DEVELOPMENT OF A CRITICAL THINKING CHECKLIST FOR GRADE 8 MATHEMATICS EDUCATION

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ABSTRACT

Sumili, Chrisper Anton T., and Mariaje Fehey B. Tagalogon: BSED Mathematics, College of Education, MSU-Iligan Institute of Technology, Tibanga, Iligan City; May 2025 **"Development of Critical Thinking Checklist in Mathematics Education"** Adviser: Mary Joy F. Luga

This study focuses on the development and validation of a critical thinking checklist with the use of identified critical thinking indicators in mathematics education. Recognizing the growing need for critical thinking in solving mathematical problems, the research designs an observation tool grounded in established literature and validated by educational experts. Employing a qualitative research design, the study involves a systematic literature review, multiple stages of expert validation, and classroom observations in two Grade 8 classes at a pilot secondary school in Iligan City. The final checklist consists of five key indicators: asking relevant questions, analyzing information from multiple perspectives, evaluating evidence, demonstrating logical reasoning, and applying mathematical concepts to real-world problems. Observations using the checklist reveal specific classroom scenarios where students exhibit various critical thinking behaviors, often prompted by teacher strategies such as guided questioning and collaborative activities. The results emphasize the value of structured questioning, reasoning-based discussions, and practical applications in promoting critical thinking. The checklist proves to be an effective tool for capturing students' cognitive engagement during mathematics instruction and offers practical insights for teachers and curriculum developers aiming to enhance critical thinking in the classroom.

Keywords: Critical Thinking, Asking Relevant Questions, Analyzing Information from Multiple Perspectives, Evaluating Evidence, Demonstrating Logical Reasoning, Applying Mathematical Concepts to Real-World Problems.

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for persevering, believing, and finishing what we started.

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CHAPTER I
THE PROBLEM AND ITS SCOPE

Background of the Study

Mathematics is vital to one's understanding of the world. It equips individuals with the tools to analyze and quantify every aspect of daily life, particularly well-paying positions with benefits in today's labor market (Abalde & Oco, 2023; Yadav, 2017; Kortering et al., 2005). Critical thinking forms the basis for understanding complex mathematical concepts and applying them effectively to real-world situations (Martinez et al., 2016; Kortering et al., 2005). Developing these skills is crucial for student success in mathematics and other disciplines, as they support problem-solving and informed decision-making (Visitasari & Siswono, 2013). Over the past two decades, research and educational practices have highlighted the significance of nurturing critical thinking to equip students for academic and career challenges.

Understanding and relating mathematics to one's daily life is a skill that a student must develop, as it enhances critical thinking skills essential for problem-solving and decision-making. Critical thinking skills in the context of mathematics education encompass the ability to analyze, ask questions, evaluate, and synthesize information, leading to a deeper understanding and application of mathematical concepts (Halpern, 2014; as cited by Nur'azizah et al., 2021). Critical thinking is a vital component of education, particularly in mathematics, where it involves analyzing problems, evaluating evidence, and applying logical reasoning to arrive at solutions. The development of these skills is essential for students to succeed academically and in their future careers. As emphasized by scholars like Facione (2015), critical thinking in mathematics enables students to approach problems methodically, question underlying assumptions, and consider multiple perspectives, thereby enhancing their problem-solving abilities.

In the Philippines, the Department of Education (DepEd) has recognized the importance of critical thinking and has implemented various programs aimed at fostering these skills in students. The K-12 curriculum, for instance, is designed to develop critical thinking and problem-solving skills across all subjects, including mathematics (DepEd, 2019). Despite these initiatives, there remains a significant challenge in effectively developing these skills among students, particularly at the Grade 8 level, where students transition from basic arithmetic to more complex mathematical concepts.

Several studies have highlighted the critical role of teachers in developing students' critical thinking skills. Teachers are tasked with creating a learning environment that encourages students to engage in higher-order thinking, ask insightful questions, and explore different approaches to problem-solving (Paul & Elder, 2014). However, the extent to which these strategies are effectively implemented in the classroom and their impact on students' critical thinking abilities in mathematics remains underexplored.

This study addresses gaps identified by focusing on the instructional methods employed by grade 8 mathematics teachers in a selected public school in the Philippines. By observing classroom instruction and using a researcher-crafted checklist based on established frameworks and literature, this study assesses how teachers stimulate critical thinking skills in their students. The findings of this study contribute to the existing body of knowledge on mathematics education and provide practical insights for educators on how to enhance critical thinking skills among students with varying levels of mathematical proficiency.

Statement of the Problem

In mathematics education, fostering critical thinking skills among students is of significant importance (Mony et al., 2024). It is essential to assess and observe how these skills are developed during mathematics classes to enhance instructional strategies and student outcomes. Specifically, this study answers the following research questions:

1. What are the critical thinking indicators based on the related literature and studies?
2. How was the literature selected?
3. How was the critical thinking checklist validated?

Significance of the Study

This study provides insights that can be used as a reference for more meaningful educational services, innovations, and teaching approaches to be utilized by mathematics teachers. Specifically, this will be beneficial to the following:

Curriculum planners. This study provides those who plan the curriculum with the facts necessary to develop more effective references such as feasible learning competencies that focus on the acquisition of critical thinking skills by the students. With the necessary information gathered from this study, a comprehensive knowledge on how to properly integrate critical thinking skills in the curriculum will be possible.

School Administration of the Junior High School. The study's findings will be helpful to schools since it will serve as a foundation for planning on learning intervention and curriculum enhancement in mathematics. With this, a proper approach and co-curricular activities can be initiated by schools to maximize students' level of critical thinking skills.

Junior High School Mathematics Teachers. The results of this study will help Mathematics teachers have a tool to evaluate students' critical thinking skills. In the advent of 21st century learning, it is essential that teachers must possess knowledge on how to properly assess their students.

