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Lesson Study Reflections: Enhancing Ratio and Proportion Instruction in a Philippine School Setting

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A B S T R A C T

Lesson Study provides an opportunity for teachers to engage in layers of individual and collaborative reflections in, on, and for practice to improve the teaching and learning process filling the gaps in the educational landscape. This paper reports on reflections on teaching ratio and proportion online using Lesson Study, which could improve the teaching-learning process, specifically on pedagogy. The study consisted of three major stages: Lesson Planning, Lesson Study Proper, and Reflection through post-lesson discussion. The research lesson study proper was participated in by Grade 9 students in a school in the Philippines and six teachers—one taught the lesson, and the other five observed the class via Zoom. Also, the six teachers were participants in the post-lesson discussion. The data gathered from this descriptive qualitative study were analyzed using thematic analysis. It was concluded that in teaching ratio and proportion, the distinction between terminologies must be emphasized so there will be no confusion for the students to use what is proper. Moreover, it is advised that a real-life problem involving ratio and proportion be included in the lesson so that students will appreciate its uses and lessen its abstraction. Teachers must also go beyond routine activities to increase students' critical thinking and employ Higher Order Thinking Skills. Thus, it is recommended that mathematics educators apply in their instructional contexts and facilitate the translation of research insights from the Lesson Study into classroom practice.

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RESUMO

O Lesson Study oferece uma oportunidade para os professores se envolverem em camadas de reflexões individuais e colaborativas na, sobre e para a prática, a fim de melhorar o processo de ensino e aprendizagem, preenchendo as lacunas no cenário educacional. Este artigo relata reflexões sobre proporção e proporção de ensino on-line usando Lesson Study, o que poderia melhorar o processo de ensino-aprendizagem, especificamente em pedagogia. O estudo consistiu em três etapas principais: planejamento da aula, estudo da aula propriamente dito e reflexão por meio de discussão pós-aula. O estudo da aula de pesquisa propriamente dito contou com a participação de alunos do 9º ano de uma escola nas Filipinas e de seis professores – um deu a aula e os outros cinco observaram a aula via Zoom. Além disso, os seis professores participaram da discussão pós-aula. Os dados obtidos neste estudo qualitativo descritivo foram analisados por meio de análise temática. Concluiu-se que no ensino de proporção e proporção, a distinção entre terminologias deve ser enfatizada para que não haja confusão para os alunos usarem o que é adequado. Além disso, é aconselhável que um problema da vida real envolvendo razão e proporção seja incluído na lição para que os alunos possam apreciar os seus usos e diminuir a sua abstração. Os professores também devem ir além das atividades rotineiras para aumentar o pensamento crítico dos alunos e empregar habilidades de pensamento de ordem superior. Assim, recomenda-se que os educadores matemáticos apliquem nos seus contextos de ensino e facilitem a tradução dos conhecimentos de investigação do Estudo da Lição para a prática da sala de aula.

Keywords:
habilidades de pensamento de ordem superior, estudo de lição, razão e proporção, reflexão, online

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Introduction

The Philippines is consistently one of the countries that ranked low in Mathematics based on the results of the Programme for International Student Assessment (PISA) 2019 and 2022 (Chi, 2023; San Juan, 2019). This shows the need for immediate improvement in mathematics instruction. Nevertheless, the pedagogy being espoused by teachers is considered one of the factors that lead to students' poor performance in mathematics (Ngiwas et al., 2022; Rabanal & Domondon, 2023). The main issue with mathematical reasoning instruction is that teachers can put up assignments that stimulate reasoning but cannot directly teach mathematical reasoning habits (Manmai, Inprasitha & Changsri, 2021).

The teachers must apply appropriate teaching methods depending on the situation, learning environment, and the nature of the students (Baig, 2015). Using proper teaching methods may lessen the confusion about the subject that leads students to dislike it. Teaching pedagogy combines technology and content knowledge (Erdogan & Sahin, 2010). The quality of teaching can be directly predicted using the measure of the teachers' mathematical knowledge and pedagogy (Clements & Sarama, 2016). Ideally, teachers use different pedagogy or teaching styles, like that reflective teaching, that improve the teaching-learning process (Sumantri, Prayuningtyas, Rachmadtullah & Magdalena, 2018; Zulfikar & Mujiburrahman, 2018), and that may help students to improve their thinking (Colomer, Serra, Cañabate & Bubnys, 2020) to quickly understand the lesson and enhance their performance and appreciation of students to the subject.

