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Exploring fractions through equitable sharing: A conceptual approach through lesson study

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Abstract: This report presents a lesson study conducted with a Year 4 class at J. Hookham Frere Primary School, Pietà, focusing on developing conceptual understanding of fractions through equitable sharing. Prompted by diagnostic assessments revealing widespread misconceptions, the teaching team designed a hands-on lesson in which students used paper models to represent halves, quarters, and eighths of a chocolate bar. The lesson was structured around the Concrete-Pictorial-Abstract (CPA) approach, promoting collaborative problem-solving, reasoning, and mathematical language development. Observations highlighted the effectiveness of tactile tasks in making fractions meaningful, while also identifying challenges related to group dynamics, language use, and spatial reasoning. Student feedback indicated high engagement, though some struggled with confidence. Post-lesson reflections underscored the importance of teacher collaboration, responsive teaching, and student agency. The report demonstrates how lesson study can transform teaching practice and support deeper understanding of foundational mathematical concepts.

Keywords: Collaborative problem-solving; CPA; conceptual understanding; fractions; lesson study; sharing

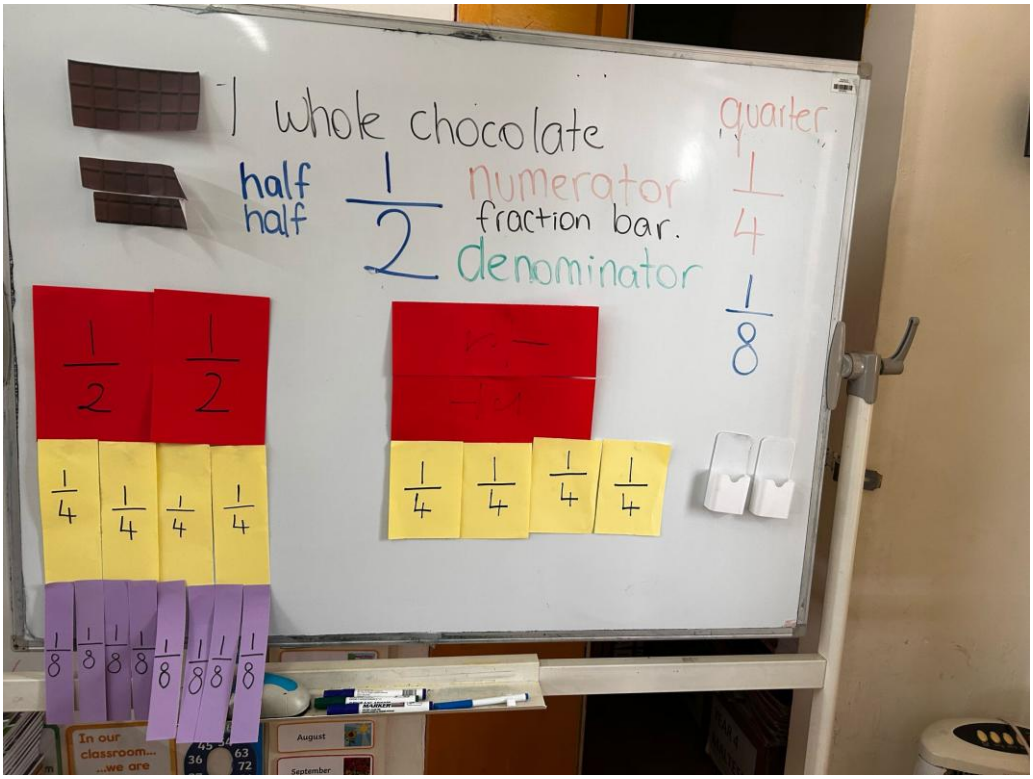
Introduction

This report presents a comprehensive account of a lesson study (LS) carried out with a Year 4 class at J. Hookham Frere Primary School in Pietà, Malta. The research lesson aimed to introduce the concept of fractions by fostering conceptual understanding through collaborative problem-solving. Emphasis was placed on equal sharing and clarifying the roles of the numerator and denominator. The lesson study process involved research, co-planning, observation, and reflection among a

multidisciplinary team of educators committed to improving student learning outcomes in mathematics.

This report outlines the process and findings of a collaborative lesson study, including background context, team composition, research focus, lesson observations, and reflections. The detailed lesson plan developed during the study is available in Appendix 1.

The primary aim of the research lesson was to build conceptual understanding of fractions as equal parts of a whole. More specifically, the lesson was intended to help students recognize that a fraction is not merely a symbolic expression but a numerical representation of a relationship—a part-to-whole ratio grounded in equal partitioning. The objectives were to establish foundational understanding of unit fractions (such as $\frac{1}{2}$, $\frac{1}{4}$, and $\frac{1}{8}$), develop vocabulary around numerator and denominator, and foster mathematical reasoning through physical modelling and collaborative discussion.



This choice of focus was deliberate and responsive. Diagnostic assessments had revealed widespread procedural interpretations of fractions with little accompanying conceptual understanding. Pupils

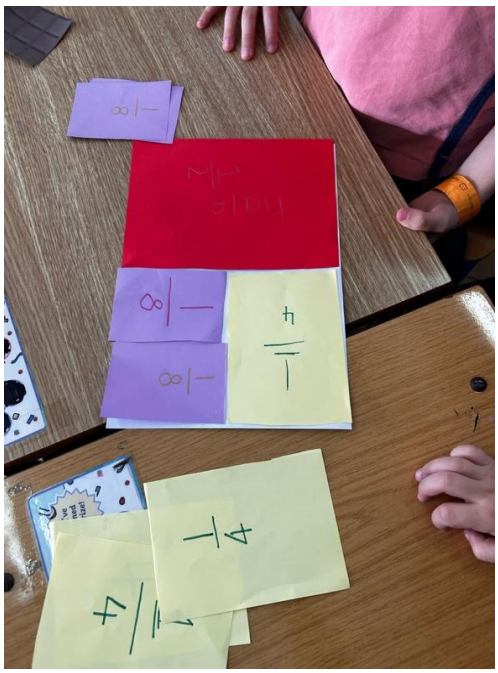
often interpreted 'one-quarter' as simply 'one' or 'four' without understanding the logic behind this symbolic notation. The decision to begin with unit fractions and introduce fractional language through tactile experience was therefore an intentional effort to root mathematical symbols in physical and visual meaning.