Mathematics Major Students of Mindanao State University's Junior High School. This study's findings can be beneficial for math majors in creating research-based lesson plans and devising strategies in teaching that will help them in their practice teaching. Understanding the students' critical thinking skills acquisition is a tool for them to emerge more on the underlying concepts in mathematics education.

Future Researchers. The study's results may give other researchers knowledge as they carry out comparable studies that relate to mathematical critical thinking skills. Additionally, this can be used as reference material for related future research.

Apart from the stakeholders mentioned, the findings of this study provide valuable insights into the teaching practices that effectively promote critical thinking in mathematics. By identifying specific strategies and approaches that are successful in stimulating critical thinking, this research can inform the development of teaching methods and instructional materials that better support students' cognitive development. For educators, the study offers practical recommendations on how to create a classroom environment that encourages critical thinking including strategies for asking insightful questions, encouraging the exploration of alternative solutions, and fostering a deeper understanding of mathematical concepts. For curriculum developers and policymakers, the study's findings can guide the enhancement of mathematics curricula to better align with the goal of developing critical thinking skills. Additionally, the study may serve as evidence supporting the presence of critical thinking among students in mathematics classrooms, as demonstrated through specific critical thinking indicators. The activities provided by the teacher during the observed sessions offered learners opportunities to engage in critical thinking. This can serve as a basis for further research on the topic, particularly in the context of Philippine education.

Scope and Limitation of the Study

This study focuses on the development and validation of a critical thinking checklist for mathematics education through identified indicators from existing literature and studies. The research focuses on Grade 8 mathematics classrooms in a selected school in Iligan City, observing how teachers implement strategies that foster critical thinking skills. To ensure a structured and evidence-based approach, the checklist development follows these key phases:

1. Literature Review and Selection – A thorough review of relevant studies and established frameworks on critical thinking in mathematics education is conducted. The selection criteria for literature are based on credibility, relevance, and alignment with the study’s objectives.

2. Checklist Development – Indicators of critical thinking are extracted from the literature and categorized according to specific mathematical problem-solving and reasoning processes. These indicators form the basis of the initial checklist.

3. Validation Process – The checklist undergoes expert validation from mathematics educators and researchers to assess its clarity, relevance, and applicability in classroom settings. Revisions are then made based on expert feedback.

4. Implementation and Observation – The validated checklist is used as an observation tool in Grade 8 mathematics classrooms. Researchers note instances of critical thinking using the checklist to evaluate its effectiveness in capturing students' cognitive processes.

This study is limited to observational data and does not account for external variables such as socioeconomic background that may influence students' critical thinking development. Additionally, while the checklist provides a structured means of assessment, it may not capture all nuances of student reasoning. The research is conducted within the second semester of the academic year 2023–2024 up to the first semester of 2024–2025. Ethical considerations such as informed consent and participant confidentiality are strictly observed.

This qualitative study aims to explore the processes, experiences, and observations related to the acquisition and enhancement of critical thinking skills inside the Grade 8 mathematics classroom. The investigation focuses on Grade 8 students and mathematics teachers at one of the secondary schools in Iligan City, particularly on the variation of prompts that stimulate critical thinking development in mathematics. The primary participants of this study are Grade 8 students, representing a specified group of junior high school learners. The results of this study are applicable only to these participants and do not guarantee the same results with Grade 8 students from different locales, although they may serve as a reference.

Observation is utilized to gather relevant concepts and insights related to critical thinking in the mathematics classroom. The study's focus on Grade 8 students provides an in-depth exploration of both individual and group perspectives; however, it limits a broader understanding of the dynamics involving teachers and the overall classroom environment. The research period is confined to the second semester of academic year 2023–2024 up to the first semester of academic year 2024–2025 and acknowledges the potential limitation in fully capturing the holistic development of critical thinking within a constrained timeframe. Ethical considerations, including informed consent and participant confidentiality, are carefully addressed.

This study determines and verifies the specific strategies teachers employ to stimulate the critical thinking skills of grade 8 students. This is fundamental in understanding how the teacher fosters the development of such skills among students. Additionally, it explores distinct patterns of critical thinking that emerge in the problem-solving procedures of grade 8. The researchers use observation sheets to record relevant classroom interactions and gather a holistic understanding of how students demonstrate critical thinking in solving algebraic problems.

Due to time constraints, the study considers only selected factors influencing critical thinking, with the primary focus on instructional practices. External variables such as socioeconomic background are not included. The small sample size may also limit the generalizability of the findings. The scope is confined to classroom instruction in mathematics and does not extend to other subjects. The study is further delimited by its focus on a single grade level, a single subject area, and the use of observation as the main method of data collection. While this approach enables in-depth analysis, it may not capture all the factors that contribute to the development of critical thinking skills. Moreover, the findings are specific to the context of the selected school and may not represent other educational settings.

Conceptual Framework

Figure 1.

Conceptual Framework (IPO)

INPUT
- Identification of critical thinking indicators and sub-indicators
-Critical Thinking Checklist

↓

PROCESS
- Data Gathering (Raw Observations and Observation Data)
- Data Analysis (Thematic Analysis and Systematic Literature Review)

↓

OUTPUT
- Development of a Checklist

This study employs the Input-Process-Output (IPO) model, originally introduced by McGrath (1964), to illustrate the structure and flow of the research. The model provides a systematic framework for analyzing the development of critical thinking skills in educational settings by showing the interaction among key components of the study. Specifically, the IPO model supports the development and validation of a critical thinking checklist tailored for Grade 8 mathematics instruction. It provides a structured process for creating, refining, and trying out the checklist through actual classroom interactions.

