

**Lesson Study in a Maltese Primary State School:  
Using different operations in mathematics problem solving**

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**Abstract:** This report explores the lesson study process undertaken to improve Year 4 students' mathematics problem-solving skills in a Maltese primary state school. It specifically focuses on their ability to identify and apply the correct operations in mathematics problems. A team of educators, including three Year 4 teachers, the assistant head in charge of the year group, the mathematics head of department and members of the Faculty of Education at the University of Malta, collaboratively designed and refined the lesson through two trial implementations. The first lesson trial revealed specific challenges, leading to targeted adjustments. Following changes to the lesson plan, observations during the second lesson trial indicated significant improvements in student engagement and understanding. These findings were shared with the wider school community, leading to the decision by the Senior Leadership Team (SLT) to adopt lesson study as a whole-school approach. The process demonstrated the effectiveness of collaborative planning, on-going reflective practice and continuous improvement in enhancing both teaching practices and student outcomes.

**Keywords:** Collaboration; lesson study; mathematics problem-solving; primary education

## **Introduction**

Professional development (PD) is critical for educators and, naturally, it needs to be given its due importance. To grow professionally, educators need PD to become part of their daily work and, as such, school leaders need to offer opportunities where educators can work together within communities of learning. In fact, Desimone (2011) argued that to improve schools, PD should be seen as key to assure quality in education. Hence, PD should not be seen as stand-alone sessions but as an ongoing collaborative journey for educators. Lesson study is one such example. In a lesson study,

a group of teachers work together to improve the learning of their pupils and to develop ways of teaching them that help them to overcome barriers or difficulties they are encountering in learning, often in learning some very specific aspects of the curriculum. (Dudley, 2015, p. 5)

In this report, we will see how lesson study provided an alternative means to more traditional PD models implemented at a primary state school in Malta. Through lesson study educators worked collaboratively on an aspect that was both challenging and of interest to them. As Formosa and Calleja (2020) argued, the experience described in this report highlights that “lesson study enabled teacher autonomy and transformative practice” (p.49).

I, the first author, am currently pursuing my master’s in educational leadership and management course at the University of Malta. As part of my studies, I conducted and led a lesson study. This leadership experience allowed me to delve deep in the process of lesson study and to create a collaborative environment amongst the educators involved. One of my aims in leading a lesson study was to better understand how targeted, collaborative inquiry into classroom practices could lead to improved student outcomes and more effective teaching strategies.

Within our role as educators, and as authors of this article, our intention in writing and publishing this report is multifaceted. Primarily, we aim to contribute to the existing body of knowledge on effective PD practices. By documenting and analysing the lesson study process, we hope to provide valuable insights that can help to inform and improve teaching practices in various educational contexts. Additionally, by documenting this journey we

aim to provide a detailed account of this lesson study process with its successes and challenges. This, we feel, will serve as a resource to other educators that are interested in implementing a lesson study. Moreover, we believe that by sharing our practices we would be encouraging other educators and schools to take up the challenge to adopt such a collaborative approach.

### **The research lesson**

Throughout our experiences as educators, we often notice that students find it challenging to choose the correct mathematical operation when having a problem-solving task. Usually, with such tasks, students start asking which operation they should use without being able to read the problem, understand it and subsequently think and apply the correct operation to solve it.

When discussing this with the other members of the lesson study team, it became evident that this problem was also evident in their classes. Following the suggestion by Fuji (2019), we developed the research theme by considering our students' current state of mathematics knowledge and the school's long-term goals for student learning and development. Also, as Stepanek et al. (2009) mention, this process "gives teachers the opportunity to stop and focus on their practice rather than simply get caught up in the flow of teaching" (p.1). Indeed, within our discussions we realised that problem-solving in mathematics was a persistent issue and a research aspect that was worth investigating in our lesson study.

The main aims of this research lesson were to:

1. Enhance student understanding of mathematical operations  
To deepen students' conceptual understanding of different mathematical operations (i.e.: addition, subtraction, multiplication and division) and when to apply them in various problem-solving situations.
2. Improve problem-solving skills  
To develop students' abilities to analyse word problems and identify the appropriate operations that are needed to solve problems. This includes translating words into mathematical expressions.

3. Use visual aids and manipulatives  
To integrate visual aids and manipulatives into the lesson to help students visualise mathematical operations and understand their practical applications.
4. Promote collaboration  
To facilitate collaborative learning among students, encouraging them to discuss their problem-solving approaches and learn from each other's strategies.

Other aims targeted to be reached:

1. Develop strategic thinking  
To encourage students to think strategically about problems by considering multiple methods and choosing the most efficient one.
2. Foster metacognitive awareness  
To enhance students' awareness of their own thought processes while solving problems. This includes recognising common errors and self-correcting as needed.
3. Increase engagement and confidence  
To boost student engagement and confidence in mathematics by providing them with strategies and tools for identifying operations, thereby reducing their anxiety, fear and frustration when working on problem-solving tasks.
4. Constructive feedback  
To provide timely and constructive feedback on students' problem-solving approaches, helping them to improve and refine their skills.

### **The lesson study context**

#### *The school*

Compared to other primary schools in Malta, the school has a relatively high population of around 600 students from Early years to Year 6. It is considered as a multicultural institution since the school caters for students from various cultural and linguistic backgrounds. This school prides itself for providing a diverse and inclusive learning environment, where this diversity not only

enriches the learning experience but also presents unique challenges and opportunities in addressing the varied educational needs of students.