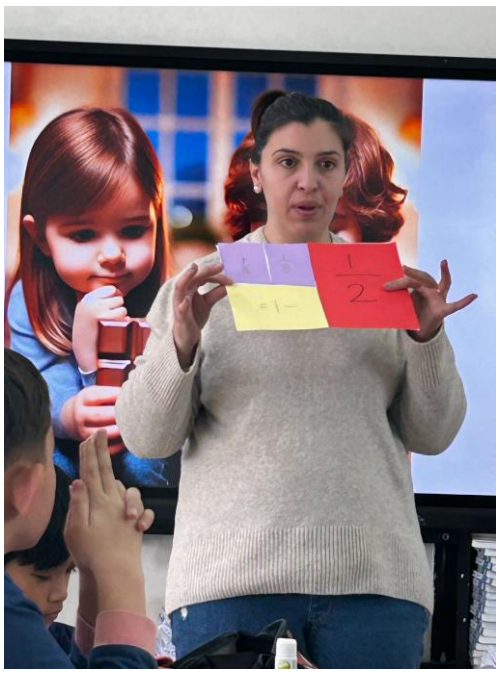
The lesson was designed as a gateway experience: it was not intended to exhaust the topic of fractions, but rather to open a space for exploration and sense-making that could support future instruction on equivalent fractions, fractions of quantities, and basic fraction operations. By treating the lesson as a conceptual foundation, the LS team aimed to avoid the common instructional pitfall of overloading students with procedures before meaning had been established. The language used throughout planning was focused on clarity and consistency – key terms such as 'equal parts,' 'whole,' 'numerator,' and 'denominator' were carefully defined and scaffolded into the lesson script.

Rationale for doing the research lesson

The significance of developing fraction understanding at the primary level has long been recognized by mathematics education researchers. According to foundational studies by Behr, Lesh, Post, and Silver (1983), children often experience conceptual difficulty when introduced to fractions, largely because of the abstractness of the concepts and their reliance on spatial and part-whole reasoning. The conceptual leap from understanding whole numbers to understanding fractions as relational quantities is not trivial. Fractions demand that learners grasp part-whole relationships, the use of new symbols (e.g., the fraction bar), and nuanced numerical reasoning involving size comparison, equivalence, and order.

Against this backdrop, lesson study offers a promising professional development model. Originating in Japan, lesson study (jugyō kenkyū) is characterized by teachers collaboratively planning a research lesson, observing it in action, and engaging in in-depth reflection and revision based on evidence of student learning. Lewis, Perry, and Hurd (2009) emphasize that lesson study improves instruction by changes in teacher's knowledge and believes, changes in the professional community and in the teaching-learning resources. For this reason, lesson study is selected as the ideal structure for improving instruction around fractions in this classroom.





Year 4 is a critical stage in the progression of fractions. By this year, students are expected to consolidate earlier understandings of simple fractions (e.g., halves and quarters) and begin extending their knowledge to include fractions with different denominators. This study, therefore, positions itself at a pivotal point in the curriculum, offering an opportunity to reinforce foundational knowledge before more advanced operations with fractions are introduced in later years.

At the end of Year 3, this class participated in an assessment. This assessment was designed to evaluate students' understanding of foundational mathematical concepts including counting forwards and backwards, basic operations such as addition and subtraction, recognition and use of money, reading time, shading halves and quarters and basic geometry. While the test aimed to identify strengths and gaps in core skills, a particular area of concern emerged around the topic of fractions. Notably, the item analysis from these assessments revealed that only 21% of students correctly identified one-quarter when presented with a visual task. The design of this lesson was also motivated by other item analysis data showing persistent student misconceptions. Research by Ni and Zhou (2005) underscores that many students fail to see fractions as numbers or quantities. Instead, they perceive them as two discrete whole numbers placed above and below a line – effectively reducing a meaningful concept to a meaningless symbol.

This misconception, viewing fractions as static symbols devoid of relational meaning, can have long-term consequences. It undermines the development of number sense and inhibits students' capacity to engage in fraction operations, proportional reasoning, and algebraic thinking later in their schooling. Consequently, addressing these misunderstandings early through meaningful, engaging, and collaborative experiences was central to the lesson study's objective.

The pedagogical approach was informed by the CPA model: Concrete, Pictorial, Abstract. This progression enables students to first explore mathematical ideas using tangible objects, then move to visual representations, and finally connect these experiences to formal mathematical notation. In this case, students used coloured paper to represent a chocolate bar, folding and cutting it to physically explore halves, quarters, and eighths. This tactile activity served as the foundation for building deeper understanding.

A further theoretical underpinning came from Vygotskian perspectives on learning. Vygotsky (1978) argued that learning occurs in the "zone of proximal development" (ZPD), the distance between what a learner can do independently and what they can achieve with guidance. Within this study, the classroom teacher and support staff scaffolded learning by prompting student dialogue, guiding physical manipulations, and mediating conceptual clarification during moments of confusion. The collaborative nature of the lesson planning and teaching ensured that student learning was both supported and closely observed.

The lesson began with an image of two children holding a single chocolate bar, designed to engage learners in an authentic problem-solving scenario. From the outset, students were invited to predict what the problem was and to propose ideas about how to share the chocolate fairly or rather equally. Their responses became the foundation for a lesson focused not only on procedural tasks but also on mathematical reasoning, communication, and reflective thinking. Throughout the lesson, students were encouraged to use mathematical vocabulary, explore the concept, and justify their ideas. Observations by team members focused on identifying evidence of understanding, misconceptions, and opportunities for extension.