In the input stage, the researchers identify critical thinking indicators and sub-indicators through a thorough review of relevant literature and established frameworks in mathematics education. These indicators serve as the basis for the initial version of the checklist. To ensure clarity and alignment with classroom contexts, the checklist undergoes several rounds of expert validation with input from mathematics educators and the thesis adviser. The goal is to create a checklist that reflects the essential aspects of critical thinking in mathematics and is ready to be tried out during classroom observations.

In the process stage, the researchers use the validated checklist during classroom observations to try out and explore its practical use. Two Grade 8 mathematics classes are observed, with each researcher assigned to one section. Observations focus on capturing classroom moments where students demonstrate critical thinking, as prompted by teacher strategies such as guided questioning and collaborative activities. The checklist is used as a tool to document these moments, allowing the researchers to evaluate its practicality, relevance, and clarity during real instruction. Ethical considerations, including informed consent and participant confidentiality, are strictly observed. Thematic analysis is conducted on the recorded observations to identify how well the checklist reflects actual student behavior, rather than measuring the frequency or level of performance.

In the output stage, insights from the classroom observations and thematic analysis are used to refine the checklist. The final version reflects adjustments made based on actual classroom use and expert feedback. While the checklist is not used to formally assess students, it serves as a working tool that teachers and researchers can use to identify and encourage critical thinking in mathematics instruction. It also contributes to improving the design of future instructional strategies and observation tools in education.

In summary, the IPO model structures the study into three main components: input (identification of critical thinking indicators), process (validation of critical thinking indicators and classroom observation using the checklist), and output (refinement of the checklist based on findings). This framework supports the study's goal of creating a usable and literature-informed checklist for recognizing critical thinking in the mathematics classroom.

Operational Definition of Terms

For common understanding, the following terms are defined operationally:

Analysis. This is the ability of Grade 8 students to break down mathematical materials or concepts into component parts so that the general concept is clearly understood.

Critical Thinking in Mathematics Education. This is defined as the ability to analyze, interpret, infer, evaluate, and synthesize mathematical information. In the present study, it refers to students' skills in breaking down complex problems, making sense of data, drawing logical conclusions, assessing the validity of solutions, and combining concepts to solve mathematical tasks, as observed through a researcher-developed checklist in Grade 8 classrooms. It involves rational and logical thinking applied to problem-solving and decision-making.

Evaluation. This is a critical thinking subskill that pertains to how Grade 8 students make judgments about the value or the process in which a mathematical problem or lesson is presented to them.

Inference. This is a critical thinking subskill of Grade 8 students that refers to how they use prior knowledge and experience to understand and draw conclusions about new concepts.

Interpretation. This is the ability to make sense of mathematical data and concepts, referring to students' capacity to understand and explain their reasoning during problem-solving, as observed in Grade 8 classrooms using the researcher-developed checklist.

IPO Model. This is a model used in research to analyze the relationship between different stages of a process by specifying the steps involved in the input, process, and output phases. In this study, it is used to guide the flow of developing, implementing, and refining the critical thinking checklist.

Synthesis. This refers to how students go beyond what they have learned and understood to create new methods or alternative ways of solving mathematical problems.

Mathematics Instruction. This includes the teaching practices and strategies used by educators to deliver mathematical content and foster critical thinking in the classroom.

Checklist-Based Observation. This is a research method that involves systematically recording observations using a predefined checklist. In this study, the checklist is used to try out and document instances of critical thinking behaviors in mathematics instruction.

Critical Thinking Indicators. These are the observable behaviors used in the development of the researcher-made checklist. In this study, the indicators are as follows:

Asking Relevant Questions to Open the Student's Critical Thinking Skills. This is also known as discovery learning through questioning. It enables students to explore complex topics, identify patterns and relationships, and develop their own understanding and explanations.

Analyzing Information from Multiple Perspectives. This is the process of examining a mathematical problem or concept in different ways. It involves encouraging students to consider alternative approaches and solutions.

Evaluating Multiple Perspectives with Evidence. This is the ability to judge the validity of information or arguments used in solving a mathematical problem. It includes recognizing potential biases, considering different explanations, and deciding how much evidence is needed to support a conclusion.

Demonstrating Logical Reasoning. This is the act of showing a clear, step-by-step thought process in solving mathematical problems. It involves connecting mathematical concepts in a logical way, which ensures coherence and clarity in reasoning.

Applying Knowledge to Real-World Applications. This is the use of mathematical concepts and techniques to solve practical problems encountered in everyday life. It demonstrates students' ability to apply classroom learning to real-world situations.

Qualitative Research. This is a research approach that explores experiences, behaviors, and patterns through observation and analysis. In this study, it is used to understand how students demonstrate critical thinking during mathematics instruction.

Systematic Review. This is a methodical process of identifying, evaluating, and synthesizing existing research on a specific topic. In this study, it is conducted to identify reliable indicators of critical thinking in mathematics education.

Literature Review. This is the process of reviewing and analyzing past research and scholarly works related to a specific topic. In this study, it informs the selection of critical thinking indicators used in the checklist.

Teaching Strategies. These are the methods and techniques used by teachers to facilitate student learning. In this study, they refer to the specific approaches employed to stimulate critical thinking in grade 8 mathematics classrooms.

CHAPTER II

REVIEW OF RELATED LITERATURE

This chapter reviews available literature and studies related to the research that helps researchers understand its variables. It synthesizes definitions, theories, and other data relative to the investigation of how to stimulate critical thinking skills in mathematics education.