#### *The targeted students*

This lesson study was designed for a Year 4 class; a year which is critical in the development of students' mathematical problem-solving. At this stage of academic mathematical progress, students are expected to build on their arithmetic skills and be able to solve problem-solving tasks more independently. However, as explained above, our students were struggling with this. So, our lesson study team aimed to provide our Year 4 students with opportunities to explore different strategies that could help them to better understand problem-solving, while also helping them to develop their confidence in doing mathematics.

#### *The lesson study team*

A diverse team of educators and teacher educators collaborated in this lesson study:

- Three Year 4 educators  
The Year 4 educators have a deep understanding of their students' strengths, weaknesses and different learning styles. Their day-to-day interactions with the students provided valuable insights into the specific difficulties faced by the children and informed the design of the lesson.
- Assistant Head (in charge of Year 4)  
The assistant head who is in charge for overseeing the Year 4 curriculum, played a crucial role in coordinating the lesson study. His guidance throughout ensured that the lesson aligned with the educational objectives of the year group. Furthermore, he also helped with the logistics when it came to set up meetings for discussions.
- Mathematics head of department  
The mathematics head of department contributed expert knowledge to the design of our lesson contributing her expertise in mathematical problem-solving. This expertise helped the whole team in creating

more effective strategies and resources that targeted the specific problem areas identified.

- Faculty of Education members within the University of Malta  
Two members from the Faculty of Education participated by providing an external perspective and additional insights to this lesson study. Their academic background in educational theory and practice, together with their experience leading and supporting lesson studies, offered valuable feedback to the lesson design and implementation.

### **Key instructional decisions within the research lesson**

Our mathematics problem-solving lesson was carefully designed by all the team members to address the challenge of helping Year 4 students identify and apply the correct mathematical operation/s in several word problems. The lesson was structured around several key instructional practices aimed at improving students' problem-solving skills and fostering a deeper understanding of mathematical concepts, as described below.

- Introduction and context setting  
The lesson began with a brief introduction of the objectives, clearly outlining the focus on problem-solving and the importance of choosing the correct operation. To engage students, we used relatable real-world scenarios (box of chocolates word problem) that required different operations, helping to contextualise the mathematical concepts.
- Collaboration  
The lesson included a collaborative activity where students worked in groups to solve word problems. Group interaction encouraged discussion and allowed students to articulate their thought processes, further reinforcing their understanding of how to choose the correct operation.
- Presentation of work  
After working in groups, students were encouraged to share their solutions and reasoning with the entire class. This sharing session helped consolidate student learning, allowing them also to learn from each other's approaches, fostering an environment where different strategies were valued.

### Use of visual aids and manipulatives

To enhance understanding, we presented the 'RUCSAC' problem-solving visual aid (see Appendix 7) as displays on the board and a bookmark so that students can refer to it. Manipulatives, like problem-solving mats and bottle caps, were also used to help students physically model the problems, making abstract concepts more tangible and easier to grasp.

- Independent practice

Students were given time to solve a problem independently. This allowed the teacher to assess individual understanding and provided an opportunity for students to apply their skills in a more autonomous setting.

- Closing reflection

The lesson concluded with the 'exit ticket' (see Appendix 8) where students were asked to stop and reflect individually what they learnt from this lesson and what they wish to learn more.

### **Our lesson study process**

The lesson study process typically involves several steps (see table below).

<b>Stage 1</b>	<b><u>Building the lesson study team members</u></b> The team members are approached and invited to take part in a lesson study.
<b>Stage 2</b>	<b><u>Establishing rules, roles and a timeline</u></b> Ground rules for collaboration are discussed, agreed upon and established within the lesson study group. Also, a timeline of meetings, lesson delivery and post-lesson discussion is established.
<b>Stage 3</b>	<b><u>Selecting research theme and class</u></b> Through discussion, a research theme is selected. The class with whom the lesson will be held, the date and time, and the teacher delivering the lesson are established.
<b>Stage 4</b>	<b><u>Planning phase (kyozaikenkyu)</u></b> Group members share their ideas and knowledge about the identified theme and then design teaching and learning resources and finalise a lesson plan.
<b>Stage 5</b>	<b><u>Involving other members</u></b> The knowledgeable person (in our case, a mathematics head of department) and other observers are invited to provide their feedback.

<b>Stage 6</b>	<b><u>Delivery of lesson study (Trial 1)</u></b> One teacher delivers the lesson while the other group members observe the lesson and collect data, using a lesson observation sheet.
<b>Stage 7</b>	<b><u>Post-lesson discussion</u></b> All members of the lesson study group engage in a discussion of what went well and what can be improved for Trial 2.
<b>Stage 8</b>	<b><u>Updating lesson plan and resources for Trial 2</u></b> During this stage, group members update their work drawing on the insights gained from the post-lesson discussion.
<b>Stage 9</b>	<b><u>Delivery of lesson study (Trial 2)</u></b> Another teacher delivers the lesson (to a different class) while the other members observe the lesson and again collect data, using a lesson observation sheet.
<b>Stage 10</b>	<b><u>Post-lesson discussion</u></b> All members of the lesson study group engage in a discussion of what went well in Trial 2 with the changes and what can still be improved.
<b>Stage 11</b>	<b><u>Sharing of practice</u></b> The positives and the challenges of the experience are shared with the rest of the school members to make them aware of it and to encourage them to take part in future lesson study practices.

### *Team meetings*

Meetings during the whole process of the lesson study were crucial as they provided us with a structured and collaborative environment where we all engaged in deep and reflective discussions with the aim of developing a successful lesson study. Moreover, these meetings brought us together and we had ample opportunities to share insights and strategies. During meetings we reflected not only individually, but also as a group – something which was enriching yet missing in our daily work as educators.

