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Incorporating Mathematical Writing Prompts Through Lesson Study

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Abstract. This study aimed to investigate how pre-service teachers utilized mathematical writing prompts through the lesson study approach. The participants were eight (8) secondary mathematics pre-service teachers enrolled in a teaching internship course, teaching Grade 8 and Grade 10 learners via an online distance learning platform. Using a qualitative, multicase study design, the research examined the integration of writing prompts by two lesson study teams. Data were collected through various sources, including lesson plans/modules, pre-lesson questionnaires, post-lesson discussions, post-lesson journal prompts, interviews, and a focus group discussion. The pre-service teachers' engagement in the lesson study was analyzed through thematic analysis, following a four-phase iterative process. Findings revealed that their use of writing prompts focused on the concept-building process of the lesson topics. Emphasis was placed on aligning writing prompts with the lesson objectives. The process of integrating writing prompts followed these steps: (1) identifying lesson objectives, (2) creating writing prompts aligned with the objectives, (3) anticipating learners' responses, (4) implementing the lesson and observing learners' responses, (5) addressing misconceptions revealed in the responses, (6) using the responses to enhance lesson discussions, and (7) revising prompts to achieve desired responses in future lessons. Process prompts were predominantly used for problem-solving activities, while narrative prompts were utilized in lessons involving real-life contexts. Nevertheless, all four types of prompts—content, process, narrative, and affective—could be integrated within a single lesson, typically in the following sequence: content, process, narrative, and finally affective.

Keywords: Writing Prompts, Lesson Study, Pre-service Teachers, Qualitative Online Distance Learning

1. Introduction

The core of the K-12 Mathematics Curriculum in the Philippines is anchored on both critical thinking and problem solving. Students must learn how to think critically in order for them to effectively learn mathematics through problem solving (Belecina and Ocampo, 2018). This relationship shaped most research projections even with the onset of the pandemic, when distance learning became the mode of education throughout the country. There is a growing need for teachers to promote deeper understanding of

mathematical specially in the distance learning modality which promotes independent learning. A number of teachers were shown to have difficulty in problem posing activities in their classrooms that promotes writing in math (Cankoy, 2010). But as to why and how were these experienced by teachers in the process of utilizing math writing prompts in distance learning wasn't studied yet.

Teachers need to have a good foundation of mathematical critical thinking skills (MCTS) to pass on to students (Afriansyah, Herman, and Dahlan, 2021). Teachers who are reflective and critical thinkers can create a classroom environment that fosters CT and RT skills of learners (Rott and Leuders, 2017; Williams, 2005 as cited by Erdoğan, 2020). With the distance learning modality in placed for more than a year and the possibility of a blended learning mode on the following, previous researchers explored asynchronous modules with open-ended questions and problem posing prompts and were found effective in enhancing the conceptual knowledge of the students independently.

Bai (2009) stated that well-designed discussion questions are fundamental in developing CT skills in online discussion. But in textbooks and learning modules, prompts limiting answers to simple solution, single-word response, or multiple choice are the most common. However, in the case of writing prompts, teachers who integrates writing prompt activities can get their learners to think actively and according to Urquhart (2009) writing prompts deepens the learning in mathematics. There are different kinds of writing prompts that are commonly employed in mathematics: content, process, narrative and affective. This provides a framework for teachers in framing the prompts that they create and how to examine their practice of integrating it inside the classroom.

A problem on sustained writing integration surfaced in the recent study of Powell, Hebert, and Hughes (2021) since only few teachers were able to maximized writing prompts in their classroom due to perceived self-efficacy. Lesson Study is effective in teacher professional developments programs and in an experimental study of (Saran, 2018), revealed that the impact in the self-efficacy of teachers was beneficial and valuable through the conduct of the lesson study. But there was no in-depth analysis of the teacher's experience and utilization process in that study that explains how the lesson study helped them, and to mention that writing in math was not the primary focus.