Level of Mathematics Education Achievement

Mathematics is considered challenging to teach in elementary and secondary education, teaching essential knowledge and skills to students for organizing their lives (Ariyanti & Santoso, 2020; as cited by Aguhayon et al., 2023). It contributes to the development of critical learning skills among students. As key implementers of mathematical learning, teachers must employ strategies for attaining mathematics objectives (Azucena et al., 2022). Regarded as the cornerstone of scientific and technological information, mathematics plays a role in the economic growth of a nation.

Despite its significance to individual success and nation-building, there has been a decline in learners' achievement in mathematics, as indicated by the results of the Programme for International Standard Assessment (PISA) and Trends in International Mathematics and Science Study (TIMSS) (OECD, 2019; Mullis et al., 2019). For instance, students' mathematical performance in Norway decreased from 2015 to 2019 based on TIMSS results (Nilsen et al., 2022). The school environment and student self-concept mediated the result.

In the Philippines, the past year's mathematics performance of Filipino learners has been deteriorating. Basista et al. (2016) found that first-year students' performance in mathematics is deficient without mastery, with almost no background, lacking knowledge, competency, and skills. Also, Cabuquin & Abocejo (2023) found that high school learners show low mathematics performance and tend to experience difficulties in their overall academic achievement. Further, Albano (2019) stated that Grade 6 pupils' performance in the National Achievement Test consistently falls within the "low mastery" level, also observable among Grade 10 students whose Mean Percentage Score only improved by 0.51 in the 2017 NAT results, still under the "low mastery" category. On the global stage, the Philippine educational system has lagged behind Asian countries. It is evident in the series of PISA and TIMSS results. For example, in the 2018 PISA result, less than 20% of students demonstrated the minimum proficiency level, while 50% showed very low proficiency.

Moreover, in the latest 2022 PISA results, the country ranked 77th out of 81 countries, perhaps increasing from 80th in the previous test (Ines, 2023). According to the Department of Education (DepEd), the result reflects a 5 to 6-year learning gap in competencies in the country. Undoubtedly, there is a need for Mathematics education to step up their game. Prioritizing efforts to bridge the mathematics learning gap guarantees that students have the skills and knowledge necessary for their academic and future employment (Aguhayon et al., 2023).

Critical Thinking Skills in the Context of Mathematics

Critical thinking is a life skill that students should develop. If a person's thinking ability is meager, success becomes difficult to achieve (Waluyo, 2018). In mathematics education, critical thinking includes the ability to analyze, evaluate, and synthesize information, leading to a deeper understanding and application of mathematical concepts (Halpern, 2014; as cited by Nur'azizah et al., 2021). These skills are essential for navigating complex problem-solving tasks and making informed decisions. Critical thinking involves finding solutions, understanding concepts, evaluating information, and making decisions—an aspect often overlooked in conventional mathematics education.

Critical thinking is necessary for solving problems, particularly in algebra (Cahyono et al., 2019). Algebraic equations often have similar structures and relationships, where recognizing patterns is crucial. Mathematically proficient critical thinkers identify these patterns and apply logical deduction to develop practical solutions. This analytical method extends beyond mathematics and applies to various real-life problems (Ononiwu, 2023). Furthermore, critical thinking goes beyond data analysis; it involves reflection and sound judgment. It supports fair decision-making in both daily life and the classroom. As such, critical thinking has become a vital skill for the 21st century (Halpern, 2014, as cited by Nur'azizah et al., 2021). Developing these abilities can help address a wide range of issues in everyday life (Utami et al., 2018; as cited by Nur'azizah et al., 2021). Recognizing algebra's importance and its role in fostering critical thinking is essential in a constantly changing world (Cahyono et al., 2019). Given its importance, mathematics teachers should possess and effectively transfer these skills to high school students. However, Kurasei & Aditomo (2019), citing Dewantara et al. (2015), found that teachers often limit students to applying formulas and answering objective questions. Hallman-Thrasher (2017) explained that this hinders students from using reasoning skills and forming arguments. This contributes to poor performance in critical thinking and reasoning-based assessments like PISA and TIMSS.

In the Philippines, the level of critical thinking among students and even pre-service teachers is generally low (Lopez et al., 2023; Dela-Cruz & Cardino, 2020). Several factors may contribute to this issue. Gagani & Misa (2018) noted that those who struggle with simple tasks often become frustrated when tackling more complex sub-problems. Reasoning ability leads to critical thinking skills, which cannot be developed in a single math course—it must be nurtured across the curriculum. Moreover, critical thinking supports the development of transferable skills beyond specific subjects. It emphasizes a student-centered approach that fosters active learning and knowledge construction based on evidence and observation (Ab. Wahid, 2022). This leads to a deeper understanding of concepts and stronger problem-solving skills.

Importance of Identifying Critical Thinking Indicators in Mathematics Discourse

Critical thinking (CT) is a vital aspect of mathematics education, as it enables students to approach problems with a deeper understanding, develop their problem-solving skills, and enhance their overall mathematical performance (Guncaga et. al., 2020). Critical thinking (CT) in learning would assist teachers and learners in meeting the challenges faced in the world we live in today. Challenges such as unemployment, rote learning, and poor moral skills can be resolved through CT in education (Ongesa et. al., 2023). In mathematical discourse, involving explanation, argumentation, and defense of mathematical ideas becomes crucial to identify critical thinking skills indicators.