Throughout the *kyozaikenkyu* stage, that is the planning phase of the lesson study, meetings were held weekly. These meetings were vital in helping us to design the mathematics problem-solving lesson that was tailored to our Year 4 students. Each meeting brought together the diverse expertise of our team where everyone felt valued. Through these discussions, specific challenges that our students face were identified as we reviewed the students' work, shared

observations and incorporated evidence-based strategies to address these difficulties. As a team we developed the lesson plan along with resources and assessment tools.

#### *Delivery of lesson-Trial 1*

During Trial 1, one of the Year 4 educators delivered the planned problem-solving lesson to her students. The lesson focused on helping students identify and apply the appropriate mathematical operations when solving word problems using different visuals and prompts. While the lesson was being taught, the other members of the lesson study team took the role of observers; they were strategically positioned around the classroom to monitor specific students, their engagement with problems and their understanding. This was done using pre-planned observation sheets (see Appendix 9) that were prepared as part of the lesson study. Each observer documented specific student responses, both verbal and non-verbal, and monitored how different students approached the problem-solving tasks, individually and within a group. The observation sheets were designed to capture detailed data on how students interacted with the lesson content, the challenges they encountered, and the strategies they employed to solve problems.

#### *Post-lesson discussion 1*

We followed the suggestion by Dudley (2008) that the post-lesson discussion is done after 36 hours post the delivery of the lesson, otherwise a lot of information will be lost. Indeed, straight after the teaching of the lesson, all the team members met for a post-lesson discussion.

The filled observation sheets were a crucial source of information for the post-lesson discussion. Data, gathered by observers, helped our reflective discussions and the analysis that emerged. The discussion began with an acknowledgment of what went well by highlighting the successful strategies that engaged students and facilitated their understanding of how to identify the correct mathematical operations in problem-solving. For instance, it was noticed that specific instructional techniques (such as direct and/or differentiated instruction and collaborative learning) and visual aids (such as the problem-solving mat and the 'RUCSAC') helped students to grasp key concepts. However, the discussion also focused on areas that needed improvement. Some students, for example, still struggled with certain aspects of the problem-solving process, since they cannot choose the correct

operational strategy to find a solution or relied on other members of the group to solve the word problems for them. Hence, this indicated that further scaffolding is necessary. The team explored various ways to address these challenges, including refining the lesson structure, adjusting pacing, and incorporating additional examples to reinforce understanding. These insights were crucial in shaping the revisions for Trial 2, playing a pivotal part so that the lesson would be even more effective in meeting the diverse needs of students. After the post-lesson discussion, we refined the lesson plan and resources according to our analysis from the discussion.

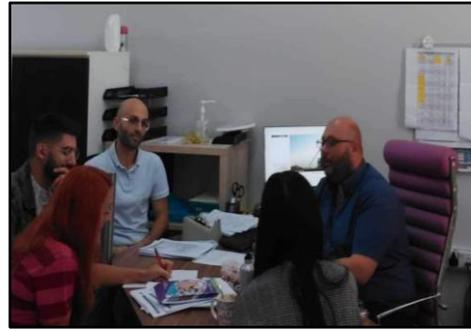
*Delivery of lesson-Trial 2 and post-lesson discussion 2*

After all amendments were finalised, we proceeded with Trial 2 in another Year 4 class taught by their teacher (also a member of the lesson study team). As in Trial 1, the other team members observed the lesson, using the same observation sheet to document student engagement and understanding.

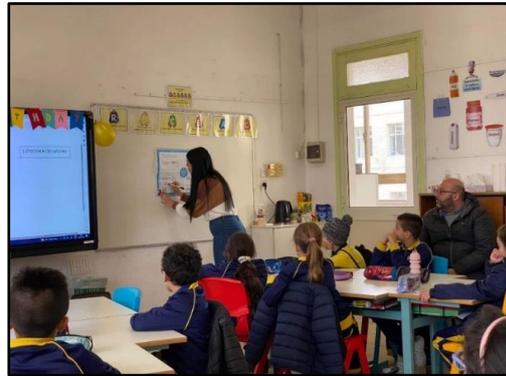
Following the lesson, we held another post-lesson discussion to review the outcomes. This time, our analysis revealed that the adjustments made after Trial 1 had significantly improved the effectiveness of the lesson in terms of student engagement. The students demonstrated a stronger grasp of the problem-solving process with their ability to correctly choose and apply mathematical operations, using different visuals. Also, collaborative as well as independent work gave all the students the opportunity to find solutions for their mathematical problems. We also identified a few minor areas for further refinement; however, the lesson had successfully met its objectives as the students were more confident and engaged. This positive outcome validated our collaborative efforts and underscored the value of the lesson study process in driving meaningful improvements in teaching and learning.

## Highlights documenting the lesson study process

In this section, we use photos of sessions held in November to December 2023.