Statement of the Problem and Research Objectives

Research on writing in mathematics generally establishes effects on students' learning and performance, not on the teachers' experience, professional development and competence in the integration of writing prompts (Giacumo and Savenye, 2020). Recommendation for researchers focusing in mathematics writing states the need to identify professional development activities that is aligned with strategies (Bray-Clark and Bates, 2003). In this research, the lesson study as a professional development strategy was used in providing a scholarly report on the pre-service teachers' practice of writing prompt integration as presented in this literature review. The focus then of this lesson study was on the integration of mathematical writing prompts in each research lesson, to aim for improvement on the teaching-learning practice and the process of implementing these writing prompts.

Hence, the main objective of the study is to explore the pre-service teachers' practice in integrating mathematical writing prompts through lesson study in distance learning modality. Specifically, the researcher determined the pre-service teachers' process pertaining to utilizing mathematical writing prompts during lesson study engagement.

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Theoretical and Conceptual Framework

This study is informed from Sociocultural Theory by Vygotsky, Theory of Change, and the Constructivist Theory (as cited by Cain, 2010). Vygotsky's sociocultural theory translates into a view that writing in certain ways and for different purposes go beyond meeting an immediate need to exhibit competency of a discrete skill or show understanding of content knowledge but extends to opening opportunities to actively engage in knowledge transformation within and across disciplinary communities (Chuy, Scardamalia, and Bereiter, 2012). Theory of change "is the study of methods used to incorporate new information received through communication into a knowledge base, when the new information may conflict with existing information" which applies for teacher's professional development in the process of lesson study since it includes their knowledge and change of instructional practice to benefit students and improve practice (Cain, 2010).

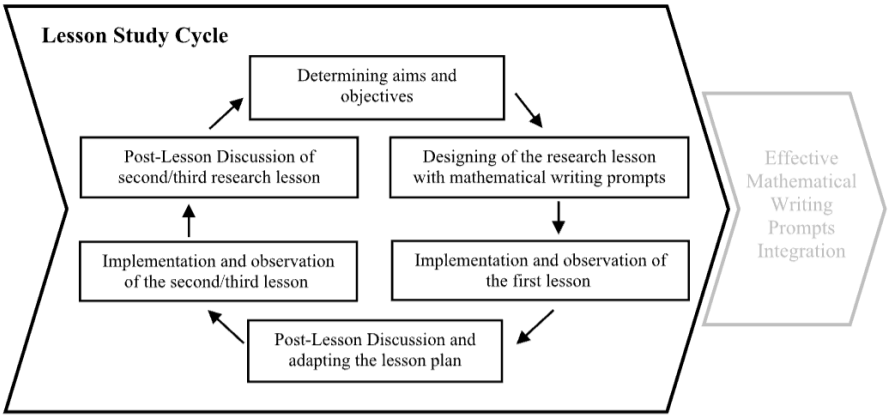


Figure 1: Conceptual Framework of the Study

The framework shown in Figure 1 comprehensively presents the two different phases of the study: 1) the lesson study engagement; and 2) examination of pre-service teachers' experience of the lesson study cycle along with the learners' perception. The lesson study in this framework is a potential approach in improving the pre-service teachers' mathematical writing prompts integration practice. In validating the pre-service teachers' responses, the learners' perception was used to support evidence of perceived effective ways of integrating writing prompts.

2. Methodology

This study was conducted in the online platform of one public school in Iligan City. The study was conducted virtually for a span of three weeks (4th Quarter), and gave the respondents time to reflect on their experience during the gathering of data. However, the research lessons only covered three lessons.

Research Participants

The subjects of the study were eight BSEd Mathematics pre-service teachers undergoing their Teaching Internship course in a public school of Iligan City which implements online distance learning modality. They developed three lesson plans together

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with the researcher through the lesson study; these were implemented to a class. However, only ten learners of the pre-service teachers in the class were considered for the interview.

Design

This research used a descriptive qualitative study employing case studies on integrating writing prompts in Mathematics lessons. The study explored cases of writing prompts integration from two lesson study teams through detailed, in-depth data collection using various data sources. Cresswell and Poth (2016) indicated that a multiple-case design provides a wider exploration of the research question and theories that allows the researcher to comprehend commonalities and differences of mathematical writing prompts in distance learning modality from multiple cases being studied. This was selected to address the need of descriptive information of teachers' experiences in the field within their content areas and school contexts. Yin (2014) as cited by Carter (2018) found multiple cases as more compelling than single case investigation to elaborate why experiences occur as they do.

