages Method Two (ii) Percentages Advanced</p>	<p>After thorough discussion around all the methodologies and the time constraints of this class, in order to achieve all the goals set. It was decided that the teacher will focus on three particular methods that consolidate learning and lead to the reinforcement of the final method.</p> <p>Method One: Fraction Strips</p> <p>Method Two: Fractions</p> <p>Method Four: Percentages Method One</p>	<p>Students will present their solutions to the class and write this method on the board.</p> <p>If it is unclear what strategy was used the teacher will ask the student to re state their explanation or will ask if any of their peers could explain to her, allowing the opportunity for deeper learning and peer learning.</p>
<p>Summing up & Reflection(5 min)</p> <p>Students will complete problem two for homework. This is a reflective task based on the learning from the lesson. This is a previous Junior Cert Higher level exam question getting students to verbalise their learning from the lesson.</p> <p>Teacher will assign students their homework and explain to students what will be expected of them to complete it. The teacher will primarily recap on the fact that the cost before VAT has been added is 100% and after VAT has been added on, the total cost represents more than 100%. Students will also be reminded to check that their answers make sense in the context of the question that they are answering.</p>		

5. Board Plan

Task One:

Method One: Fraction Strips

44 20%	44 20%	44 20%	44 20%	44 20%
44 20%				

$120\% = 100\% + 20\%$... 6 equal parts

Bill before VAT = $44 + 44 + 44 + 44 + 44 = 220$ euro

Method Two: Fractions

$100\% + 20\% = 120\%$

$120\% = 6/5$

⇒ $6/5 = 264$ euro Divide by 5

⇒ $1/5 = 44$ euro multiply by 5

⇒ Bill before VAT = $5 \times 44 = 220$ euro

Method Five: Percentages Method Two

$100\% = ?$

$120\% = 264$ euros

$1\% = 264/120 = 2.20$ euros

$100\% = 220$ euros

Posing the Task: *WHO GETS YOUR MONEY?*

The price of a meal for eight people in a restaurant is €264 after VAT of 20% is included.

Find the price of the meal before VAT is added.

Discussion of Task 2: The Homework

Reflection: Did you learn anything today?

Some of you didn't get the correct answer initially, would any of you like to share how you knew your answer was incorrect and how did you fix them?

Task 2: A meal in a restaurant costs Jerry €30.52. The price included VAT at 9% Jerry wanted to know the price of the meal before the VAT was included he calculated 9% of €30.52 and subtracted from the cost of the meal. Explain why Jerry will not get the correct answer using this method.

Evaluation of the research lesson:

The main focus of the evaluation of this lesson is on student engagement with the task and student achievement of the goals of the lesson.

The observers will record students work and conversations that occur as a result of the task set. The group will use an observation sheet which will be used to gather evidence on how students engaged with the research theme, what key skills the students used when completing the task and also record whether the students achieved the goals of the lesson (see Appendix for Observation sheet).

Teachers will also record any misconceptions students had, identify students who had difficulty understanding the problem and students who self-corrected.

Reflection (from Post Lesson Discussion notes):



Board work from Research Lesson

Each of the observers found the lesson to be a positive learning experience and enjoyed the observation. The observers commended the teacher on her delivery of the lesson, her words of encouragement to students and the way she facilitated the lesson.

The teacher that taught the lesson started the feedback session. Overall she was happy with how the lesson went and how students engaged with the task. She noted that two students were absent due to adverse weather conditions and unfortunately this made the group quite small. She felt that the students enjoyed the topic even though they found it difficult. It was a very positive learning experience for the students with some students self-correcting their work with probing from their teacher. The teacher felt that when students came up to the board to show their solutions she should have encouraged them to explain their workings in more detail to the class. She also felt that she could have spent more time discussing the task given for homework. It was noted during the lesson that upon reflection a student recognised why her solution was incorrect and verbalised this to the class. This was a very positive moment during the lesson as it showed good understanding of the subject matter and showed that the goals of the lesson had been achieved.

The teacher led a discussion with the students on VAT linking it to real life situations and prior knowledge. Students demonstrated a good knowledge of the purpose of VAT and this linked in nicely to the task at hand. The task set was a real life situation regarding the cost of a meal in a restaurant. Teachers involved feel that it was a very worthwhile task as it is a

section which often causes problems for students, particularly when working backwards to find the original cost.