A. Photos of Trial 1 (Held on 10<sup>th</sup> January 2024)



B. Data collection (a lesson observation sheet filled by an observer during Trial 1)

LESSON OBSERVATION SHEET			
<b>Activity 1- Whole class situation</b>			
<i>During this activity, students will be presented with a whole-class situation by the teacher and they will be encouraged to help her solve it.</i>			
Student	Yes	No	How is it evident?
Student <b>Khassim</b> Understands the task presented by the teacher.	✓		<del>attentive</del> and rods.
Contributes to the discussion as a whole class		✓	Although child was attentive, he did not contribute to the class discussion.
Able to give solution/s.		✓	Silent throughout all task.
<b>Activity 2-Group work situation</b>			
<i>During this activity, the students will work in a group to solve their group situation.</i>			
Student	Yes	No	How is it evident?
Reads carefully and analyses the given information.	✓		Only member who takes the initiative to analyze each section on the mat.
Understands the task and the work he/she needs to do in relation to it.	✓		Quickly came up with right equation to use - making sense of what needs to be done.
Highlights keywords to help him/her solve the problem.	✓		Once prompted by the teacher, he found this easy to do.
Engages himself/herself and participates with the rest of the group	✓		Yes - he was evidently the leader in the group.
Take initiatives to use the provided tools such as the visual aids and the problem-solving mat.	✓		Relies on the mat and RUCSAC as useful tools.
<b>Activity 3-Presentation of solved situation as a group</b>			
<i>During this phase, students in a group will be encouraged to share their situation with the rest of the class. Then they need to tell the rest of the class how they solved their situation.</i>			
Student	Yes	No	How is it evident?
Present their ideas clearly to the whole class	✓		Very No prompts required to do this.

Able to explain the thinking when solving the situation.	✓		Clearly explains the reason behind the choice of equation used
Able to question the work presented by others.		✓	listened to the others, but remained quiet.
<b>Activity 4- Joining situations</b>			
During the closure, the teacher will encourage all the students to join all situations together and by posing questions, solve problems to finish the party.			
Student	Yes	No	How is it evident?
Able to make connections between all the situations.	✓		He accepted his <del>to</del> classmate's suggestion when she said "we need to add totals."
Shows understanding of problem-solving	✓		Was a strong participant throughout and seemed like.

C. Data collection from students (some examples from the exit ticket from Trial 1)

**Exit Ticket**

Name Ala Date 10-1-24 Circle how you feel:

What I learnt today:  
I learnt that you don't just use adding everytime. You can multiply and you can make it silly or fun!

What I'd like to know:  
I don't need anything else

I don't get this!  


I'm getting there!  


I've got it!  


**Exit Ticket**

Name Thas Date 10/1/2024 Circle how you feel:

What I learnt today:  
Today I learnt a lot of math

What I'd like to know:  
nothing

I don't get this!  


I'm getting there!  


I've got it!  


D. Post-lesson discussion (following Trial 1 held on 10<sup>th</sup> January 2024)



E. Photos of Trial 2 (held on 9<sup>th</sup> April 2024)



F. *Post-lesson discussion (following Trial 2 held on 9<sup>th</sup> April 2024)*



G. *Sharing the lesson study experience with the school community during a Community of Professional Educators (CoPE) session held on 10<sup>th</sup> May 2024*



## **Main takeaways from teaching the research lesson**

### *Personal reflection from the educator leading the lesson study*

This was my first experience in leading and being part of a lesson study. Embarking on this journey has been a very good experience which was marked by collaboration, constructive discussion, reflection, ownership and professional growth and improvement in my teaching practices. This experience of being a leader of this lesson study, allowed me to guide a team of very dedicated educators that not only left an impact on myself but also on all our teaching practices to improve students' learning.

One central aspect throughout this experience was collaboration. We are used to working very well together, and I think this helped us to overcome challenges (e.g., the planning of the lesson and resources) that we encountered throughout this lesson study. Every member was on board and took ownership of this experience by exchanging ideas and insights to make this lesson study successful for all. Through collaboration, I think we brought richness in our constructive discussion as we listened and valued each other's opinions. We also asked for feedback from other members, such as the mathematics head of department and academic members from the University of Malta – constructive feedback which we took on board to improve and learn from our lesson study.

Throughout this journey, I kept on reminding myself that a lesson study is an iterative process. We regularly reflected on the effectiveness of our approaches and tried to adjust our planning and teaching methods based on the needs of our students. As Bush (2009, p. 9) states, "the lesson study is jointly planned, it is jointly owned by the group". Indeed, I could feel a sense of ownership by the other members of the group since we were building the lesson together and the sense of empowerment could be felt strongly.

Leading this lesson study was a challenging task, especially when considering the short timeframe that we had, and the hectic timing linked with the Christmas activities. Suffice to say, it was not easy to fit in all the meetings with all the members within the team and I tried to overcome this challenge by planning the meetings ahead. Moreover, leading a lesson study required a lot of work and effort which was challenging being a full-time primary teacher and a part-time student at the University of Malta. However, I think that it was all worth it as it gave me the opportunity to move out of my comfort zone and

experience being at the helm of a lesson study. I hope that I will have more opportunities to lead and be part of other lesson studies in the years to come.

*Personal reflection from the knowledgeable other (mathematics head of department)*

This was my first experience of being invited to participate in a lesson study. I had heard about it on various occasions and heard testimonials of the experience. In my role, that of supporting educators, professional development is a key area. One of my main mottos is that for any positive change to take place, educators need to own the new ideas, strategies and pedagogies. They need to feel the need for a change and have a voice in proposing the way forward. Hence, it was very encouraging to experience this situation, where educators identified the challenges that they were encountering and felt the need to explore new ways in how to try and overcome them.

The opportunity to sit in class, observe specific students and witness their conversations closely was an enriching opportunity. It helped me to understand how different learners react to the opportunities presented to them and, in turn, influencing future planning on the part of us educators.