Sampling

Purposive sampling technique was used to choose the pre-service teacher respondents and ensured that they were committed to the whole duration of the study. In this manner, the researcher was able to acquire an authentic and in- depth understanding of their experiences and practice. This study considered four pre-service teachers per lesson study team teaching in two different junior high school grade levels, for a total of eight pre-service teachers. Through purposive sampling, interview data were also gathered from ten (10) learners of the pre-service teachers.

Data Collection

Multiple data sources were collected to provide a deeper understanding of each case. Following Carter's (2018) method of data collection, data in this study were collected from lesson designing, lesson plans or modules, observations, and interviews. This is to support a holistic view and insight on the pre-service teachers' practice.

First, the researcher set up an initial meeting with all the pre-service teacher participants once all the necessary letters and documents have been complied. This is to conduct the training and workshop in integrating mathematical writing prompts and to identify the research lessons included in the course of this lesson study and of this research. The lesson study cycle began in the making of the first research lesson and a copy of the lesson plan/module was secured. The researcher observed two consecutive actual classes of the pre-service teacher teaching the class. The lesson study team convened after the first lesson for a post-lesson discussion. The interview was conducted shortly after. This process was repeated for the three research lessons.

Instruments/Questionnaires

The research instruments used in this study are the structured questions guide prepared in advance for the inquiry with the participants. These questions were adapted from the study of Carter (2018) and were modified according to the need of this study. Lesson plans/modules, transcripts from lesson designing and lesson study post-lesson discussions, and interview guide questionnaires were used to determine the pre-service teachers' utilization process of mathematical writing prompts.

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Data Analysis

The procedures for the analysis of data in this study were directed by the works of Braun and Clarke (2006) and Stake (2006) in conducting a thematic analysis of the qualitative data that was gathered. While the data analysis process was ongoing, analytic notes were written to make a preliminary data analysis. To find patterns and relationships among the participants integrating writing prompts, the thematic analysis has had a four-phase iterative process.

3. Results and Discussion

Looking at the process of mathematical writing prompt utilization involves a detailed observation on (1) the pre-service teacher's process of designing a research lesson, and (2) the implementation and insights taken from the post-lesson discussion. An interview was also conducted to triangulate the responses gathered from other data sources. Following the lesson study cycle in this study's framework, the pre-service teacher's process of utilizing mathematical writing prompts was determined.

For the purposes of this study, the researcher pre-identified the area of instruction which served as the research theme expressing the long-term goals of utilizing mathematical writing prompts in an online classroom. However, the two lesson study teams revisited these research themes with the researcher. This includes improving the pre- service teacher's process of integrating writing prompts while promoting critical thinking and reflective thinking for learners. Content goals were identified by the lesson study teams during the research lesson designing phase. Drafts of the lesson plans/modules used during the three research lessons were initially created by the pre-service teacher teaching the class and previewed to all other members of the team during their meeting. Presented in the following sections are the process of designing the three research lessons with mathematical writing prompts for the two cases.

Case 1: Lesson Study Team A

The research lessons of LSTA include topics on Methods of Proof. Research lesson 1 was about Indirect Proof by Contrapositive, research lesson 2 was on Proof by Contradiction and research lesson 3 was a comprehensive review lesson on the Methods of Proof. Only Research Lesson 2 is presented in these findings since research lesson 3 cycle wasn't completed. The assigned pre-service teacher for the class, presented the lesson plan she made at the start of the meeting. Parts of the lesson plan were already embedded with writing prompts following the experience she had from the previous research lesson. Lesson objectives for this lesson was taken from the course syllabus and it includes the following: a) to identify the steps on proving by contradiction, and b) to prove statements by contradiction. The research theme was also reviewed; this targets the critical and reflective thinking of the learners.