Current curriculum initiatives in mathematics call for the development of classroom communities that take communication about mathematics as a primary focus. Learning goals at all educational levels tend to emphasize the development of CT in teaching and learning (Ongesa et al., 2023). Despite this emphasis, teachers often lack concrete tools to observe and assess critical thinking during classroom instruction. Critical thinking (CT) in this study is broadly defined as a skillful, reasonable thought that brings good judgment because it has criteria, is self-correcting, and is sensitive to a context given for identifying such indicators. In Mathematics, critical thinking usually comes when students ask why, rather than taking what they learn at face value. Critical thinking leads to skills that can be learned, mastered, and used. It is the rational examination of ideas, inferences, assumptions, principles, arguments, conclusions, issues, statements, beliefs and actions (Alcantara & Basca, 2017). Learners placed together in small learning communities with other learners of like minds but having varied opinions can develop diverse ideas and come up with various solutions to a problem under study. If those solutions are evaluated further, they can produce reliable knowledge (Ongesa et al., 2023). Thought-provoking questions, therefore, can promote the development of critical thinking. Identifying the strategies/steps for solving a given problem are essential to understand how the problem is to be solved. The steps needed to solve a critical problem are logical and demand deductive and inductive reasoning to be actualized (Maweu et al., 2023). Developing critical thinking skills indicators can impact educational fields, with education not only providing information to the students but aiming to raise individuals who can think, examine, and solve problems in general (Artuz & Roble, 2021).

Critical Thinking Indicators in Mathematics Discourse

Critical thinking is a highly-valued skill in the field of mathematics education, as it enables students to approach mathematical problems in a manner with clarity, accuracy, and flexibility (Paul & Elder, 2014). Otherwise, in mathematics discourse, critical thinking includes the ability to analyze, evaluate, and construct mathematical arguments in addition to problem-solving skills (Biddix & Hinrichs, 2007). Despite its significance, the development of critical thinking indicators is frequently ignored or underemphasized in mathematics education (Santos-Reyes & Coutinho, 2017). This is especially concerning because research has demonstrated that critical thinking indicators are necessary for problem-solving and mathematical literacy. Moreover, the development of critical thinking indicators can have a positive impact on students' overall academic performance and future success (Hart Research Associates, 2006). To address this issue, there is a need to develop and identify the critical thinking indicators in mathematics discourse. Some of the indicators presented in the previous research are the students' ability to justify their answers, explain their reasoning, and recognize the limitations of their solutions. More comprehensive research is needed for identifying and evaluating critical thinking indicators in mathematics discourse. The purpose of this review is to provide an overview of the current state of research on mathematical discourse indicators of critical thinking. It will examine the existing literature on the topic, highlighting the various indicators that have been identified and their implications for teaching and learning mathematics. By synthesizing the existing knowledge on this topic, this review aims to contribute to the development of a more comprehensive understanding of the discrete critical thinking indicators in mathematics discourse. The following are the critical thinking indicators in mathematics discourse:

A. Asking Insightful Questions

According to Hmelo-Silver (2018), insightful questioning is a key component of discovery learning, as it enables learners to explore complex topics, identify patterns and relationships, and develop their own understanding and explanations. Asking insightful questions is a form of discovery learning as it demonstrates a deep understanding of mathematical concepts and an ability to think critically about complex problems in any manner and in any type of questions that are clearly related to the topic. Students who engage in deeper levels of thinking have a higher level of mathematical proficiency, and according to research, are more likely to ask insightful questions (Chin & Theo, 2015; Diyarova, 2024).

When the students are able to ask insightful questions related to the topic, it demonstrates, not just critical thinking skills, but also language and communication skills (Diyarova, 2024). Effective questioning from the students is an effective strategy to promote students' knowledge of linguistic structures, effective communication, the process of metacognition, and reflection (Rakhmonova, 2024). Meanwhile, students must acquire skills such as recognizing patterns, analyzing relationships, and identifying key concepts in order to ask insightful questions in mathematics discourse. Concept-based questions, think-aloud protocols, and Socratic questioning can be used (Biehler et al., 2013). Teachers can use open-ended questions, encourage students to look into their own questions, and give students opportunities to think about what they have learned (Lesh et al., 2016). Students can learn to ask insightful questions that help them better understand and think critically about mathematics by doing this. In addition, research has demonstrated that students tend to acquire a more complex comprehension of mathematical concepts when given the opportunity to ask questions and participate in discussions (Krebs et al., 2018).

Asking insightful questions also entails asking the right questions. This is because students might ask actual questions, inferential questions, out of the topic questions, and etc. Teacher's choices to entertain questions are important. With this, the following are the sub-indicators of asking insightful questions. Sub-indicator 1, "Questions are directly related to the current mathematical concept or problem being discussed," student’s questions that are more likely focused on the topic or problem being discussed demonstrate a deeper understanding of the material without any distractions (Krebs et al., 2018). Sub-indicator 2, "Questions seek to resolve misunderstandings or errors in reasoning," indicates that students are able to identify gaps in their understanding and actively seek to fill them, which is a key component of critical thinking (Lesh et al., 2016). Sub-indicator 3, "Questions challenge the assumptions underlying a problem or a solution," shows that students are able to think critically about the assumptions and premises that underlie mathematical concepts (Biehler et al., 2013). Sub-indicator 4, "Questions consider alternative methods for solving a problem," demonstrates that students are able to think critically and consider different approaches to solving problems, which is an essential skill for mathematicians (Krebs et al., 2018). Sub-indicator 5, "Questions prompt further investigation," students that are curious and motivated to learn more consider that the student demonstrates critical thinking (Zandri et al., 2017). Sub-indicator 6, "Questions reflect on the learning process and personal understanding," indicates that students are able to reflect on their own learning and understand how they arrived at their conclusions, which is an important aspect of metacognition (Flavell, 2016). Finally, sub-indicator 7, "Questions seek to understand the underlying principles or theories behind," shows that students are able to think about the “bigger picture” and understand how mathematical concepts fit into larger frameworks (Koedinger et al., 2012).