The post-lesson meeting was another excellent opportunity for reflection, based upon evidence, with the intention of refining our practices, not just in this classroom or this school, but in my case reflections which can be transferred to other work environments. In my opinion, without increasing any extra pressure on educators, this practice can be recommended as an ongoing professional activity within the CoPE-hours framework, which educators are entitled to. It would be an excellent way to give educators ownership of their own professional development, without adding on to the extra load of finding more time to do it in their own time.

### **Reflections on future works**

After completing the lesson study process, the SLT recognised the significant improvements in both our teaching practices and the students' outcomes that emerged from our lesson study. Seeing the positive effect of this approach on both educators and students, the SLT decided to propose lesson study as a whole-school PD approach. In fact, Mon, Dali and Sam (2016) argued that a lesson study "is a school-based in-service programme that requires educators to work together and collaboratively improve their teaching practices" (p.90). This decision by the SLT reflects a huge commitment to foster a culture of

continuous professional development and collaboration across the school community.

To facilitate this transition, we shared our experience during a CoPE session, held in May 2024, where we explained the process, outcomes and benefits of doing a lesson study (see images below). The session provided an opportunity to pass on the knowledge we had gained to educators of all year groups, ensuring that every educator in the school was informed and prepared to adopt this approach. We highlighted the collaborative planning, ownership and empowerment, and reflective discussions that were integral to our success, emphasising how these elements could be adapted to different subjects and student needs. In fact, Trust, Krutka and Carpenter, (2016) highlighted that “sharing and collaborating to grow professionally is more relevant than top-down requirements” (p.25).

The response from the teaching staff was overwhelmingly positive as most educators expressed enthusiasm and a strong interest in incorporating lesson study into their teaching practices for the next scholastic year. With the support of the SLT and of CleStuM, the school is now leaned to embrace lesson study as a cornerstone of our PD programme. This whole-school approach will not only enhance the quality of teaching but also create a more collaborative and reflective teaching culture, ultimately leading to better learning outcomes for all students. The upcoming scholastic years promise to be an exciting time of growth and innovation as we collectively work towards refining and enriching our educational practices.

## Appendices

### Appendix 1: Lesson plan (Trial 1)

<b>Lesson Plan</b>
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<b>Subject</b>
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Mathematics

<b>Lesson title</b>
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Mathematics problem-solving

<b>Class</b>
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A class of 18 students: 11 boys and 7 girls in a mixed-ability Year 4 classroom.

<b>Theme</b>
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Celebrations

<b>Lesson date</b>
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Lesson Trial 1: Wednesday 10th January 2024

<b>Lesson time and duration</b>
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11:00 – 12:00 (1 hour)

Post-lesson discussion: 12:10 – 13:00 (50 minutes)

<b>Link with syllabus</b>
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5.2.23: I can work through simple one-step situations using addition, subtraction, multiplication and/or division

<b>Learning Outcomes</b>
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By the end of the lesson the students will be able to:

- Read and understand a situation.
- Analyse and create a solution.
- Work collectively in a group.

<b>Resources</b>
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- Interactive whiteboard
- Chocolate box investigation for whole-class discussion

- Party investigation for group work
- Problem-solving mats
- Problem-solving visual aid bookmark ('RUCSAC')
- RUCSAC displays in class
- Timer
- Bottle caps for manipulatives
- Power Point presentation
- Exit Ticket

**Introduction and welcome (5 minutes)**

*When all observers enter the class, the teacher will say:*

*Today we are going to do a lesson that I prepared together with other educators. These educators will be with us for this lesson, and they are here to see us work and learn with us. I would like you to feel relaxed, like usual. During this lesson, we will use different operations such as addition, subtraction, or multiplication to solve different problems. At some point in the lesson, you will be working in groups to solve different problems together and later, you will share it with the rest of the class.*

**Explanation of the situation: whole class approach (10 minutes)**

The teacher is going to introduce the lesson by showing a whole-class situation on the Interactive Whiteboard (IWB) while explaining the situation to the children.

*The teacher will say:*

*As you know Christmas is over and during the holidays, I received a lot of presents and one of them was a box of chocolates. I opened this box of chocolates, and I ate it all! Now I am worried, and I want you to help me to find out:*

- *The total of chocolates that I ate.*
- *The total of calories that I ate (given that each chocolate has 30 calories).*

When the situation is shared with the children, they will be encouraged to engage in a whole class discussion to solve the two problems together. The teacher will show the problem-solving visual aid 'RUCSAC' (displayed on board) and go step by step through it. The teacher will work the problems by using the problem-solving mat displayed as A3 on the whiteboard from the children's responses. This will be done by giving the children some time to think about it and then they will be encouraged to raise their hand

if they know the answer. After, the teacher will try to elicit from the children if there was any other way how it could have been worked out.

Question prompts:

- How can I find the total number of chocolates in this box?
- If one chocolate has 30 calories, how many calories did I eat for the whole box?

**Development of the lesson**

**Step 1: Group work (15 minutes)**

During this part, the children will work in groups to solve a party investigation to set up a birthday party for one of our LSEs. All groups will be given the same investigation on a laminated paper and each group will be encouraged to use the problem-solving mat (given to them on an A2 laminated paper). A problem-solving visual aid will be given to all the groups to help them in the steps of problem-solving.