In the lesson plan, the pre-service teacher already gave the steps before the writing prompt was placed. As a group, they decided to remove the steps that were supposed to be directly given to the learners and made it learner- centered since the learners will be identifying the steps instead. They also anticipated that the writing prompt responses of their learners will be similar to their previous lesson. The researcher supported their decision and asked for the possible student outcome of this prompt. They successfully targeted the first lesson objective in this research lesson design with the writing prompt they used. They removed examples that were not similar to the previous lessons following the goal of connecting the lessons and showing the similarities in the process of proving. Due to the online learning modality of the class which includes synchronous and

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asynchronous sessions, they decided to let the learners prove a given statement during an asynchronous session to target the second lesson objective. This is the designing process for the research lesson 2 from Lesson Study Team A. Table 1 shows the writing prompts that were implemented for research lesson 2.

Table 1: Mathematical Writing Prompt in Research Lesson 2

Types	Mathematical Writing Prompt	Purpose
Narrative Prompt	"Define Contradiction in your own words."	To introduce concept of contradiction
Process Prompt	"Identify the steps in proving the theorem from the proof shown."	For a learner-centered discussion
Content/Affective Prompt	"Which do you prefer, Proof by Contrapositive and Proof by Contradiction, why?"	To assess if learners noticed the similarities of the two

The whole process of designing the research lesson started with an initial draft of the research lesson plan. This was then presented to the group and the research theme and lesson objectives were reviewed. Explicit connection of the constructed writing prompts was shown as the previous lesson was considered in the making process. Parts of the lesson plan were revised after adding a process prompt ensuring a good sequence of the whole lesson and considering the time, the remaining lesson objective was sought during their asynchronous time. This research lesson was implemented in two sections.

During implementation in the first class, the pre-service teacher followed the research lesson plan and used their first writing prompt responses to build the discussion on the concept of proving by contradiction. The utilization of the process prompt revealed that the learners were having a hard time identifying the steps from a given Proof by Contradiction despite its almost similar process with Proof by Contrapositive. The decrease in the interaction with learners worried the pre-service teacher; however, the lesson was still delivered as charted in the research lesson plan.

> *"...to identify if the goals were achieved. This may have referred to an arrangement about where to insert the writing prompt." [Zed]*

Suggested improvement as observed by the lesson study team for the second class during the post-lesson discussion includes placing the process prompt after the examples in order to avoid learner's confusion as commented by the lesson study team A members.

The time for the first and second research lesson implementation was consecutive, hence they only had a few revisions done for the second class. The learners' participation is seen as they engaged with the writing prompts and with the learners' responses. With this attempt, they also perceived the learners' challenges. There was a discrepancy between how the pre-service teacher perceived the lesson; this went right after the lesson implementation and after going through learners' writing prompt responses. One advantage of asynchronous sessions is it allows the learners to engage more deeply with study materials as they have more time to reflect on their ideas (Stein et al., 2009 as cited by Libasin et al., 2021). The writing prompt utilized during asynchronous sessions was also beneficial to learners as they study their lesson. This was affirmed through a learners' response during an interview day after the research lesson implementation.

> *"...when I try to self-review, those writing prompts can also be my guide questions just like the writing prompts that were used in the asynchronous task, which also served as a study guide for the students in their exam last Friday." [SA2]*

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During the one-on-one interview with Olive after the class, her reflection mentioned the personal goal for this class. Following this was her suggestion for improvement regarding the process prompt when asked what she would do differently if she is to teach the lesson again.

> *"I also wanted to know [by writing prompts] how well my students can construct their thoughts into words, like if they are capable of forming a sentence… forming a phrase in a creative way."[Olive]*
> *"That's it sir, I will just rephrase Question 2 to make it easier for the students to understand without a pause, during which they will say "ha?", what question is this?" [Olive]*

After the lesson study cycle, Olive revised the research lesson plan and the only part that was changed was the process prompt. Table 2 shows the revised process prompt.