Ultimately, this report shows how collaboration among educators and careful attention to student thinking can lead to the design of effective

and meaningful learning experiences. Furthermore, it underscores the potential of seemingly simple resources, such as coloured paper, to create rich opportunities for deep mathematical engagement.

The following sections detail the school and class context, the composition of the lesson study team members, the purpose and rationale of the lesson, the planning process, and a comprehensive narrative of the lesson implementation, observations, post-lesson discussions, and key reflections. Through this case, we hope to demonstrate how lesson study, can be transformative for both teaching practice and student understanding.

The lesson study context

The school

The setting for this lesson study was J. Hookham Frere Primary School in Pietà, Malta – a school situated on historically significant grounds and adjacent to the gardens of Villa Frere. The school serves a diverse student population of approximately 225 children, ranging in age from 3 to 10 years. Reflecting local community values and cultural heritage, the school's ethos prioritizes holistic education, moral development, and collaboration between teachers, students, and families. These guiding principles are embedded in both policy and everyday practice, making the school an ideal environment for a collaborative research initiative such as lesson study.

J. Hookham Frere Primary emphasize equity, inclusion, and competency-based learning. The school's commitment to continuous improvement is evident through its involvement in national development programmes, its investment in teacher training, and its use of diagnostic tools to monitor student learning outcomes.

The students

The class selected for this study was a single Year 4 cohort, consisting of 21 students with varying levels of mathematical proficiency. Some children had only recently acquired foundational number skills, such as recognition of place value and basic arithmetic fluency. Others demonstrated age-appropriate mastery of numerical concepts and were beginning to explore mathematical relationships. This diversity provided both a challenge and an opportunity for lesson study, as it required the research team to design a lesson that was inclusive, differentiated, and grounded in sound pedagogical theory.

From a sociocultural standpoint, the class included a mix of students with different learning profiles, and socio-economic backgrounds. Most students were fluent in both Maltese and English however there may be varying home experiences with mathematics—some students had parents actively engaged in supporting learning, while others did not. This meant that the lesson needed to stand on its own as a powerful and accessible learning opportunity.

The team members

The effectiveness and depth of this lesson study were significantly influenced by the varied expertise and collaborative commitment of the team members involved (see Table below). This was not merely a group of individuals fulfilling roles but rather felt as a community of professionals who brought complementary perspectives, skills, and insights to the process. Their combined contributions enriched each phase of the study, from diagnostic analysis and planning to implementation, observation, and reflection.

At the helm of the facilitation process was Joanne Vella, the Head of Department for Mathematics at San Gorg Preca College. Joanne has been supporting Pietà Primary School for over eight years, and her longstanding relationship with the staff made her a natural choice to guide the team through this process. In addition to her responsibilities as facilitator, Joanne approached this experience as a professional development opportunity, actively engaging with the methodology of lesson study for her own growth. Her dual role, as both a leader and learner, brought a balance of leadership and humility to the meetings. She was instrumental in ensuring that conversations remained focused on student learning, while also allowing the space for authentic teacher voice and inquiry.

The class was taught by Marilyn Portelli, a teacher with more than a decade of experience at the school. Known for her commitment to developing a love of learning in her students, Marilyn brought to the lesson study a deep understanding of her learners' needs and prior experiences. Her familiarity with students' personal and academic profiles allowed her to anticipate potential misconceptions and tailor instructional strategies accordingly.

Two learning support educators (LSEs), Karen Caruana and Sandra Vella, played a crucial role in this context. Their responsibilities extended beyond simple classroom assistance; they work collaboratively

with the teacher to differentiate instruction, implement individual education plans (IEPs), and support both behavioural and cognitive development. Their insights were essential during the co-planning stages and during the observation of the research lesson.

A key logistical and strategic role was played by Nadine Borg Gove', the Deputy Head of School. With three years of experience in school leadership, Nadine is the link person for teaching, learning, and assessment in Mathematics. Her involvement was indispensable in setting the timeline, scheduling meetings, and ensuring that teachers were given the institutional support and release time needed to fully engage with the process. Ms. Borg Gove also participated in the lesson observation and discussions, where she offered valuable insight into how this approach could be scaled or adapted across other subjects and classes within the school.

Serving as the external expert was Marthese Morris, Head of Department for Mathematics at St. Thomas More College and a member of the mathematics support team (MST). Marthese brought with her both depth and breadth of experience in mathematics education. While she had been involved in lesson studies before, this was the first time she had participated throughout the entire cycle – from planning and observation to reflection and reporting. Her research on common misconceptions in fractions was especially valuable in shaping the lesson's focus and ensuring alignment with national learning outcomes. During the classroom observation, she adopted the role of a "more knowledgeable other," identifying subtle indicators of conceptual understanding or confusion and suggesting how future lessons might build on those observations.

Also supporting the initiative was Josianne Borg, a mathematics support teacher at San Ġorġ Preca College and serves as the support person for Pietà Primary School. She has been supporting this school for three years. She has carried out the diagnostic test for the year 3 students at the end of scholastic year 2023 – 2024 and carried out an item analysis of this test. Through this analysis, the LS group was able to identify the learning outcome for the lesson.

What united this team was a shared belief in the importance of understanding how children think about mathematics. Across professional roles and experience levels, the group demonstrated mutual respect, active listening, and a collaborative spirit that elevated

the work. This spirit of collaboration extended into the classroom during the lesson delivery. While Marilyn took the lead in guiding students, the other members observed with purpose, each focusing on specific areas such as language use, manipulation of materials, student engagement, and evidence of reasoning. The diversity of these observational lenses enriched the subsequent discussions and allowed the team to triangulate student learning from multiple vantage points.