B. Analyzing Information from Multiple Perspectives

Analyzing information from multiple perspectives is one of the components of fostering deep mathematical understanding and critical thinking (Moonma & Kaweera 2022). Students are encouraged to consider alternative approaches and solutions as a result of this process, which involves evaluating mathematical concepts and problems from multiple perspectives. According to Brookhart (2010), critical thinking in mathematics requires students to "investigate and explore various perspectives and approaches" to fully grasp the complexity of problems and identify the most effective solutions. This multidimensional analysis improves problem-solving abilities and fosters a deeper comprehension of mathematical concepts. Students who practice analyzing information from multiple perspectives develop a more nuanced understanding of mathematical principles, as they are better equipped to recognize biases, assumptions, and potential errors in reasoning (Paul & Elder, 2014). Allowing students to connect seemingly unrelated ideas and approaches, encouraging students to adopt multiple perspectives in mathematics discourse results in more innovative and creative problem-solving strategies (Alcantara & Basca, 2017). Integrating this practice into mathematics education not only improves critical thinking but also prepares students for complex real-world problems that require complex solutions.

Analyzing information from multiple perspectives is more likely a process of examining a math problem or concept in different ways of using methods and representations (Cahyono et al., 2019). Critical thinkers must be able to analyze and synthesize information from various perspectives to fully understand complex problems. The following are the sub-indicators of analyzing information from multiple perspectives. Sub-indicator 1, "Student recognizes multiple approaches to the problem," this recognition enables students to explore a variety of strategies, encouraging a flexible mindset and creative problem-solving (Lamaro et al., 2024). Sub-indicator 2, "Student compares outcomes of various strategies for the same problem," this comparative analysis is vital for identifying the most suitable approaches for specific problems (Polya, 2014). Sub-indicator 3, “Student examines alternative solutions and explains why they work or not (Calkins et al., 2019), this practice promotes a deeper comprehension of mathematical principles by enhancing reasoning and justification skills. Sub-indicator 4, "Student synthesizes insights from various perspectives for a comprehensive understanding," according to Alcantara & Basca (2017), enabling students to recognize the interconnectedness of mathematical ideas and techniques pondering how considering numerous viewpoints upgrades understanding is significant for metacognitive turn of events. Finally, sub-indicator 5, “Student reflects on how multiple perspectives enhance understanding” (Calkins et al., 2019). It argued that this reflection helps students appreciate the value of diverse viewpoints, leading to more understanding and thorough comprehension.

C. Evaluating Evidence

Evaluating evidence is a critical component during mathematical discourse, where students have the ability to assess the validity and relevance of data, arguments, and conclusions including computations or methods used (Duncan et al., 2022).

According to Paul & Elder (2008), this includes recognizing the limitations and potential biases of the data, considering alternative explanations, and making informed judgments regarding the amount of evidence required to support a conclusion. This skill is essential for developing rigorous mathematical reasoning and problem-solving abilities (Santos & Coutinho, 2017). Critical thinking in mathematics involves the ability to evaluate the credibility of sources, the logic of arguments, and the reliability of data. In educational settings, students who are capable of assessing proof are better prepared to recognize the strength of numerical evidence, mathematical proofs and the validity of statistical data. Students who actively engage in evaluating evidence demonstrate greater accuracy in their problem-solving approaches, as they are more likely to identify errors, biases, and assumptions that could undermine the reliability of their conclusions. Moreover, teaching students to evaluate evidence fosters a more analytical mindset, encouraging them to question and verify information before accepting it as true. This critical evaluation process not only strengthens mathematical understanding but also prepares students for real-world challenges where the ability to assess evidence is crucial.

Evaluating evidence in mathematical discourse involves several key sub-indicators that contribute to the development of critical thinking skills. The following are the sub-indicators of evaluating evidence. Sub-Indicator 1, "Student/s select/s evidence that directly supports a mathematical argument or solution," In mathematics education, critical thinking is an agent for building valid mathematical arguments, as it ensures that the conclusions drawn are based on reliable and appropriate information. This skill not only reinforces the logical structure of mathematical reasoning but also helps students avoid the pitfalls of using irrelevant or misleading information. Sub-indicator 2, "Student/s verify/ies the accuracy of calculations and provide/s enough evidence," accurate calculations are foundational to sound mathematical arguments, and the process of verifying these calculations enhances students' attention to detail (Kurasei & Aditomo 2019). By ensuring that their calculations are correct and adequately supported by evidence, students demonstrate a deeper understanding of mathematical principles and a commitment to rigor in their problem-solving processes.

D. Demonstrating Logical Reasoning

Demonstrating logical reasoning is characterized by a clear, step-by-step thought process that connects mathematical concepts. Demonstrating logical reasoning is a fundamental indicator of critical thinking (Ongesa, 2020). Demonstrating logical reasoning is a fundamental indicator of critical thinking, this logical progression not only facilitates problem-solving but also ensures that students' reasoning is both coherent and well-founded (Ononiwu, 2023). As indicated by Polya (2014), the ability to systematically break down a problem and link each step with underlying mathematical principles is essential for effective problem-solving. Students' solutions become more transparent and understandable to others as a result of their ability to clearly articulate their thought processes through the use of logical reasoning. In educational settings, students who consistently demonstrate logical reasoning are better able to construct valid arguments and draw accurate conclusions, as they are adopted to connect various mathematical ideas in a structured manner. Furthermore, teaching logical reasoning in mathematics not only enhances students' critical thinking skills but also prepares them to tackle more complex problems with confidence, as they develop a robust framework for approaching and solving mathematical challenges (Namwambah, 2020).