Table 2: Revised Mathematical Writing Prompt in Research Lesson 2

Types	Mathematical Writing Prompt	Revised Writing Prompt
Process Prompt	"Identify the steps in proving the theorem from the proof shown."	"Identify the steps from the given Proof by Contradiction in the previous example."

Case 2: Lesson Study Team B

The research lessons of LSTB include topics on Quadrilaterals and Similarities. Research Lesson 1 was about Ratio and Proportion, Research Lesson 2 was on Triangle Similarity Theorem and Research Lesson 3 was on Quadrilaterals. Research Lesson 3 is presented in this discussion since it is the last research lesson that went through a complete lesson study cycle.

Teacher Angel, the pre-service teacher teaching the class, presented the lesson plan she made at the start of the meeting. Writing prompts have already been placed in some parts of the lesson plan following the experience she had from the previous research lessons. Lesson objectives for this lesson includes the following: a) to define quadrilaterals and parallelograms, b) to state the properties of quadrilaterals and parallelograms, and c) to provide a real-life structure of a quadrilateral. The research theme was also reviewed which targets still the critical and reflective thinking of the learners.

The team initially wanted to present the concepts and properties before adding the writing prompts. However, the researcher asked if it was possible to do the writing prompts before introducing the concepts. They transferred their asynchronous activity to a motivation during the class where learners were asked if they could look around their house and write down what they perceived as quadrilaterals together with how these were used in real life.

The researcher observed that this activity served as a diagnostic writing prompt where they will be able to assess how much their learners know about quadrilaterals. It was also observed that Angel used the profile and frame- writing strategy where profiles to be filled in were quadrilaterals, real life structure, and reason. The third lesson objective was planned with this writing prompt. Angel proceeded with the next writing prompt referring to the rectangle to ask the learners' observation with the figure.

> *"Show students the figure and ask them what they see?"*
> *"The answers should be in line with the properties." [Angel]*

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Angel already anticipated the writing prompt responses of the learners as she planned to use their responses to build the properties that she will be introducing in the next part of the lesson. Other parts of the lesson which have no writing prompts were then converted to a more learner-centered activity using a fast-paced content prompt where she presents some figures, and the learners would write down their answers in their chat box for a few seconds. This is the part where Angel introduces that square satisfies the given condition and property, and she will then introduce the definition of a regular quadrilateral. This was the designing process for the Research Lesson 2 from Lesson Study Team B. Table 3 shows the writing prompts that were implemented for Research Lesson 3.

Table 3: Mathematical Writing Prompt in Research Lesson 3

Types	Mathematical Writing Prompt	Purpose
Narrative Prompt	"Identify at least three quadrilaterals and list one real life structures of each identified quadrilateral. Provide reasons for how these quadrilaterals are used in real life structures."	To encourage students to make a connection between abstract math concepts to real life phenomena.
Content/Narrative Prompt	"Why is square the only regular quadrilateral?"	To promote reasoning to support answers.
Content Prompt	"Differentiate Parallelogram and Rectangle." "Differentiate Rhombus and Kite." "Differentiate Rectangle and Square."	To promote reasoning among students by citing facts from known definitions.
Content/Narrative Prompt	"Write down all of your observations from this given figure."	To encourage students in contributing their own ideas for a learner-centered discussion.

The whole process of designing the research lesson started with an initial draft of the research lesson plan. This is followed by a presentation to the group and then a review of the research theme and lesson objectives. Writing prompts were given before introducing the concepts and properties. Parts of the lesson plan was restructured and revised after placing the writing prompts before the concepts, ensuring a good sequence of the whole lesson. Considering the time, the remaining writing prompt for one lesson objective was sought during their asynchronous session which is a continuation for the next discussion. This research lesson was implemented in two sections.

During implementation in the first class, Angel followed the research lesson plan and used their first writing prompt responses to build the discussion on the properties of quadrilaterals.

> *"...they have an answer which is quite different from the anticipated answer; however, I understood the thought of those answers." [Angel]*

Angel was able to interact with her learners since they were participating through their responses with the first writing prompt. While some learners were able to clearly provide examples of quadrilaterals, she noted some responses from her learners that were not quadrilaterals. The misconception was addressed after this narrative prompt as she already had an idea about what some of her learners think. Teacher Kurt, teaching the second half of the lesson, observed that learners were able to provide concrete answers or properties to the writing prompts that he gave. He also observed that they really understood the discussions because learners were able to observe some properties already.