The twin goals of Philippine Basic Math Education are critical thinking and problem solving that may nourish the concept and application of the content areas of Mathematics (Ngiwas et al., 2022). Critical thinking covers many concepts, from criticism, synthesis, analysis, evaluation, problem-solving, and creating, which makes it a broad term (Heiman & Slomianko, 1987). Critical thinking relies on oneself, wherein rather than passively learning something from someone else, one does an active process of thinking things through, raising questions, and looking for relevant information from oneself (Fisher, 2001). Encouraging students to ask critical questions will result in them learning how to think (Mason, 2008). Teachers should use strategies that are going to produce active learners that are creative and critical workers who value the never-ending importance of continuous learning. On the other hand, problem-solving is dealing with a problematic situation or a particular problem that involves choices to make and decisions to answer or solve an issue (Bailin & Siegel, 2002). High-quality math instruction should be based on validated methods that focus on understanding the concepts and will also improve the reasoning and problem-solving skills of the learners (Maccini et al., 2008).

Specific topics involving problem-solving in Mathematics, like ratio and proportion, were found difficult by the students (Jitendra et al., 2009; Debreli, 2011; Boudreaux et al., 2015; Dougherty et al., 2017) due to learning difficulties like misconceptions and lack of

understanding (Çalışıcı, 2018; Domondon, Pardo & Rin, 2022). Moreover, learners found it difficult to complete problems that have different contexts, the learning material of ratio and proportion topics presented in textbooks are not depth, and the lack of ability of the teacher to create problems (Andini & Jupri, 2017). Aside from the traditional way, different teaching approaches like schema-based instruction (Jitendra et al., 2009), creative drama-based instruction (Debreli, 2011), and envelope technique (Çalışıcı, 2018), were already used in teaching ratio and proportion; however, there are still some students who find the topics complicated.

For those reasons, this study aims to engender reflections on (knowing- and) reflecting-in-action (Schön, 1992) about teaching ratio and proportion using Lesson Study to fill the gaps in the educational landscape by improving not only the reflective pedagogy of teaching the topics but also the students' critical thinking problem-solving as it would be applied inside the classroom. As mentioned by Thorsen and DeVore (2013), teachers engaging in this particular reflective practice (reflecting-in-action) like Lesson Study engender a purpose to tailor their teaching methods, line of questioning, and the complexity of the content they are teaching to address the learning needs of their learners. This paper, alongside other reflective research done in Mathematics Education, endeavors to improve mathematics instruction through Lesson Study, a teacher professional development model that systematically allows teachers to engage in collective reflections-in-practice and subsequently reflect on and for practice (Schon, 1992). According to LaBoskey (as cited in Thorsen & DeVore, 2013), an effective method for reflective practice must promote reflection and allow the execution of important analysis of outcomes that develop from reflection on and for action. Thorsen and DeVore (2013) posit that teachers engaging in reflection-on-action, deemed to improve their effectiveness in instruction, bring about improvement in student learning outcomes, while those doing reflection-for-action seek to promote transformational education to promote social justice, equity, and equal opportunities.

Methodology

Lesson Study, as a reflective methodology, is widely used in Japan (Makinae, 2019). The four essential features of Japanese lesson study are a common long-term goal for teachers, lesson content, analysis of students, and live observations of lessons (Lewis, 2002). The lesson study rests on the old saying that two heads are better than one; however, other experts in the field should join the activity to complement the possible limitation of the collective wisdom of the group members (Fernandez & Chokshi, 2002). Lesson study focuses not only on teaching but also on the improvement of teachers, which increases mathematical knowledge and beliefs that support instructional improvement and improve student learning (Lewis et al., 2012). Lesson Study follows a systematic cycle by which mathematics teachers in the same school or workplace collaborate by determining a goal for the lesson, collaboratively crafting a lesson

plan, and executing the research lesson while colleagues and some experts in the field are observing, reflecting on the teaching and learning the occurred, possibly revising the lesson, and iteratively repeating the process (Elipane, 2012).