In essence, the composition of the team exemplified the potential of interdisciplinary professional learning communities in primary education. By involving not only the class teacher and school-based MST staff, but also an external MST, and a leadership figures the lesson study created a dynamic space for growth. It modelled a form of teacher learning that is contextually relevant, collaboratively driven, and deeply anchored in the real-time experiences of students.

Name	**Role at school**	**Role in lesson study**
Joanne Vella	Head of Department (Maths)	Facilitator
Josianne Borg	Maths Support Teacher	Facilitator
Marilyn Portelli	Teacher	Team member + taught the lesson
Karen Caruana	LSE	Team member
Sandra Vella	LSE	Team member
Nadine Borg Gove'	Deputy head of school	Team member
Marthese Morris	Mathematics Support Teacher	Knowledgeable other

The lesson study process

The meetings

The planning process for the LS was based on a series of structured, collaborative meetings that brought together the collective expertise of the entire team. These sessions provided an opportunity not only to design the research lesson but to reflect on pedagogical intent, anticipate learner responses, and define success criteria. The team approached the planning process as iterative and dialogic, with each meeting serving as both a continuation of previous discussions and a refinement of emerging ideas.

The first planning meeting took place on December 10, 2024. During this session, team members introduced themselves and clarified their

respective roles. Joanne Vella, as facilitator, outlined the structure and purpose of lesson study, emphasizing the goal of using a collaboratively designed lesson to gain insight into student thinking. The team began by familiarizing themselves with the Year 3 diagnostic assessment, but no specific focus had yet been identified.

Between the first and second meetings, the class teacher and LSEs independently reviewed the diagnostic results more closely and identified fractions as an area of concern. The item in question, a task asking students to shade one-quarter of a rectangle divided into eight equal parts, was one where many students struggled, and the responses confirmed the existence of widespread misconceptions. The Mathematics Support Team immediately acknowledged this difficulty, noting that this is a nationally observed pattern. Many students misinterpret this task due to a lack of conceptual understanding, often shading only one part without considering the equality of parts or their relationship to the whole.

As a result, by the time the second meeting took place, fractions—specifically the understanding of unit fractions – had emerged as the

most pressing issue. The group collectively agreed that this would be the focus of the study, aiming to address the problem not by rote correction but by guiding students toward a deeper, conceptual understanding of fractions.

By the end of this meeting, the team had identified fractions – specifically the understanding of unit fractions – as the focus of the study. They agreed that misconceptions around identifying fractional parts were persistent and detrimental to students' mathematical development. The team's shared goal became to design a lesson that could address these misconceptions not through procedural correction but through conceptual exploration. The idea of beginning with a simple, relatable problem – such as two children sharing one chocolate bar – was suggested to ground the mathematics in a familiar context.

The second meeting, held on January 14, 2025, was dedicated to refining the focus of the lesson and beginning to sketch its structure. The team revisited the diagnostic data, this time zeroing in on the reasons behind students' misconceptions. They discussed the tendency of pupils to treat the numerator and denominator as separate whole numbers, rather than components of a unified concept. The importance of concrete resources and visual models was emphasized, and the team committed to using a CPA approach.

During this session, the team also explored a range of possible resources and tasks. At one point, there was considerable discussion about using the children's story When the Doorbell Rang to frame the lesson. While the narrative of the story aligns well with ideas about sharing and increasing quantities, the team eventually decided that introducing it in the first fractions lesson could shift the focus toward fractions of quantities too soon. Moreover, using real or pretend biscuits raised logistical concerns related to time, distraction, and messiness. The consensus was to retain the idea for a future lesson, once the foundational concepts had been established.

The third planning meeting, conducted on January 21, 2025, focused on lesson structure and student engagement strategies. At this point, the first full draft of the lesson plan had been developed, and team members began to critically evaluate its components. The lesson introduction, use of manipulatives, vocabulary, and predicted student responses were reviewed. Of particular importance was the decision to begin with a THINK–PAIR–SHARE activity, encouraging all students to participate

in identifying the problem of how two children might fairly share one chocolate bar.

One of the critical discussions during this session concerned the shift in focus from fractions of quantity to the understanding of fractions as a number. Team members agreed that moving beyond rote application to a more conceptual framing would make the lesson more effective. This

also prompted a re-evaluation of the types of questions the teacher would ask, ensuring that they supported reasoning, comparison, and the development of precise vocabulary.

The final meeting before the lesson delivery occurred on February 4, 2025. This session was highly practical and detail oriented. The team finalized all aspects of the lesson: the resources (coloured paper, scissors, glue, whiteboards), group configurations, observation protocols, and anticipated challenges. Roles were clearly defined—while Marilyn would teach the lesson, the observers were each assigned specific focal points such as language use, accuracy in folding, student participation, or evidence of misconceptions. Contingency plans were discussed in case of technical or behavioural disruptions.

The lesson plan co-designed and refined through this lesson study is provided as a separate document. It complements the reflections and observations shared in this report and offers a practical overview of how research and collaboration informed our classroom approach.

A shared observation sheet was designed to collect qualitative data during the lesson. This included prompts for noting student responses, questions posed, visual representations used, and the level of peer collaboration observed. The team emphasized the importance of documenting not only what students did correctly but also how they approached tasks, where they hesitated, and how they verbalized their thinking.

Throughout these meetings, the collaborative tone remained constructive and focused. However, one of the main challenges the team encountered was time management. The team could only meet during a specific time slot on Tuesdays, which allowed for a 90-minute session. While this may seem like a lengthy meeting, it was ideal for enabling all members to share their insights, raise concerns, and contribute meaningfully to the process without rushing into decisions. The length of the meeting fostered thoughtful discussion and genuine collaboration.