The teacher will say:

*As you know our LSE's birthday was yesterday and we need to set up a birthday party for her. I will give each group a party investigation to set up this birthday party. (Here the teacher will show and read the investigation).*

*Party Maths investigation:*

*Food:*

1. *How much would it cost to buy a sandwich, sausage roll and mini burger for 10 people?*

*Cake:*

2. *As the cake costs €50 and the cake stand costs €30. What is the total cost?*
3. *If 18 pieces are cut from this cake and only 10 people take a piece, how many pieces will be left over?*

*Decorations:*

4. *What is the total cost for 10 balloons, 1 banner and 10 paper flowers?*

*Present:*

5. *If we collect €5 from each person, how much money would we collect from 10 people to buy the present?*

*I will allocate 15 minutes to discuss the investigation that you have and solve it on the problem-solving mat. I will give each group the 'RUCSAC' visual aid to help you. When time is over, each group will be invited to come out and tell the rest of the class how your problem was solved. I will be coming around to guide you if needed.*

The teacher will say:

*Time is over. You need to stop so each group will share with the rest of the class.*

**Step 2: (20 minutes): Presentation (Neriage phase)**

The teacher will say:

*Now that you all had time to discuss and work the problems in groups, I want you to share with everyone how the investigation was solved in your group.*

Each group will be invited, one after the other, to come out and share how they solved the investigation to the rest of the class. The A3 problem-solving mat will be displayed on the board so the rest of the children will follow. When each group will share how they solved the problem, the rest of the class will be encouraged by the teacher to share their ideas and hence agree with the method used to solve the problem or show an alternative method. So, at this stage, children will be given the opportunity to compare approaches. When all groups finish their presentations, mats will be left hanging so all the situations will be seen.

Question prompt:

- How did you solve your problem?
- Do you agree on how the problem was solved?
- Do you have other methods/ ideas how it could be solved?

**Closure: Part 1 (5 minutes)**

As closure, the teacher will show different methods by using different operations (if there is more than one way) to solve the investigations. This will be done by a Power Point presentation. Keywords will be highlighted. After teacher will encourage children to find out the total cost for the party.

The teacher will say:

*Now that you explained to us how you solved the investigations, I will show you different operations that can be used to solve it.*

*(Showing Power Point presentation)*

*Now that I know how much I will spend on food, cake, decorations and present, how much will the whole party cost?*

Question prompt:

- Is there another way how I can solve it?
- How much will the whole party cost?

**Part 2: Exit ticket (5 minutes)**

In this part the teacher will give an Exit ticket to all students. Using the Exit ticket, the teacher will have an indication on how students feel, what they learnt and what is still unclear.

The teacher will say:

*Now I am going to give you an Exit ticket where you are going to circle how you feel and write down what you learnt today and what you are still not sure and so you want to learn.*

Question prompt:

- How do you feel about this lesson?
- What did you learn from this lesson?
- What is still unclear, and you wish to learn?

**Differentiation**

The activities will be differentiated as follows:

- Graded problem-solving tasks are presented in group work, where students can choose only few questions to answer, based on which ones they think best fits their level of ability.
- Question prompts will allow the teacher to pose problems and stimulate thinking.
- Children will be given the opportunity to use manipulatives during group work if they think it should be of any help.

Appendix 2: Lesson plan (Trial 2)

**Lesson Plan**

**Subject**

Mathematics

**Lesson title**

Mathematics problem-solving

**Class**

A class of 18 students: 10 boys and 8 girls in a mixed-ability Year 4 classroom.

**Theme**

Celebrations

**Lesson date**

Lesson Trial 2: Tuesday 9<sup>th</sup> April 2024

**Lesson time and duration**

10:00 - 11:00 (1 hour)

Post-lesson discussion: 11:10 - 12:00 (50 minutes)

**Link with syllabus**

5.2.23: I can work through simple one-step situations using addition, subtraction, multiplication and/or division

### **Learning Outcomes**

By the end of the lesson the students will be able to:

- Read and understand a situation.
- Analyse and create a solution.
- Work collectively in a group.

### **Resources**

- Interactive whiteboard
- Chocolate box investigation for whole-class discussion
- Party investigation for group work
- Problem-solving mats
- Problem-solving visual aid bookmark ('RUCSAC')
- RUCSAC displays in class
- Timer
- Bottle caps for manipulatives
- Power Point presentation
- Exit Ticket

### **Introduction- Welcome- (5 minutes)**

*When all observers enter the class, the teacher will say:*

*Today we are going to do a lesson that I prepared together with other educators. These educators will be with us for this lesson, and they are here to see us work and learn with us. I would like you to feel relaxed, like usual. During this lesson, we will use different operations such as addition, subtraction, or multiplication to solve different problems. At some point in the lesson, you will be working in groups to solve different problems together and later, you will share it with the rest of the class.*

### **Explanation of the situation: whole class approach (10 minutes)**

The teacher is going to introduce the lesson by showing a whole-class situation on the Interactive Whiteboard (IWB) while explaining visually the situation to the children.

*The teacher will say:*

*As you know Christmas is over and during the holidays, I received a lot of presents and one of them was a box of chocolates. I opened this box of chocolates, and I ate it all! Now I am worried, and I want you to help me to find out:*

- *The total of chocolates that I ate.*

- *The total of calories that I ate (given that each chocolate has 30 calories).*

When the situation is shared with the children, they will be encouraged to engage in a whole-class discussion to solve the two problems together. The teacher will show the problem-solving visual aid 'RUCSAC' (displayed on board) and go step by step through it. The teacher will work the problems by using the problem-solving mat displayed as A3 on the whiteboard from the children's responses. This will be done by giving the children some time to think about it and then they will be encouraged to raise their hand if they know the answer. After, the teacher will try to elicit from the children if there was any other way how it could have been worked out.

Question prompts:

- How can I find the total number of chocolates in this box?
- If one chocolate has 30 calories, how many calories did I eat for the whole box?