Critical Reflection with the discussion of different perceptions and views of the nature of teaching and learning through Lesson Study will benefit the collaborating teachers. It will provide an excellent opportunity to learn from experienced teachers to gain professional development (Davison, 2006) since the goal of reflection is to translate observations into informed actions (Alam, 2016). Through Lesson Study, reflections on feelings, experiences, understandings, and learnings from the process involved are critically discussed (Rock & Wilson, 2005). Moreover, the effective collaboration involved in Lesson Study requires trust, honesty, and a shared time of interaction between collaborators for them to be familiar with how each one thinks, which will allow open disagreement for the benefit of the topic (Perry & Lewis, 2008). In introducing Lesson Study as a professional development model in the Philippines, Elipane (2017) asserted that it "provides affordances for its participants to learn by seeing other teachers (or their colleagues) teach, and afterward discuss an actual lesson wherein they can link theories with practice" (p.1128).

These characteristics of Lesson Study fit the definition of Reflection, which was put forward by Mena Marcos et al. (2009) as a cyclical problem-solving process carried out systematically and intentionally in which theory interacts with practice. They continued that the cognitive process or reflection comprises other sub-processes of thought and action like planning, evaluation, observation, and collaboration.

The researchers utilized Lesson Study to facilitate reflections on reflecting-in-action– which, according to Schön (1992), must allow a teacher to be able to "observe herself in the doing, and to communicate what she discovers, she must describe it; there is an art of description distinct from the art that may be involved in the action described" (p. 126). Lesson Study, in turn, provides opportunities for collaboration in allowing the Lesson Study participants to do the observations for a teacher as s/he was momentarily engaged in his/her actions as the research lesson unfolds.

This descriptive qualitative Lesson Study was voluntarily participated in by fifteen (six males and nine females) Grade 9 students in a Laboratory School at a university in the northern part of the Philippines, and six teachers as one taught the lesson, and the other five observed the class. The six teachers, including the lesson study teacher, were the participants in the lesson study's post-lesson discussion, where the data were gathered. The Lesson Study utilized three major stages, namely 1) the Lesson Planning, 2) the Lesson Study Proper, and 3) the Reflection through post-lesson discussion.

During the lesson planning, the topic was carefully selected considering the Most Essential Learning Competencies (MELCs) of Grade 9 students at the particular time the research lesson was conducted. It was about ratio and proportion. MELCs are a response of

the Department of Education (DepEd Memo 012, s. 2020) in addressing the challenges of the pandemic and part of the long-term response to Sustainable Development Goal 4 (SDG4) to develop resilient education systems (UNESCO, 2017). Ratio and proportion are topics with many possible activities the students can do. Besides that, understanding these materials is needed daily.

Moreover, besides being used for activities connected with mathematics, ratio and proportion are also used in various other subject areas such as geography, cartography, science, economics, technological studies, and many more. By looking into the importance of ratio and proportion concepts, the understanding and ability of students about these concepts became the basis for studying the concepts at a higher level and applying those in their lives. However, students often need help in learning these concepts. According to research, most students have obstacles in solving simple ratio and proportion problems because they need help understanding the concepts and even have difficulty solving problems with different contexts (Andini & Jupri, 2017). In this light, the team thought of meaningful learning activities to get an understanding of the concept so that students could construct their thoughts to understand the concept.

In addition to the planning stage, online meetings and consultations were made to craft the research lesson for the Lesson Study. Also, the detailed lesson plan was organized; communication letters were distributed to all concerned, and the ICT instructional materials were classified and sorted out.

Students participated actively and diligently throughout the research lesson via Zoom on April 30, 2022, at 9:00 in the morning. The teacher started with the preliminary routine activities like prayer and checking attendance and ended with an assignment (homework).

The final stage, the Post-Lesson Discussion, was done after the research lesson. It focused on the reflections of the acting teacher and the observers regarding the research lesson. Comments and suggestions were given for the improvement of the research lesson on teaching ratio and proportion. However, the whole process of the Lesson Study was also discussed and reflected on. The conversations were transcribed and used as the primary data of the study. Themes were identified, coded, and interpreted from the reflections gathered during the post-lesson discussion through thematic analysis by Caulfield (2019). Inter-rater reliability checks were also considered.