That said, having only one available slot each week introduced a level of fragility to the process. If a school event, outing, or unforeseen emergency coincided with the Tuesday slot, the meeting would need to be postponed to the following week—if possible. This limitation underscored the reality that lesson study requires dedicated, protected time in the school schedule to function effectively.

To the team's advantage, a strong sense of collective commitment emerged. The class teacher, LSEs, and Deputy Head Ms. Nadine made the deliberate decision not to hold meetings unless the full team could be present. Even when some members could only attend virtually, the meetings continued as scheduled. This decision ensured that everyone had equal access to the discussion and that all planning decisions were made with full consensus. The inclusive approach reinforced the spirit of collaboration and unity that defined the entire planning process.

The problem-solving lesson

At the time of planning, it became clear during one of the team's initial meetings that this would be the first formal lesson on fractions for this Year 4 class. Although pupils had been introduced to basic fraction concepts such as halves and quarters in Year 3, there had been a significant gap in instructional continuity – an issue made more pressing given that the lesson study was taking place in the second term of the academic year. This lack of recent engagement with fraction content may have contributed to the diagnostic results, as students had not yet had the opportunity to revisit or reinforce their earlier learning.

For the Mathematics Support Team, it was somewhat surprising to discover that fractions had not yet been addressed by this point in the year. The team had assumed a degree of progression that was not borne out in the classroom experience. As a result, the only available evidence of students' understanding came from the diagnostic test. This limitation made the lesson study even more valuable, offering the team an opportunity to collect real-time observational data and student responses that could clarify how pupils were conceptualizing fractions in the absence of recent instruction.

The lesson study team acknowledged that while the class teacher had previously engaged students in group work, there was uncertainty about whether students would be able to manage the physical demands of the planned hands-on tasks. Specifically, concerns were raised about the students' fine motor skills, including cutting and folding paper accurately – skills that are essential when exploring fractions through physical representation. This concern may reflect a broader trend, where in early years classrooms, the focus on literacy and writing development sometimes overshadows the development of fine motor coordination. While it would be inappropriate to attribute this solely to early years practices, it is important to consider how foundational motor skills influence learning in upper primary grades.

Given these reservations, the team was cautious but optimistic. Initially, the team had considered using the story "When the Doorbell Rang" as the basis for the lesson. This children's book presents a narrative where a group of children must continuously re-divide a batch of biscuits as more friends arrive. While rich in mathematical potential, especially around the concept of fractions of quantity, the team recognized that this context might shift the focus away from the conceptual understanding

of fractions as numbers representing parts of a whole. Using the story would likely have required students to immediately apply fraction knowledge to solve sharing problems involving a growing number of participants.

Moreover, introducing a narrative at this stage, particularly one involving real or pretend biscuits, raised logistical concerns. The team anticipated that biscuits might serve as a distraction or invite behaviour unrelated to mathematical reasoning. There were also practical issues such as the potential messiness of the resource, variability in biscuit size, and challenges in ensuring fairness across the groups. Additionally, time management became a critical consideration. Starting the lesson with a story would likely have reduced the time available for the hands-on folding and cutting activity, which was central to the learning objectives.

Therefore, the team collectively decided to delay the use of the story for a future lesson and instead began with a simplified and concrete problem: two children sharing one chocolate bar. This choice provided a context that was highly relatable, visually interpretable, and easy to model using manipulatives. It created an accessible entry point for students to explore the meaning of equal sharing and set the stage for building vocabulary and reasoning around fractions without overwhelming them with extraneous elements. This streamlined approach ensured that the lesson's focus remained on conceptual clarity rather than procedural application.

The lesson plan

A critical consideration in choosing fractions was the students' prior learning experience. Although Year 3 curricula introduce students to the idea of halves and quarters, the long gap without reinforcement had seemingly eroded their confidence and fluency with these ideas. Starting with a revision of halves and quarters and extending to eighths offered a logical progression that aligned with national learning outcomes, particularly 5.1.13: "I can recognize and name fractions with denominators up to 12 that are parts of a whole (which is divided into equal parts)."

In the planning meetings, a recurring theme was the importance of not assuming prior knowledge but instead using the lesson as an opportunity to surface what students remembered and misunderstood. As such, the lesson was structured to include multiple forms of

formative assessment. The opening scenario with the chocolate bar allowed the teacher to elicit existing ideas about sharing and fairness. The paper-folding activity provided insight into students' spatial reasoning and their ability to conceptualize equal parts. The labelling task revealed whether students could map symbolic notation onto concrete models.

Choosing a lesson on fractions also aligned with broader curriculum goals in Malta, where increased emphasis is being placed on reasoning and problem-solving across mathematical strands. The National Curriculum Framework and the Learning Outcomes Framework both encourage the use of real-world contexts and concrete-pictorial-abstract (CPA) progression. The chocolate bar problem represented a familiar and meaningful context that would allow students to engage in inquiry without being overwhelmed by unfamiliar representations.

The lesson was also seen as an opportunity to reinforce mathematical language. This emphasis was not solely due to the multilingual nature of the classroom but rather because mathematics itself is a language—one with its own vocabulary, syntax, and structures. For students to engage in meaningful mathematical reasoning and communication, they need access to this language. Key terms such as 'fraction,' 'equal part,' 'whole,' 'numerator,' and 'denominator' are not just labels but tools for thinking, explaining, and justifying. By introducing these terms within a concrete and familiar context—sharing a chocolate bar—the team

aimed to make the vocabulary accessible and purposeful. This approach helped to bridge the gap between physical experience and abstract representation, ensuring that students could not only perform tasks but also describe and reflect on their mathematical thinking.

One of the guiding rationales for the lesson was the belief that fractions, though abstract, can become meaningful through action and dialogue. Rather than treat fractions as static facts to be memorized, the team wanted students to experience them as dynamic relationships that could be explored, questioned, and represented in different ways. This intention influenced every aspect of the planning—from the choice of paper over pre-cut manipulatives, to the phrasing of teacher questions, to the arrangement of student groups.