A series of interconnected sub-indicators that collectively ensure a clear and structured approach to problem-solving are necessary to demonstrate logical reasoning in mathematical discourse. The following are the sub-indicators of demonstrating logical reasoning. Sub-indicator 1, "Student/s ensure/s each step of the reasoning process is clear and follows from the previous step," this successive clearness is fundamental for robust mathematical arguments, as it prevents gaps in reasoning and promotes transparency in problem-solving (Tee et al., 2018). Sub-indicator 2, "Student/s support/s claims with appropriate mathematical evidence, examples, theorems and principles," the use of well-founded evidence not only strengthens students' reasoning but also deepens their understanding of mathematical concepts (Tee el at., 2018). Sub-indicator 3, "Student/s avoid/s contradictions in reasoning and calculations," which is essential for maintaining the integrity of the logical process, also Ononiwu (2023) emphasized that recognizing and correcting contradictions ensures that students' conclusions are consistent and reliable. Sub-indicator 4, "Student/s apply/ies general principles to specific cases accurately," this skill demonstrates students' ability to transfer abstract concepts to practical situations, reflecting a deep comprehension of mathematical principles (Can, 2020). Lastly, sub-indicator 5, "Student/s use/s patterns and examples to form generalizations," as it allows students to extend their understanding from specific instances to broader concepts, and this process of generalization is vital for developing higher-order thinking skills in mathematics (Skagenholt et al., 2023).

E. Applying knowledge to real world situations

Applying knowledge to real-world applications is a crucial indicator of critical thinking in mathematics discourse, reflecting students' ability to use mathematical concepts and techniques to solve practical problems encountered in everyday life (Halpern & Dunn, 2021). This application demonstrates, not only a deep understanding of mathematical principles, but also the capacity to transfer this knowledge to address real-world situations effectively. The ability to apply mathematical knowledge in practical contexts is a vital aspect of mathematical literacy, enabling students to navigate and solve complex problems outside the classroom (Thaikam et al., 2024). This skill includes the integration of abstract mathematical theories with tangible, everyday challenges, such as financial planning, engineering problems, or data analysis. Critical thinking in genuine settings expects students to adjust their mathematical knowledge to new and frequently realistic situations, which encourages creativity and innovation. Furthermore, students are more likely to see the relevance and value of the subject when they apply it to real-world situations, which can increase motivation and creativity. This process not only reinforces students' critical thinking skills but also prepares them to function as informed and capable citizens who can use mathematics to make reasoned decisions in their personal and professional lives (Da, 2023).

Applying knowledge to real-world applications in mathematics involves several key sub-indicators that collectively enhance students' critical thinking and problem-solving abilities. The following are the sub-indicators of "Applying knowledge to real-world applications". Sub-indicator 1, "Student/s demonstrate/s how mathematical theories and principles can be used to solve practical problems," for students to understand how mathematics applies to everyday life, they need to apply theoretical knowledge to real-world situations (Dinglasan et al., 2023). Sub-indicator 2, "Student/s justify/ies the selection of specific methods based on the problem context," students who can explain their choice of methods demonstrate a deeper understanding of both the mathematical techniques and the real-world situations they are addressing (Artuz & Roble, 2021). Sub-indicator 3, "Student/s develop/s mathematical models to represent real-world situations," the creation of such models facilitates analysis and solution by assisting students in translating complex real-world problems into manageable mathematical representations (Selba, 2024). Sub-indicator 4, "Student/s interpret/s the results of mathematical models in the context of the real-world problem," is equally important, as it ensures that students can connect mathematical outcomes and, this interpretation bridges the gap between abstract calculations and their real-world implications (Pentang et al., 2024). Sub-indicator 5, "Student/s explain/s the application of mathematical concepts and solutions clearly," is critical for effective communication, both in educational settings and in real-world problem-solving contexts (Cahyono et al., 2019). Lastly, sub-indicator 6, "Student/s reflect/s on the effectiveness of applying mathematical knowledge to real-world problems," such reflection is a key component of critical thinking, as it allows students to learn from their experiences and refine their approaches to future challenges (Le et al., 2021).

Note: The development of critical thinking indicators in mathematics discourse has been done through validations, validated by experts.

Related Studies

Several studies, both local and international, have explored the integration of critical thinking in mathematics education, particularly its role in improving student learning outcomes. These studies provide empirical evidence supporting the development of observable indicators of critical thinking and highlight gaps in instructional practices that this research seeks to address. In the Philippine context, Lopez et al. (2023) investigated the critical thinking levels of Filipino high school students and found that most learners scored low in tasks requiring analysis, inference, and evaluation. Their results emphasize the limited opportunities provided in classrooms for students to engage in reasoning-based activities, especially in mathematical problem-solving. This reinforces the need to embed critical thinking skills in mathematics instruction to improve students' performance in local and international assessments.

Similarly, Dela-Cruz and Cardino (2020) studied the critical thinking dispositions of pre-service mathematics teachers. Their findings revealed that while pre-service teachers understand the concept of critical thinking, they often lack the ability to apply it effectively in solving mathematical problems. The study suggests that integrating explicit instruction and practice of critical thinking strategies in teacher education programs can improve both teacher competency and future classroom instruction. Artuz and Roble (2021) explored the effect of the Online Process-Oriented Guided Inquiry Learning (O-POGIL) approach on students' critical thinking skills. Conducted among education students in Bukidnon, their study showed significant improvement in critical thinking domains such as communication, interpretation, and problem-solving after using the O-POGIL method. The study underscores the impact of well-designed inquiry-based materials in fostering higher-order thinking in mathematics learning.

Another study by Benedicto and Andrade (2022) investigated the effectiveness of problem-based learning strategies in enhancing the critical thinking skills of pre-service teachers in Laguna. Using a quasi-experimental design, they found that while students improved in argument evaluation and reasoning, difficulties persisted due to a lack of mastery of mathematical concepts. This highlights the need for carefully scaffolded instruction and assessment tools to support critical thinking. From a senior high school context, Lepasana (2018) examined the metacognitive functions and critical thinking abilities of Grade 12 STEM students in Pitogo High School. The study revealed varying levels of critical thinking, which were influenced by the students' mathematical ability and exposure to higher-order thinking tasks. The research emphasized the value of assessing critical thinking through open-ended, non-routine mathematical problems that demand more than procedural fluency.