Since this is a human-participated research project, correct procedures, and ethics were observed in this investigation. Permission was granted by proper authorities to perform the research at a laboratory school in a university. The participants of the study were all volunteers. The privacy and confidentiality of the data gathered were rigorously adhered to.

Results and Discussions

In the post-lesson discussion, the observers were allowed to evaluate and reflect on the outcome of the research lesson and the whole Lesson Study cycle, emphasizing whether the topic of ratio and proportion was discussed sufficiently. The emergent perspectives that emanated from the reflections on reflecting-in-action (on teaching Ratio and Proportion went along the lines of (a) choice of appropriate terminologies, illustrations, and concept applications; (b) real-life and relevant problem situations, which include critical thinking and problem-solving; and (c) going beyond the routine.

Choice of appropriate Terminologies, Illustrations, and Concept Applications

In teaching mathematics, language skills like using proper math terminology play a critical part in mathematics development and understanding math concepts (Xu et al., 2022; Rabanal & Domondon, 2023). Proper selection of terminology will make it easier for students to understand the mathematical concepts the teacher wants to give. In mathematics, teachers often make mistakes in selecting the right words that fit the learning context. Mistakes that are not recognized and constantly committed by the teacher might end up embedded in the student's mind and form a justification for the inappropriate concepts.

In the research lesson, the teacher used the word "equal" in explaining the concept of proportionality.

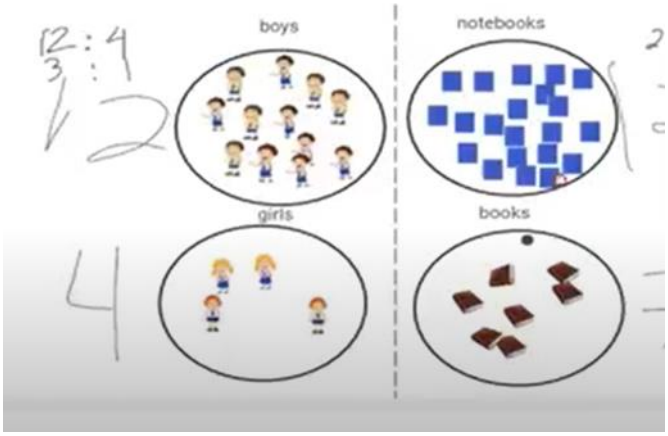


Figure 1.

Activity on Engagement Part of the Research Lesson

The activity above (Figure 1) was part of the Engagement Part, where students were asked to differentiate boys from girls and books from notebooks. After that activity, the teacher asked about the ratio of boys to girls and notebooks to books. The teacher also asked the students about their observations considering the two ratios.

Teacher: *"What can we conclude?"*

Student: *"The ratios are proportional."*

Teacher: *"Do we say that they are equal?"*

It looks like there is no problem because we think that the word "equal" in this context is just appropriate. However, the reflection question for the teacher is, "what is the difference between equal and equivalent?"; "Is it appropriate to explain the proportion context?"

"Equal" and "equivalent" are used frequently in mathematics. The main difference between equal and equivalent is that the term equal refers to things similar in all aspects. In contrast, the term equivalent refers to similar things in a particular aspect. When talking about proportion, the appropriate word we can use to explain the proportion is "equivalent."

Many practitioners need clarification about the distinctions between different mathematical concepts and terminologies (Lele, Marrill, Keim & Boyce, 2013). One should choose proper representations in mathematics (Rowland, 2013) since the selection of suitable mathematical terminologies, expressions, and equations are essential (Roldan et al., 2015; Snidaro, Garcia-Herrera, Llinas & Blasch, 2016), and the clarification of concepts and terminologies leads to a correct application in the real world (Lele, Merrill, Keim & Boyce, 2013).

Aside from the proper use of mathematical technologies, teachers must also be considerate in using things/people as an example.

"Sometimes it is hard to use grouping by gender because we have a different sexual orientation, gender identity, or expression (SOGIE). We have different sexual orientations. Not everyone wears a particular color. Not all girls have long hair, something like that."

As reflected in the post-lesson discussion, only some students have the same categorization. Students may understand it culturally, but still, teachers must be cautious about this. As we promote a healthy environment, students must experience an environment where all feelings are accepted without judgment.