Finally, the lesson (see Appendix 1) was planned with a deep awareness of the importance of building a positive mathematical disposition. For many students, fractions are a source of confusion and anxiety, often because they are introduced through procedural exercises that lack meaningful context. By beginning with a situation that was simple, familiar, and relatable—two children sharing a chocolate bar—the team hoped to invite curiosity rather than apprehension. In doing so, they sought to create a classroom culture in which mathematics was not something done to students but something they could do, explore, and understand.

Learning from observations of students working in group

Group work is widely recognised as a powerful pedagogical tool in mathematics education. It fosters communication, collaboration, and the co-construction of knowledge, enabling students to articulate their thinking, confront misconceptions, and learn from their peers. Research by Webb (2009) and Boaler (2016) highlights that group-based learning not only supports cognitive development but also contributes to students' mathematical identity and engagement.

During this lesson, observers noted the varying dynamics across student groups, which significantly influenced learning outcomes.
In one group, students displayed a mix of personalities and engagement levels. Student 1 appeared hesitant, frequently seeking confirmation from peers before proceeding with tasks. Two dominant members often competed for control, which limited others' participation. Other group members contributed meaningfully but remained passive unless

prompted. The group showed uneven interaction, with quieter students needing support to engage.

In another group, collaboration was more balanced. Student 2 took a leadership role, confidently guiding peers and articulating fraction concepts. Though occasionally hasty, this student showed initiative and deep understanding. The rest of the group contributed consistently, rephrased instructions collaboratively, and showed effective teamwork. The dynamic encouraged inclusive participation and deeper engagement in extension activities.

The third observation highlighted effective collaboration, where one student emerged as a leader with a deep conceptual grasp. Other students were quieter but participated when prompted. Mathematical reasoning and communication were strong, and instructions were often rephrased within the group to support understanding.

The fourth group displayed varied levels of engagement. One student confidently led discussions and demonstrated a strong understanding of fractional concepts and mathematical language. Another student, however, struggled with precision and required prompting to remain engaged. Despite these differences, the group successfully reconstructed the whole using fractional pieces.

In the final observation, the observer noted that a student who has a support assistant showed limited level of mathematical understanding. It was also noted that the group understood better when the teacher was demonstrating rather when the explanation was just verbal. At the conclusion of the lesson, three out of four students showed a clear understanding of the concept, whereas the fourth student had not yet grasped it.

Across all groups, the hands-on and visual aspects of the lesson were well received. Students demonstrated a sound understanding of fundamental fraction concepts, even as they encountered challenges with physical execution, such as folding paper accurately. Misuse of mathematical vocabulary, such as labelling two halves as 1 and 2, also emerged. Nonetheless, spontaneous mathematical reasoning was evident in every group.
Differences between groups were mainly driven by group dynamics. In some cases, dominant students limited the contributions of their peers, while in others, leadership was inclusive and constructive. Groups that achieved a balanced approach to collaboration demonstrated greater engagement and deeper reasoning, especially when reconstructing wholes from fractional parts.

These observations underscore the double-edged nature of group work. While collaboration can deepen understanding, unequal dynamics may hinder the learning experience. Dominant personalities can unintentionally overshadow quieter students, reducing their opportunity to contribute and grow. As this lesson lacked a dedicated individual phase, students had limited time to process ideas independently before or after collaboration.

Educational research (OECD, 2017; Vygotsky, 1978) highlights the importance of integrating both independent and group learning. Individual thinking time fosters personal reasoning and supports all learners in contributing meaningfully to group discussions. Future lessons should balance these modalities by incorporating reflective pauses, structured roles, and strategies to promote equitable interaction.

Ultimately, group work must be intentionally designed and facilitated to ensure all students are heard, supported, and intellectually challenged.

Student feedback

The feedback collected from students after the lesson study provides valuable insight into their emotional engagement and perceptions of learning. Across all five reflective statements, the data reveals a consistently high rate of positive responses, particularly in relation to enjoying the lesson content and appreciating the collaborative nature of the task. Specifically, over 84% of students indicated a positive emotional response to both the initial problem posed by the teacher (Q1) and their desire to have more lessons like this one (Q5).

Students also responded favourably to working with peers and learning something new, with nearly 79% indicating smiley responses for both Q2 and Q4. Confidence, while still mostly positive, showed the highest degree of uncertainty – only 68% responded positively to Q3, and six students chose a neutral face, suggesting that some learners may have felt unsure of their abilities or overwhelmed by the group task.

Notably, two sad face responses were recorded: one for Q1 and one for Q5. These responses remind us that while the general sentiment was positive, a small number of students did not connect emotionally with the lesson or its structure. It would have been ideal to interview these two students to gather more insight.

Written comments echoed these mixed experiences. Many students described the lesson as "fun" and enjoyable, highlighting parts like folding, playing, or working in a team. Others pointed out social difficulties, such as peers not sharing, team arguments, or feeling left out, which suggest that not all students experienced group work as inclusive. One child noted that their understanding came from help at

home ("My dad taught me this"), showing that students bring diverse prior experiences that can impact classroom confidence.

In summary, the feedback affirms the lesson's success in engaging learners emotionally and cognitively. However, it also highlights the need for:

- Better scaffolding of group roles and dynamics to ensure fair participation.
- A balance between individual and group thinking time to support student confidence.
- Opportunities for checking understanding mid-task, especially for those less vocal.

These insights can directly inform future iterations of the lesson and support the team's ongoing refinement of collaborative tasks and inclusive classroom practices.