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"...It's like the students already provided some explanation to their answers, just like if I ask them about the features of this, then they already have some concrete answers to provide, which is very good since it means that they have already understood the topic during my discussion." [Kurt]

Observation data from the other members of the lesson study team suggested some improvements for the second class during the post-lesson discussion. This is because they would be the one to teach the research lesson in the following class. This includes improvements on processing the writing prompt responses of the learners during the quadrilateral hierarchy. This also entails being observant at all times with the writing prompt responses in response to a learner referring to a circle as a quadrilateral. The researcher also added the need to rephrase the content/narrative prompt asking the learners to differentiate one quadrilateral from another on the quadrilateral hierarchy. This is due to the learners' responses which only described the properties of quadrilaterals separately rather than differentiating them by providing a connection of the two.

Angel noted in her observation that there were questions that the learners presented along with their writing prompt responses. However, Gladys stated that these where only clarifications from the learners as they are not yet completely sure of their responses. Gladys addressed some of their questions during discussion. A slight misconception occurred in how she processed their responses and said that this was because of the noise distraction in their place. The writing prompt responses of the learners, however, was correct. In a follow-up one-on-one interview with Gladys, she reflected the need to master the concept of the lesson in order to provide the appropriate feedbacks to the learners' misconception. Alice also mentioned that her part of the lesson delivery was clearly understood.

Table 4: Second and Final Revision of Mathematical Writing Prompts in Research Lesson 3

Types	Mathematical Writing Prompt	Revised Writing Prompt
Narrative Prompt	"Identify at least three quadrilaterals and list one real life structures of each identified quadrilateral. Provide reasons for how these quadrilaterals are used in real life structures.	"Identify at least three quadrilaterals and list one real life structures of each identified quadrilateral. Provide reasons for how these quadrilaterals are used in real life structures. Use the profile/format: *1) Quadrilaterals:, 2) Real-Life Structure:, 3) Purpose*:"
Content Prompt	"Differentiate Parallelogram and Rectangle." "Differentiate Rhombus and Kite." "Differentiate Rectangle and Square."	"Make a statement or sentence using the keywords: a. Parallelogram and Rectangle b. Kite and Rhombus c. Rectangle and Square"

Kurt commented that the flow of the discussion is already good. Finally, the researcher added a suggestion on how the first writing prompt was given since it was observed during discussion that only a few learners wrote about the purpose of the real-life quadrilaterals. Learners' responses improved when the content prompt was revised

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during the second implementation. They were able to identify the connections of the quadrilaterals instead of simply stating their properties independently. The team found that one activity did not come with instructions. This refers to the profile and frame writing strategy where profiles to be filled in were quadrilaterals, real life structure, and reason. Hence, the second and final revision of the narrative prompt for Research Lesson 3 in Lesson Study Team B together with the retained content prompts are presented in Table 4.

It can be noted that the pre-service teacher's process in utilizing mathematical writing prompts with the lesson study engagement follows a certain progression. The lesson study framework used in this research was the basis in coming up with a framework of utilizing the writing prompts.

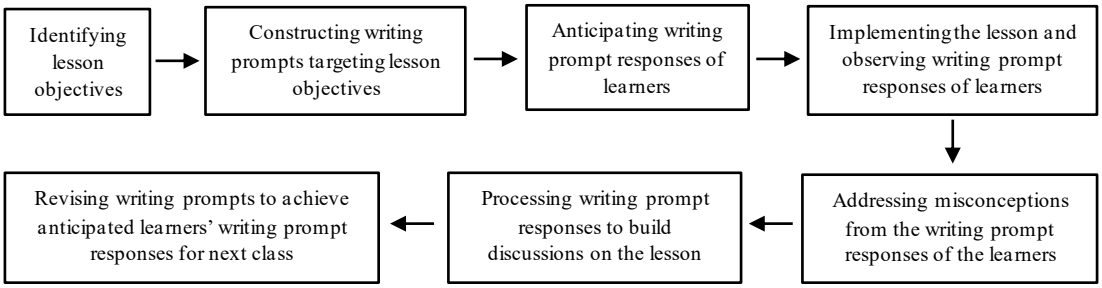


Figure 2: Pre-Service Teacher's Process of Utilizing Mathematical Writing Prompts