The evidence gathered showed that students engaged very well with the task. During the lesson the teacher was constantly circulating the classroom, observing students work, offering support and encouraging self-correction where necessary. This worked very well as it created a safe and positive learning environment for students who were struggling with the task. The initial worksheet on fraction strips given to the students took longer than anticipated as students had to think on the task however, we still felt it was a valid part of the lesson.

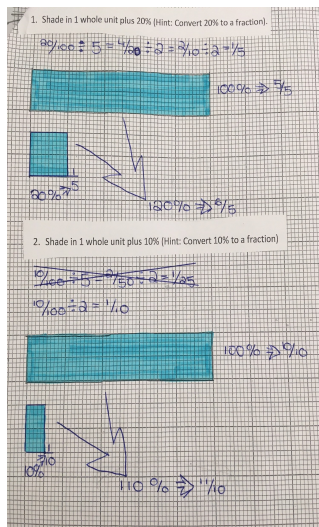
Through our observations we noticed that students did not use the percentages as a method. A lot of students used fractions and this may have been as a result of the mention of fractions on the initial worksheet. Upon reflection the worksheet would be edited for future lessons in order to encourage the use of different methods.

One student used a method that we feel should have been included as part of the Ceardaíocht. This method had been discussed during the planning stages of the lesson and it was decided not to use it. [Calculation of the VAT and then taking this value away from the overall bill, see percentages method in possible student solutions]

At the end of the lesson it was obvious that students were very intrigued by the task as they were eager to discuss and compare their solutions with their peers.

Overall the research lesson was a success with all the key skills and research themes being attained. Throughout the lesson students expressed their ideas clearly and accurately. Student's confidence and positive disposition to learning was promoted by the safe learning environment that was created by the teacher. Students also reflected on and evaluated their own learning which was facilitated by the teacher.

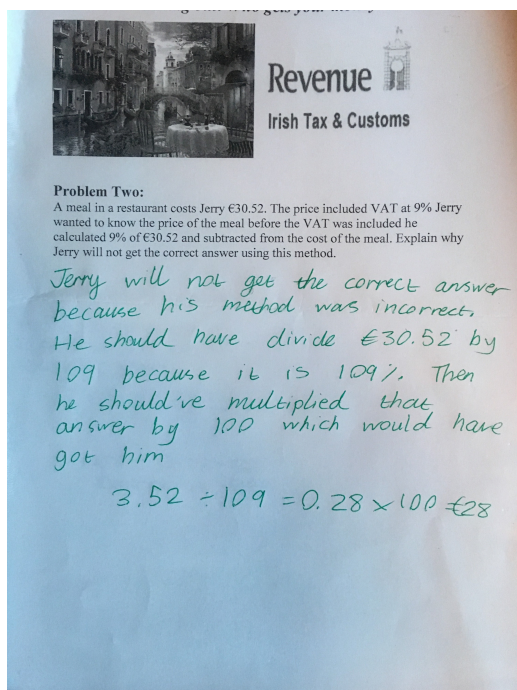
Two valuable life lessons that resonated for teachers occurred during this lesson and involved two particular incidents (i) one particular student who had excellent grasp of the fraction and percentage conversion struggled immensely with the task, it was questioned whether this was due to his difficulty with language as he is studying Maths through his second language or was it that he had difficulty with applying his knowledge in a more complex scenario, further investigation maybe needed to identify why he found this task difficult. The other incident involved a child who had a visual impairment. The teacher had prepared her usual enlarged worksheet for this student. However, this student wanted on this occasion to take the opportunity to be treated the same as all his peers and coped exceptionally well.



This is work from the student who is learning through his second language, struggled with finding solution to problem but had no issue with fraction or percentages.

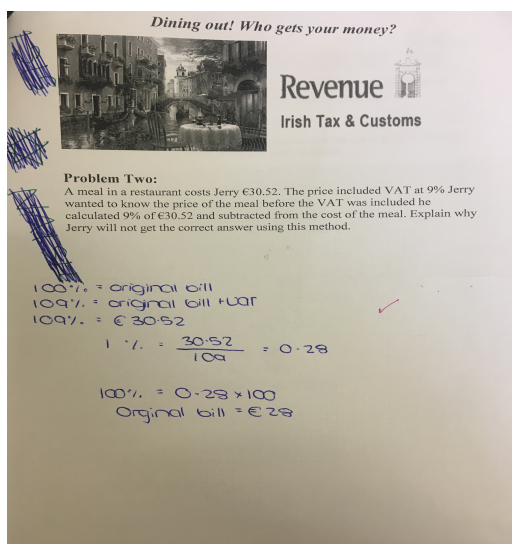
As the group parted ways there was a distinct excitement about teaching this lesson to our own third years which reflects immensely on the lesson itself and the value of giving students the time to reflect and try to different approaches to a task that we as teachers often get frustrated with.