The post-lesson discussion and reflections from the project co-leader

The post-lesson discussion was a crucial reflective stage in the lesson study process, allowing all team members to analyse the lesson delivery, pupil responses, and areas for refinement. The discussion revealed several noteworthy outcomes and offered direction for future practice.
The lesson began with an image of two children and a single chocolate bar, prompting an open-ended discussion. Pupils demonstrated initiative and creativity in their interpretations, immediately engaging with the idea of fairness and equal sharing. Some began folding paper diagonally, revealing their willingness to explore independently.

During the mini lesson, a conceptual shift was made from seeing fractions as quantities to understanding them as numbers. While most pupils grasped the idea, pronunciation and use of vocabulary like numerator and denominator presented a challenge. Observers noted this as an area for future reinforcement.

The folding and cutting activities exposed a common misconception: pupils sometimes labelled two halves as "1" and "2," misunderstanding the concept of part-to-whole. This provided an opportunity to clarify that ½ and ¼ represent single parts of a whole, not separate whole numbers.

Several students made insightful, observations. Some students asked if one forth is a quarter: "What is one eighth called?" while another linked the activity to Year 3 learning. These moments of independent reasoning affirmed the need to create space for student-led inquiry during lessons.

Group work brought out different levels of engagement. Students typically passive in whole-class settings were more active during group tasks, though dominant personalities occasionally restricted participation. One student only voiced her thinking to the support teacher, illustrating the subtle barriers that can exist even within active classrooms.

The task requiring pupils to reconstruct the whole using fractional pieces challenged spatial reasoning. While students approached it with resilience, some struggled to rotate and align pieces correctly. This pointed to a developmental area worth exploring further in future planning.

Dr James Calleja reflected deeply on the lesson, praising the simplicity of resources and the power of the mathematical task. He warned against overcomplicating lessons with materials that can dilute focus and

consume valuable time. The A4 paper activity proved that minimal tools could yield rich learning if the task itself is well designed.

He stressed the importance of using relatable images to launch mathematical discussions, as they offer accessible entry points for all learners. He also highlighted that the task itself, not the materials, must drive the learning. A good mathematical task raises further questions, generates curiosity, and links to broader concepts.

Dr Calleja challenged the assumption that pupils begin with no knowledge. He emphasised the value of building upon what children already know, whether from prior schooling or home learning. Recognising this empowers students and validates their experiences.

When students introduced ideas like symmetry during the lesson, Dr Calleja recommended "shelving" these for later exploration. Teachers don't need to address every tangent immediately, especially if students are not yet ready to explore them in depth.

He also underscored that mistakes are vital learning moments. "The more mistakes they make, the more we have to discuss," he noted. Such errors offer opportunities for clarification and deeper insight.

Lastly, Dr Calleja advocated for beginning lessons with individual work to allow students time to form their own ideas before entering group discussions. He also advised that what is written on the board should remain visible throughout the lesson, supporting shared understanding and reinforcing student contributions.

Together, these reflections reinforce the value of balancing structure with responsiveness, individual with collaborative learning, and simplicity with depth. The lesson served as a rich example of how thoughtful design, active observation, and reflective discussion can advance teaching practice.

Main takeaways

Participating in the planning and teaching of the research lesson was a transformative experience for the team. It fostered a collaborative culture where each member, regardless of role, was valued for their insights and contributions. Team members reflected on how this experience differed from conventional professional development.

Rather than passively receiving training, they actively shaped the lesson through thoughtful dialogue and joint decision-making.

The class teacher appreciated the mutual respect and trust shown by the group. She noted how empowering it was to be considered a key decision-maker in designing the lesson, especially given her knowledge of the students' capabilities and classroom context. This ownership was cited as a motivating factor in the success of the lesson and reinforced the importance of involving classroom teachers meaningfully in educational innovation. She also observed that weeks after the lesson, students continued to refer to the concepts and activities experienced during the study when working on fractions – evidence of long-term impact and retention.

Throughout the reflective process, members remarked on the intensity and richness of planning. Unlike typical lesson preparation, every step was scrutinised: from the way tasks were introduced to the wording used in explanations. While demanding, this depth of analysis made the lesson more focused and effective. It also led to greater awareness of small details that might otherwise go unnoticed, such as the pacing of transitions or how instructions are perceived by different learners.

Another powerful insight emerged during the classroom observation: even with a well-planned lesson, the reality of classroom learning is fluid and often unpredictable. The team was struck by the creativity and adaptability of students, who brought their own prior knowledge and ideas to the task. Some pupils even recalled previous learning or family discussions to make sense of the problem, affirming the need to honour the diverse experiences students carry with them.

A recurring theme in the reflections was the value of using simple, accessible materials. The decision to forgo digital tools in favour of paper helped focus students' attention and made the mathematical thinking more visible. Observers found that without the distraction of screens, students communicated more, manipulated materials more thoughtfully, and stayed focused on the mathematical ideas.

The team also recognised the importance of reflection not just after the lesson, but as an embedded part of the planning and delivery process. The post-lesson discussion revealed how each team member had noticed different things, reinforcing that observation is inherently subjective and

dependent on the observer's lens. This multiplicity of perspectives enriched the collective understanding of the lesson's impact.

In conclusion, the lesson study process demonstrated the power of collaboration, teacher agency, and reflective practice. It highlighted the importance of creating space for both teacher and student voices, of balancing structure with responsiveness, and of viewing every lesson not just as a teaching opportunity but as a window into the learning process. The mini takeaways – about trust, simplicity, student agency, and the value of reflective dialogue – will continue to inform the team's approach to lesson design in future cycles.

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Appendices

Appendix 1 – The lesson plan

	One chocolate – two children Break it in two. Share it equally. Share it fairly! Ask: Have you ever been in a similar situation? When? How and what did you do? ….. Ask: What is sharing? How do we share equally? Wait for responses. Explain: Today we are going to share **equally**. How can Tina and Paul share this chocolate equally? Ask pupils to THINK – PAIR - SHARE – Teacher waits for responses – teacher writes all responses on whiteboard. (Discuss all responses). Incorrect responses: Are these equal? Ask: How much of the chocolate bar does Paul have? One half for Paul and one half for Tina		3. Give opportunity to pupils to share in other ways which are still equal. Show the different ways pupils divided the bar into two equal parts so all groups can see different ways how to divide by two. If all pupils divided the piece of bar in the same way teacher shows another way and asks if this is correct as well. Is this half? How do we know?