First, the lesson objectives were identified from the lesson plan. The lesson plan was embedded with writing prompts targeting these lesson objectives. The pre-service teachers then anticipated the writing prompt responses of the students to rephrase the writing prompt if needed. During the implementation, the pre-service teachers observed the writing prompt responses of the students and started to address the misconceptions before proceeding to process their responses towards the lesson discussion. Finally, the pre-service teachers revised their lesson plan according to the needs of the students and to achieve the anticipated responses from them.

During the data gathering, there was no writing prompt integration data that were collected from before the pre-service teachers participated in the lesson study. This was because they were accustomed to classroom discussion only where they directly give the lesson during a synchronous session. However, some of them recognize that they have given some writing prompts during their asynchronous sessions before but they were yet to recognize it as such by then.

The use of writing prompts in a mathematics classroom can be difficult for teachers who are used to a direct instruction approach. However, pre-service teachers' questionnaire, journal and interview responses with the lesson study in their classes provided some emerging themes in the three research lessons that were implemented by both lesson study teams describing their utilization of mathematical writing prompts as shown in Table 5.

The "concept-building from writing prompt responses" and "improving lesson structure" in an online classroom discussion appeared as both lesson study teams described how they utilize writing prompts. Concept-building as a theme refers to the pre-service teachers' means of structuring the concepts in the discussion from the learners' ideas and in this case, their writing prompt responses. Improving lesson structure is derived from the significance of the writing prompts in the discussion flow, stemming from the pre-service teachers' organization of the lesson plan and the construction of writing prompts as well.

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Table 5: Generated themes and some supporting quotes on teacher's utilization of writing prompts before and after the lesson study

Pre-Service Teachers' Responses	Codes	Themes
A4 ["…like we presented a topic, then discussed the topics and then related the students answer to the problem in their own ways or they can use the knowledge given by us sir. They have the freedom to … solve the problem…"]	Question and answer during classroom discussion	Concept-building from writing prompt responses
A1 ["Some of our writing prompt questions that we tried to connect or link concepts to real world or in real life situations…"] **B2** ["When they are given an activity which is [to generate] implication of real-life application of quadrilateral and they're asked to give reasons. It is most meaningful to me because they are able to bridge and give real life application to what we have discussed that day and they give their own reason.]	Using Narrative Prompts for Real-life situations	
A1 ["Without writing prompts before designing the lesson plan, it was not that organized."] **A4** ["The lesson plan became more organized sir. Like it's clearer, how we conduct the lesson plan."] **A3** ["Yes, sir, because in the lesson plan, prompts can be placed as they are in our format: not just on the discussion, but also on the practice exercises and activities."]	Organization of Lesson Plan	
A3 ["We improved the writing prompts, we make clear and concise writing prompts that could spark the idea of the students."]	Writing Prompts Construction	
B2 ["…since if writing prompts were integrated, interaction with the students is possible. So, the teacher will not discuss the topic over and over again since the students can share their ideas also to their classmates."] **B4** ["…sometimes I wonder if more writing prompts were integrated, the discussion from my part will be reduced, so it will be more by them, and I will just be the facilitator."] **B2** ["When writing prompts are integrated, the discussions are minimal since when we integrate prompts, the class is focused more around the interaction of the students."]	Learner-centered activity	

One of their purposes for utilizing writing prompts in their class is to have a learner-centered discussion. Hence, the learners were able to contribute ideas during discussion through their writing prompt responses. Their ideas were used by the pre-service teacher assigned to teach the lesson in building the concepts with the topic. In this manner, the pre-service teacher was also able to assess if learners really understood the lesson based on their written responses. Some questions from the learners helped contribute to this emerging theme as well.