Real-life and Relevant Problem Situations

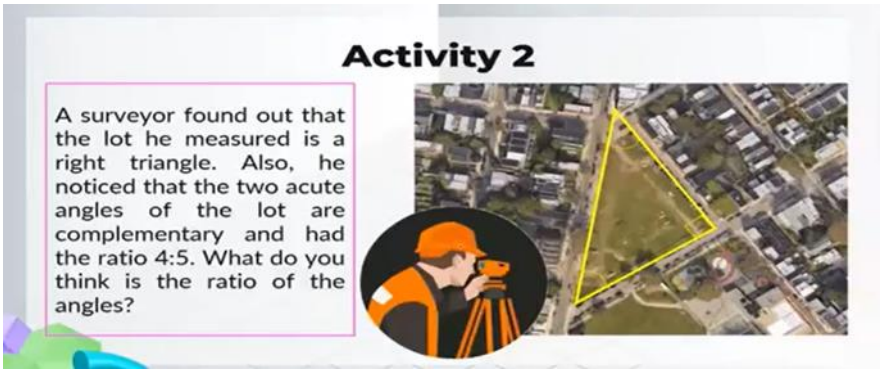
The presentation of mathematical concepts for learning is often purposely associated with real-life contexts to promote meaningful appreciation of the learners regarding the content. Students are said to be able to resolve a problem when they can analyze it and apply or transfer their knowledge or skills to a new situation.

Applying to real-life problems of mathematical learning, especially on the topic of ratio and proportion, is an important and excellent way to train and improve the ability of students' critical thinking, creative thinking, problem-solving, and decision-making abilities.

This research lesson reflects real-life situations, but the reflection question for the teacher is, *"Why do we need to know the measures of the angles given the ratio of 4:5?"* Indeed, the collaborative/group reflection provided an opportunity to discuss how the lesson/approach could be improved. In this case, privileging real-life situations in problem-solving activities must be supported, and the problem situations must be full of meaning and reason.

Figure 2.

Activity 2 of Discussion Part of the Research Lesson

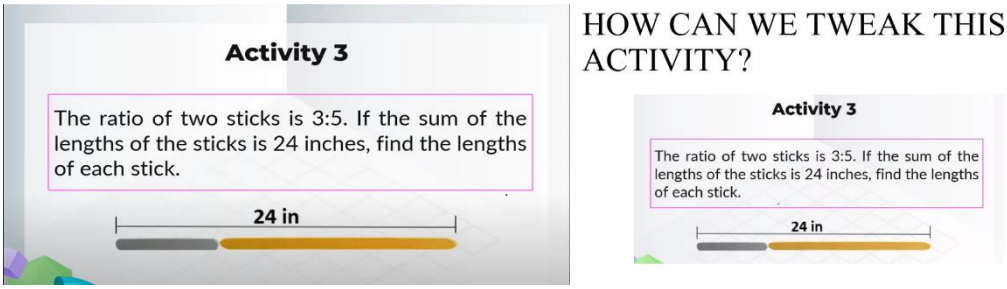


Higher Order Thinking Skills (HOTS) are necessary for the 21st century, and these could be developed in mathematics learning (Pratama & Retnawati, 2018). These are the abilities to connect, manipulate, and transform existing knowledge and experience critically and creatively in determining decisions to solve real-life problems or situations (Sumirattana, Makanong, and Thipkong, 2017). HOTS focuses on holistic student learning participation (Abdullah et al., 2016).

Activity 3 allows the students to apply their prior knowledge of algebra to solve the problem. Although it fosters HOTS, the researchers realized that it would be much better if it would relate to a real-life situation. The questions on *"how can we tweak this activity"* will guide the researchers to improve the lesson's content, as shown in Figure 3 below.

Figure 3.

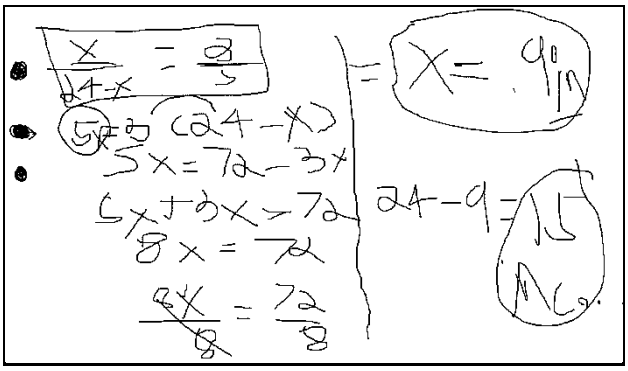
Activity 3 of Discussion Part of the Research Lesson



The student's sample solution for Activity 3 using Google Jamboard is shown in Figure 4.