The Lesson Phases			
Phase 1 Introduction Resources: Picture of children with chocolate bar Picture of chocolate bar Scissors At the back of chocolate bar teacher writes half/ ½ Whiteboard Children are divided into 4 groups of 4 and 1 group of 5	*How will the lesson be introduced? What will you say and/or do to get them interested?*  Ask: What do you think is the situation here? Note all responses and repeat their responses in teachers wording. E.g. Child says Yes! They must break the chocolate Teacher says: They must break the chocolate – what else can we say instead of 'break the chocolate'	*What difficulties might students encounter?* 1.Sharing fairly - Sharing fairly means distributing resources in a way that accounts for individual needs, circumstances, or fairness beyond numerical equality. Sharing equally - Sharing equally means dividing resources so that everyone gets the same amount, regardless of needs or other factors. 2. They do not share the bar equally! 3. All pupils share the bar of chocolate the same way thinking there is only one way how to share it. **4. Do no use the appropriate vocabulary such as equal or divide. SHARE EQUALLY or DIVIDE IN TWO.**	*How do you intend to address these difficulties?* 1. If a child struggles to understand **sharing a chocolate** or does not see the importance of sharing (e.g., suggests buying another one instead), I will respond in a way that encourages **empathy and reasoning.** I can say "That's an interesting idea! **Buying another chocolate** means everyone gets their own. **But what if** we only have one chocolate and can't get another? What could we do then?" This helps the child **think about limitations and real-life situations** where sharing is necessary. *2.If they do not share it equally* - Put the two pieces on top of each other and ask children if the pieces area equal. If not – we give pupils another opportunity to divide equally

	Teacher cuts the chocolate bar in half, turns the chocolate bar to show the children the word 'half' and ½. Ask: What can you tell me about the two halves? EQUAL and together make one whole Teacher sticks on whiteboard, another whole chocolate bar and the 2 halves underneath. Mini-lesson- Explain We write half as ½ - teacher points to the numerator- numerator – fraction bar and the denominator. Explain: fraction is a type of division of a whole into equal parts. The denominator represents in how many parts the whole is divided. The chocolate is divided into two parts (show concretely) that is why the denominator is a 2.	5. Children write the fraction bar slanting.	5. Correct pupils to write the fraction bar horizontally and explain the meaning of the fraction bar.

	Then we can focus on the numerator. what about the numerator. How many parts do we have here, 1 part, write 1 as the numerator. One part of two.		
Phase 2 Students' work Resources: Coloured A4 papers pencils/colours Scissors 30cm Rulers	*How will students work? Will they be involved in individual work? Or will they be asked to work in pairs or within a small group of 3 or 4 students? Explain how this will be* Introduce the Paper as the "Chocolate Bar" (Teacher gives one paper per group – red colour) Say: "This piece of paper is going to represent the chocolate bar. Imagine you have to share it equally between two children." Ask: How can we share this chocolate bar equally between two children? Pair-think-Share Pupils: Hold the paper horizontally/vertically/diagonal. Make sure that the edges are held together. Emphasize equal parts.	*What difficulties might students encounter with the set task/s as they start working on it?* Folding the paper to have two equal parts. Pupils may assume that half is finding the line of symmetry.	*How do you intend to address these difficulties? What kind of help do you intend to provide?* Demonstrate again the importance of being accurate when folding equally. Suggest using paper clips to hold the paper for accuracy. If pupils do not share equally give another paper for practice. Show halves that are not symmetrical and halves that are symmetrical. Emphasize the definition of half

	Emphasize: "This fold shows how we can divide the chocolate bar into two equal parts." Step 3: Children cut the paper into equal parts. Step 4: How can we check that they are equal? Ask: "Are the two parts equal? How can we tell?" Step 4: Label the Parts Write "1/2" on each part. Say: "Now you have two halves of the chocolate bar." Teacher roams around and finds different halves Teacher discusses the different ways how to make halves.	Pupils may find it difficult to write one half in numbers.	Show and demonstrate on whiteboard.

	Say: Now you just shared the chocolate bar between two children and you each have a half. Now let's share another chocolate bar equally between the 4 of us. Teacher gives yellow coloured paper to each group. Say: The chocolate bar is the same size as the red paper. Think – Pair – Share Children are instructed to cut the paper into 4 equal parts. Ask: How did group 1 share the chocolate equally between 4 students? Ask: Is there a group who did it differently? How can you check that all four parts are equal? What do you think we call that part now? Say: Fraction is $\frac{1}{4}$ (quarter) Say: Check if all four quarters are equal.		

	Write one quarter on each piece --- Show the whole, the half and the quarter. Say: Look at whole, the half and the quarter. What do you notice? Repeat the same with eights? - purple paper ---		
Phase 3 Summary and closure White papers to represent the whole. Glue	*How do you intend to bring the lesson to a closure?* *Problem Solving:* *Now, if I had to ask you to put the whole back together, how would you do it?* *Think-pair-share* Encourage the pupils to take the different fractions and put them together as a whole. Encourage them to recite the names of the pieces and say how they put back the whole, E.g, One half and one half is one whole	*What difficulties might students face during this phase of the lesson?* 1.They may not put back the original whole – or try to put all the pieces together.	*How will you try to address these difficulties?* 1. Make sure that they have the original A4 paper to compare their whole with the original whole.

	One quarter, one quarter, one quarter and one quarter makes one whole. One half and one quarter and one quarter makes one whole		