**Development of the lesson**

**Step 1: Group work (15 minutes)**

During this part, the children will work in groups to solve a party investigation to set up a birthday party for one of our LSEs. All groups will be given the same investigation on a laminated paper and each group will be encouraged to use the problem-solving mat (given to them on an A2 laminated paper). *[An additional laminated paper will be given if they need more space where to work]*. A problem-solving visual aid will be given to all the groups to help them in the steps of problem-solving.

The teacher will say:

*As you know our LSE's birthday was yesterday and we need to set up a birthday party for her. I will give each group a party investigation to set up this birthday party. (Here the teacher will show and read the investigation).*

*Party Maths investigation:*

*Food:*

1. *How much would it cost to buy a sandwich, sausage roll and mini burger for 10 people?*

*Cake:*

2. *As the cake costs €50, and the cake stand costs €30. What is the total cost?*
3. *If 18 pieces are cut from this cake and only 10 people take a piece, how many pieces will be left over?*

*I will allocate 15 minutes to discuss the investigation that you have and solve it on the problem-solving mat. I will give each group the 'RUCSAC' visual aid to help you. When time is over, each group will be invited to come out and tell the rest of the class how your problem was solved. I will be coming around to guide you if needed.*

The teacher will say:

*Time is over. You need to stop so each group will share with the rest of the class.*

**Step 2: (20 minutes): Presentation (Neriage phase)**

The teacher will say:

*Now that you all had time to discuss and work the problems in groups, I want you to share with everyone how the investigation was solved in your group.*

Each group will be invited, one after the other, to come out and share how they solved the investigation to the rest of the class. The A3 problem-solving mat will be displayed on the board so the rest of the children will follow. When each group will share how they solved the problem, the rest of the class will be encouraged by the teacher to share their ideas and hence agree with the method used to solve the problem or show an alternative method. So, at this stage, children will be given the opportunity to compare their approaches. When all the groups finish from all their presentations, all mats will be left hanging, so all the situations will be seen.

The teacher will say:

*Now that you explained to us how you solved the investigations, I will show you different operations that can be used to solve it.*

*(Showing Power Point presentation)*

The teacher will show different methods by using different operations (if there is more than one way) to solve the investigations. This will be done by a Power Point presentation. Keywords will be highlighted.

Question prompt:

- How did you solve your problem?
- Do you agree on how the problem was solved?
- Do you have other methods/ ideas how it could be solved?

**Closure: Part 1 (5 minutes)**

In the closure of the lesson, the teacher will ask the students to work individually to find the total cost for the party. Hence students need to add the total cost of food with the total amount of the cake with stand.

The teacher will say:

*Now that you know how much we will spend on food and cake with stand, how much will the whole party cost?*

Question prompt:

- Is there another way how I can solve it?
- How much will the whole party cost?

**Part 2: Exit ticket (5 minutes)**

In this part the teacher will give an Exit ticket to all the children and will encourage them to answer it. By this method the teacher will have an indication on how they feel, what they learnt and what is still unclear.

The teacher will say:

*Now I am going to give you an Exit ticket where you are going to circle how you feel and write down what you learnt today and what you are still not sure and so you want to learn.*

Question prompt:

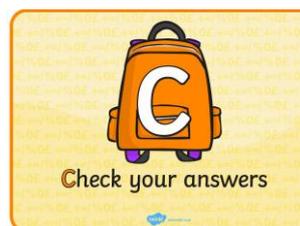
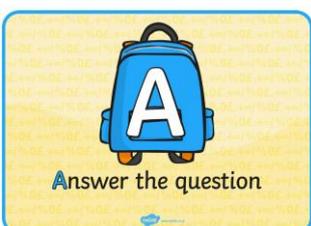
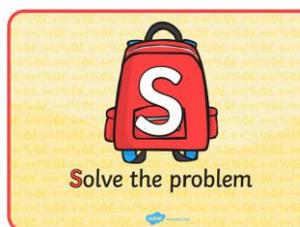
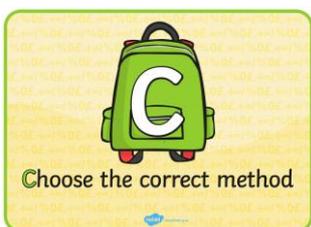
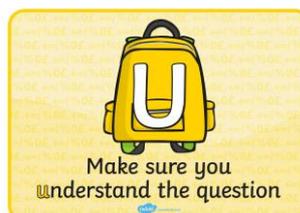
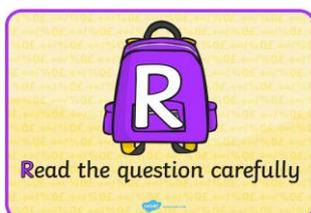
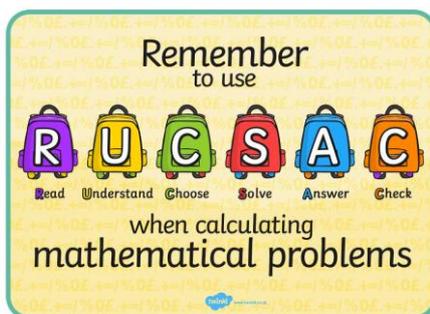
- How do you feel about this lesson?
- What did you learn from this lesson?
- What is still unclear, and you wish to learn?

## Differentiation

The activities will be differentiated as follows:

- Graded problem-solving tasks are presented in group work, where children can choose only few questions to answer, based on which one they think best fits their level of ability.
- Question prompts will allow the teacher to pose problems and stimulate thinking.
- Children will be given the opportunity to use manipulatives during group work if they think it should be of any help.