Prior to their participation in the lesson study, Teacher Angel stated that there were senseless questions being asked during classes that led to learners' confusion. This was

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affirmed during a learners' interview. Moreover, the pre-service teachers shared similar experiences where questions or prompts were not prepared in advance in their lesson plan. With the integration of mathematical writing prompts, their questions were prepared and were specifically organized in their lesson plan, and that was understood clearly in how they conducted their lesson. Falco (2020) highlighted the importance of planning as an effective method in increasing academic achievement and motivation. This includes the processing of questions that should help learners assume responsibility for that which they encountered and learned, making the discussion time a learner-centered activity through the writing prompts.

Improving lesson structure was notable as it describes the two-way benefit of utilizing the writing prompts and designing a lesson. The sequence and arrangements of the writing prompts added an impact to the organization of their lesson. The following quote describes the good sequence of the writing as perceived by Teacher Olive.

> *"Content prompts are somehow like the intro of our lesson. The process prompts, on the other hand, are where the students are able to process the methods of solving a problem since the examples have already been provided. The narrative prompts concern those that the students know after the introduction of the topic, and their ability to solve the problem and their realizations about that lesson. Then, the affective prompts are like the conclusions or the generalizations of the lessons." [Olive]*

This describes that the content prompt was given first, followed by a process prompt during the examples, then a narrative prompt to help the learners realize its importance, and the last is the affective prompt, which serves as the conclusion of their lesson. However, other pre-service teachers also explained that their utilization of the writing prompts is dependent on the objectives of their lesson which was observed in the summary of their utilization process.

Commonly used mathematical writing prompts during online classroom discussions are the process prompts which require the learners to describe their method of solving the given problem. According to Urquhart (2009), writing about problem solving requires monitoring and reflecting on the processes and strategies the learners used. For topics which only require the learners to provide their solutions, pre-service teachers mentioned that it was the writing prompt that they can easily provide. This also means that their assessments in asynchronous classes included process prompts where pre-service teachers could really assess how their learners understood their online classroom discussions. Moreover, narrative prompts were used to link the concepts to real world situations; learners were given time to think and they were asked to give their comments.

In general, the utilization of the writing prompts with the lesson study as experienced by the pre-service teachers relies on getting a bigger picture of the lesson. This includes the lesson objectives, the sequence of the writing prompts, the writing prompt responses of the learners, the learner-centered discussion, and the iterative process of making a clear and concise writing prompt in response to how learners received it.

4. Conclusion and Recommendations

The utilization process of mathematical writing prompts as experienced by the pre-service teachers with lesson study includes the following:

a) identifying lesson objectives;
b) constructing writing prompts targeting lesson objectives;
c) anticipating the writing prompt responses of learners;

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d) implementing the lesson and observing the writing prompt responses of learners;
e) addressing misconceptions from the writing prompt responses of the learners;
f) processing writing prompt responses to build discussions on the lesson;
g) revising writing prompts to achieve anticipated learners' writing prompt responses for next class.

The pre-service teachers' utilization process of mathematical writing prompts mostly relied on the concept-building process of the topics at hand, hence, careful attention is given to the lesson objectives as they make the writing prompts. Process prompts were mostly used for problem solving and narrative prompts were employed when real-life situations are involved. However, all four writing prompts can be integrated in one lesson discussion following this sequence: 1) content, 2) process, 3) narrative, and 4) affective prompt. The order of writing prompts created a more organized lesson plan, as explained by the pre-service teachers.

Mathematical writing prompts are recommended to be integrated in online discussions to encourage interaction and assess learners' understanding of the lesson. The writing prompts should be mapped with the lesson objectives and promote higher order thinking skills. Teachers who plan to integrate mathematical writing prompts for the first time should consider conducting a lesson study for a quarter, in order to draw ideas and observations from a lesson study team. This can guide the teachers to identify areas of improvement concerning integrating the writing prompts, and in turn, enhance mathematical knowledge of the teachers involved as well.

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