Figure 4.

Student's Solution to Activity 3



Based on the figure above, the student just followed the routine process of solving the problem. Even though the student got the correct answers, he could not appreciate and apply the concept learned because the construction of the problem activity needed to incorporate a real-world problem. Tweaking the activity is very important in constructing appropriate real-world problems.

Mathematics is a process in which the students must "resolve" the problems in real life; they need the skills and abilities acquired in school and their own experiences. The mathematics process starts with a real-life problem. Then the students try to identify the problem and its relation to mathematics and form it into a mathematical concept to be completed. Then the solution is reverted to a real context.

It is important to note that real-world problems are a source or a starting point for learning and developing mathematical concepts (Sumirattana, Makanong & Thipkong, 2017). With that, mathematics learning should be applied to solving real-life problems (Firdaus & Herman, 2017) and be part of real-life experiences (Bonotto, 2013).

Going Beyond Routine

Good learning is always a three-way process involving teacher, content, and student interactions (Friesen & Osguthorpe, 2017). It was evident in the first part of the research lesson that students frequently learned by memorization. It can be represented by a triangle, illustrating that teachers could relate to students using the contents. At the beginning of the lesson, the usual way of reviewing was done by the teacher, where he asked specific questions about the past topic. One of the questions was, *"What is a trapezoid?"*

A student then volunteered to answer, *"a trapezoid is a quadrilateral with only one pair of parallel sides."* The teacher then proceeded with the same type of question involving different shapes.

The students' answers were read from their past notes or the textbook, which was easily discernible as the class was online. At this point, the teacher (and the Lesson Study

observers/participants) would need to ascertain whether the students could describe the shapes using their own words or understood the concepts. Conceptual learning in mathematics focuses on teaching mathematics by concepts rather than just asking students to memorize isolated facts, formulas, or methods. Concepts are the big ideas or the "whys" related to solving math problems. More evidence was added by a study from the Programme for International Student Assessment. It was found that students who memorized mathematics material performed worse than those who approached mathematics as critical thinking and problem-solving. One of the comments from the observers during the Post Lesson Discussions was:

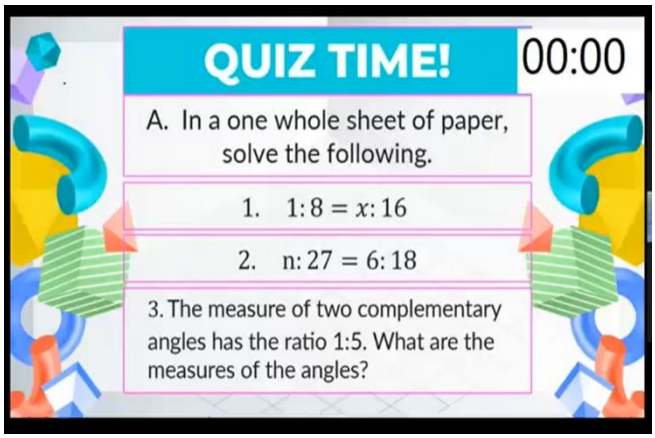
"You started up with a review. You asked them about different properties or what they (students) could say about quadrilaterals. It agreed to be routine because they seemed to be reading their textbooks. Because we are on online platforms, we sometimes need to know when they are reading. There is nothing wrong with reading, but most importantly, they can explain it in their own words because it means they understand."

Hence, as reflected during the Post Lesson Discussions, the researchers realized that reviewing the previous topic was routine. Students read their textbooks and conveyed their answers in the language of the book that they had memorized. So, they were not free to explore more deeply and did not present explanations in more straightforward language and easier to apply.

Moreover, for the students to better understand the topic, the teacher should relate the lesson to real-life situations and scenarios relevant to the subject matter. It avoids the usual mode of reviewing past lessons by only asking the students to recall what the last lesson was about. For instance, how they can differentiate quadrilaterals. Besides that, the questions can be modified to add purpose on why ratio and proportion must be identified. An example of this is the question about the missing angles of a triangle. A question explaining why the measurements of those angles are needed will give depth to the topic and improve students' comprehension. Teaching and learning will be able to go beyond the routine activity because students can apply and value the lesson using their critical thinking skills.