### Appendix 3: Resources (Posters displayed in class)



Appendix 4: Resources (Whole-class approach investigation)

**Box of chocolate- Maths investigation**



1 chocolate=30 calories

1. How many chocolates did I eat in all?
2. How many calories did I eat for a whole box of chocolate?

Appendix 5: Resources (Group work investigation)

**Party- Maths investigation**

**Food:**

 Sandwich-30c each	 Sausage rolls- 40c each	 Mini burgers-90c each
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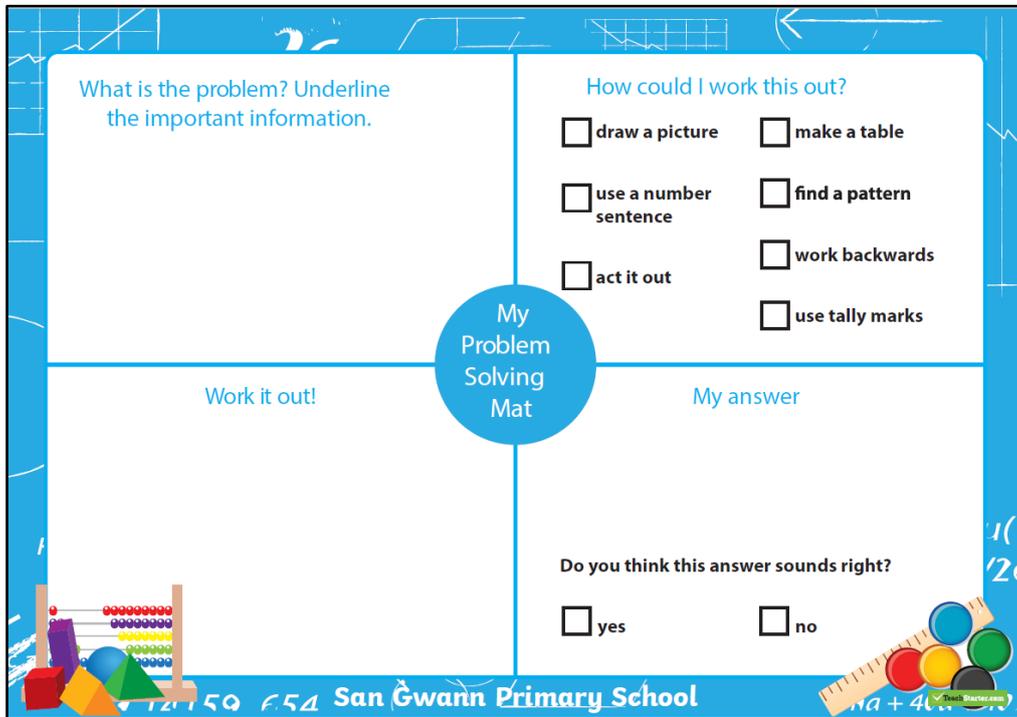
1. How much would it cost to buy the sandwich, sausage roll and mini burgers for 10 people?

**Cake:**

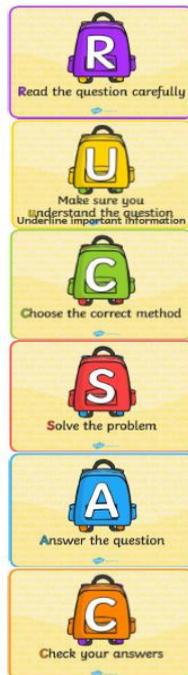


2. The cake costs €50 and the cake stand costs €30. What is the total cost?
3. If 18 pieces are cut from this cake and only 10 people take a piece, how many pieces will be left over?

Appendix 6: Resources (Problem solving mat)



Appendix 7: Resources ('RUCSAC' bookmark visual aid)



Appendix 8: Resources (Exit ticket)

Exit Ticket	
Name _____ Date _____	Circle how you feel:
What I learnt today: _____ _____ _____ _____	I don't get this! 
What I'd like to know: _____ _____ _____ _____	I'm getting there! 
	I've got it! 

Appendix 9: Lesson observation sheet

<b>Activity 1- Whole class situation</b>			
<i>During this activity, students will be presented with a whole-class situation by the teacher, and they will be encouraged to help her solve it.</i>			
The student	Yes	No	How is it evident?
Understands the task presented by the teacher.			
Contributes to the discussion as a whole class			
Able to give solution/s.			
<b>Activity 2-Group work situation</b>			
<i>During this activity, students will work in a group to solve their group situation.</i>			
The student	Yes	No	How is it evident?
Reads carefully and analyses the given information.			
Understands the task and the work he/she needs to do in relation to it.			
Highlights keywords to help him/her solve the problem.			
Engages himself/herself and participates with the rest of the group			
Uses the visual aids and the problem-solving mat.			

**Activity 3-Presentation of solved situation as a group**

*During this phase, students in a group will be encouraged to share their situation with the rest of the class. Then they need to tell the rest of the class how they solved their situation.*

The student	Yes	No	How is it evident?
Presents ideas clearly to the whole class			
Explains the thinking when solving the situation.			
Questions the work presented by others.			

**Activity 4- Conclusion**

*During the closure, the teacher will show different methods of how the investigation could be solved while trying to show connections to join situations for the whole party by posing questions. Then students will be given an exit ticket where they will be encouraged to write down what they learnt and what they still need to learn.*

The student	Yes	No	How is it evident?
Makes connections between all the situations.			
Shows understanding of problem-solving.			
Expresses what was learnt and what still needs to be learnt.			

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