Appendix 1: Samples of Task 2



Problem Two:
A meal in a restaurant costs Jerry €30.52. The price included VAT at 9% Jerry wanted to know the price of the meal before the VAT was included he calculated 9% of €30.52 and subtracted from the cost of the meal. Explain why Jerry will not get the correct answer using this method.

Jerry will not get the correct answer because his method was incorrect. He should have divide €30.52 by 109 because it is 109%. Then he should've multiplied that answer by 100 which would have got him

$$3.52 \div 109 = 0.28 \times 100 = 28$$


Problem Two:
A meal in a restaurant costs Jerry €30.52. The price included VAT at 9% Jerry wanted to know the price of the meal before the VAT was included he calculated 9% of €30.52 and subtracted from the cost of the meal. Explain why Jerry will not get the correct answer using this method.

*100% = original bill
109% = original bill + VAT
109% = €30.52
1% = $\frac{30.52}{109} = 0.28$
100% = 0.28×100
Original bill = €28*

Excerpt from teachers report on Task 2:

Following the lesson study on 17/01/18. Students presented to me their homework. "Initial observation on my behalf noted the students that wrote an explanation for the answer to problem 2. One student completed this problem with a detailed account (including calculations) of the process involved in coming to the correct conclusion and therefore why Jerry's method would not work. The second student completed the calculation first, which was then used to back up his written account of why Jerry's method would not work. This is validation that students were able to make a connection to the lesson study where the addition of VAT to the cost price equalled the total cost. Students were commended on answering the question asked as they had provided a written account."

this I noted the student that used the fraction $\frac{6}{5}$ in his answer to write an explanation of why Jerry would not get the correct answer. The students reasoning was on the right path but he used the incorrect fraction amount (from the previous day). The student was made aware of this error and asked to retry. One student stated correctly that the full price included VAT, however did not come the correct written conclusion. On review the student corrected his error. I noted the students that calculated the correct answer however did not back this up with a written account of why Jerry's method would not work. It was observed here that students completing the problem found the correct solution using the fact that the total percentage was 109. This is validation that students were able to make a connection to the lesson study where the addition of VAT to the cost price equalled the total cost. Two students that arrived at an incorrect answer in the lesson study found the correct solution to this type of question however did not back his up with a written account. All calculations completed this way had the correct solution. Students were then asked to provide a written account to finish the question that was asked. When I questioned the students as to why they completed calculations when the question asked to explain why a particular method did not work. They admitted to assuming the answer must always be a calculation. Once they felt they got the correct answer they presumed no explanation was necessary."

Appendix 2:

Observation: Lesson
Research Proposal for 3rd
Years

Research Theme:

- grow as learners through respectful interactions and experiences that are challenging and supportive
- enjoy their learning, feel motivated to learn, and expect to achieve as learners.

Goal of the Lesson:

Students will be able to:

- Solve challenging VAT problems
- Develop strategies for solving difficult VAT problems
- Reflect on their learning through problem number analyzing incorrect answers

Key Skills to be developed during lesson:

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: Student's will have the opportunity to reflect on their own learning.
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. Reflecting on and evaluating their learning.
8. Managing information and thinking: Students will be encouraged to think creatively and critically.

Student 1	Student 2	Student 3	Student 4	Student 5	Student 6	Student 7	Student 8

Appendix 3: Seating Plan

White Board

Computer	Teachers	Desk
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Row 1

Ruairi			Ceili		Seamus
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Row 2

Cian			Laura		Pawel
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Row 3

Holly			Daragh		Victoria
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Row 4

			Cian		Emma
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Teachers Observing

Julie		Sinead		Lynn	
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Appendix 4: Worksheet



Dining out! Who gets your money?

Problem One:

The price of a meal for eight people in a restaurant is €264 after VAT of 20% is included. Find the price of the meal before VAT is added.