Figure 5.

Evaluation Part of the Research Lesson



A comment from an observer went,

"You did many activities with Kahoot and other online applications. These are good, but sometimes too much is too overwhelming. So, but then again, my observations on different activities were that they were still routine. So given the two hours that you spent with them, it would have been nice–it would have been a good opportunity–if they had engaged in a deeper exploration of the concepts, if you allowed them to engage in some Higher Order Thinking Skills, rather than having more. So, the depth of the lesson against the quantity."

Furthermore, the teacher had given too many routine quizzes like that in Figure 5 but did not allow students to engage in Higher Order Thinking Skills (HOTS). Perturbing or putting students in a problem situation will allow them to use their HOTS and fully understand the new concepts discussed. The teacher should allow students to explore concepts more deeply and engage in HOTS versus quantity (many activities) because just a few activities with a depth of the lesson are better than many activities without critical thinking. The depth of the lesson should be the focus rather than the number of activities being discussed. Moreover, the teacher may be given some activities as homework that they could submit online. As we know, too much activity overwhelms students, and it impacts the learning to be ineffective and maximum. The learning process requires a teacher's ability to understand the situations and conditions. Sometimes, as teachers, we cannot force ourselves to do all that we have planned or prepared in advance. Teachers must be clever and wise in improvising for the learning process to run correctly and be enjoyed by the students.

Indeed, reflecting on this theme generated from the research lesson, there is a need to develop methods and even classroom instruction structures that go beyond routine practice.

On the use of technology in teaching which lessens routine practice in teaching and learning Math, it was observed online that students also have difficulty in utilizing it (Cadorna et al., 2023), which affected their efficiency in solving math problems through Kahoot, Jamboard, etc.

Conclusions

The conduct of the Lesson Study provided a platform where teachers, practitioners, and researchers may collaboratively reflect in practice. The collective reflections of each participant, despite the diversity and disagreement of perspectives, in this unique professional development endeavor allow for a more robust and profound understanding and approach to how lessons could be delivered–intending to enhance student understanding and develop HOTS needed for 21st-century life. Thus, being able to generate ruminations on singular lessons, if done iteratively, would not only improve instructions on specific lessons but would develop amongst Lesson Study participants certain habits of mind that would have some influence on reflecting-on-practice and reflecting-for-practice. Being able to dynamically

reflect on how to incorporate education goals such as critical thinking and problem-solving skills could seamlessly integrate into the tacit core of beliefs and practices of teachers and practitioners as we engage in continuous discussions on how to improve our practice.

Despite the limitations found in the research process, such as the sample size constraints, and contextual factors, meaningful findings were comprehensively discussed. In teaching ratio and proportion, as several computational and mechanical skills are to be developed, it was suggested to go beyond routine – learners must be able to explain the concepts on their own and solve problems revolving around the topic ratio and proportion in novel ways. This would also affect the problem situations that must be privileged for classroom instruction. As such, real-life applications would be a facilitative factor that would enable the learners to make sense of the problem situations and transfer learning into other situations, cementing the skills they could learn from the activities. Teaching mathematics must go beyond the routine and maximize the use of HOTS questions. Additionally, applying the lesson to real-life situations makes the lesson more valuable to the students. Furthermore, because of the diversity of the students, teachers must be extra cautious when using things as an example, as students do not have the same categorizations. Finally, proper use of appropriate terminologies is just one of the reflections after the conducted Lesson Study.

Conducting a Lesson Study is an excellent avenue for educators to improve the quality of teaching. It can help the teachers to reflect on what needs to be improved, what can be improved, what must be presented, and what may not be considered in the mode of delivery of the lesson and the time allotted. Through this, it can maximize students' engagement, improve learning, and stimulate reflections from teachers' practice. It is recommended that mathematics educators apply in their instructional contexts and facilitate the translation of research insights from the Lesson Study into classroom practice. They can also explore alternative instructional strategies, investigate the impact of Lesson Study on student learning outcomes, and examine the transferability of findings to different educational contexts.

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