In another local study, Magpantay and Pasia (2022) assessed the effect of using problem-based learning materials in enhancing critical thinking among Grade 10 students. The results showed that students exposed to the PBL materials performed significantly better in inference, communication, and reasoning tasks compared to those taught with traditional methods. The researchers recommended the continued development and validation of instructional tools tailored to improve critical thinking in mathematics. International studies also support these findings. Kurasei and Aditomo (2019) examined the influence of Indonesian classroom instruction on students' mathematical reasoning. Their results indicated that traditional teaching methods focusing on memorization hindered the development of evaluation and analysis skills. The authors suggested using observation tools to track student engagement with critical thinking indicators, which aligns with the aim of the present study. In Nigeria, Ononiwu (2023) focused on logical reasoning and its role in solving algebraic problems. The study found a strong correlation between students' ability to reason through mathematical steps and their academic achievement in mathematics. It recommended instructional strategies that emphasize step-by-step problem-solving and justification of answers, similar to the logical reasoning indicators emphasized in the present checklist.

Moreover, Duncan et al. (2022) in the United States explored how structured classroom observation tools could be used to assess critical thinking behaviors. The study found that when teachers used specific checklists to observe indicators like evaluation, justification, and application of concepts, students showed deeper engagement and more reflective problem-solving behaviors. Perez and Andrade (2023) conducted a comparative study on students' thinking styles and their relation to critical thinking and creativity in mathematics. Results showed that students with "grasshopper" thinking styles demonstrated higher levels of critical thinking compared to "inchworm" thinkers. The researchers proposed that instructional strategies and assessment tools should be tailored to accommodate diverse cognitive styles to foster critical thinking more effectively. While many studies have focused on instructional strategies and student outcomes, only a few have proposed practical tools that systematically observe critical thinking during classroom instruction. Duncan et al. (2022) introduced a checklist-based approach to capture real-time student behaviors related to evaluation and justification. However, their tool lacked subject-specific depth, particularly in mathematics. Similarly, Yusof et al. (2018) developed a rubric to assess higher-order thinking in mathematics, but the authors acknowledged that the instrument was too general for daily classroom use, making it less practical for teachers to apply regularly. Santos-Reyes and Coutinho (2017) also emphasized the absence of validated frameworks for tracking critical thinking development in subject-specific contexts like mathematics, noting that many educators rely on subjective impressions rather than structured observation.

These findings highlight a significant research gap: while the importance of critical thinking in mathematics is widely recognized, there is limited availability of classroom-ready, validated tools to support its observation and development. Few studies focus on the actual process of developing, validating, and applying such tools for real-time instructional use. The current study addresses this gap by designing and validating a researcher-developed checklist of critical thinking indicators, tailored for mathematics discourse among Grade 8 students. Grounded in literature and refined through expert feedback, this checklist offers a structured, practical means to support both teaching and assessment, bridging the divide between theory and classroom practice.

Synthesis

The literature and related studies highlight the need for effective strategies to address the declining mathematics performance among students. Mathematics is considered challenging (Ariyanti & Santoso, 2020), as reflected in students' performance in PISA and TIMSS assessments (OECD, 2019). Given the persistent difficulties in learning mathematics (e.g., Boulton Lewis, Cooper, Atweh, Pillay, & Wills, 2001; Demana & Leitzel, 1988; MacGregor, 1996; Martinez, 2016), educators must carefully select instructional methodologies that foster knowledge transfer (Cardino & Ortega-Dela Cruz, 2020). Since critical thinking (CT) skills play a vital role in mathematics, particularly within the Philippines' K–12 Curriculum, studies report that students often lack foundational practices that enhance these skills (Artuz & Roble, 2021). Traditional instructional approaches often limit students' opportunities to explain their reasoning, evaluate ideas, and justify solutions. Without a clear framework for identifying these skills, it becomes difficult for teachers to intentionally design lessons that promote critical thinking. This results in missed chances to develop and observe critical thinking behaviors during classroom instruction. Therefore, it is essential to establish clear and observable indicators of critical thinking that teachers can use as a guide in their instructional practice. This study focuses on the development of a critical thinking checklist specifically designed to capture these indicators in the context of Grade 8 mathematics instruction. The checklist aims to assist educators in stimulating critical thinking skills in alignment with the goals of the K–12 mathematics curriculum in Iligan City.

CHAPTER III

RESEARCH METHODOLOGY

This chapter presents the research design, respondents, and procedure in the conduct of the study.

Research Design

This study uses a pure qualitative research design. A qualitative design aims to analyze and interpret non-numerical data to gain a deeper understanding of social reality, including the participants' perspectives, behaviors, and beliefs. Observation serves as the primary method for collecting data from participants in their natural classroom setting. The objective of this research is to explore how critical thinking, particularly in the context of mathematical reasoning, can be stimulated among students. This design allows the researchers to identify meaningful patterns and insights into how students demonstrate critical thinking skills during mathematics instruction.

Research Setting

This study is conducted at the laboratory high school of a university in Iligan City. The school offers both junior high school (Grade 7 to Grade 10) and senior high school (Grade 11 to Grade 12) programs. The study takes place in two grade 8 mathematics classes, where regular classroom observations are carried out.

Research Subjects

The study is performed in two grade 8 classes (Class A and Class B), each consisting of 34 students, within the junior high school department of the school. The entire population of both classes is included as research subjects. These classes serve as the observation group, with both sections being facilitated by a pre-service teacher. Observations were conducted during their regular class schedules.

Research Instrument

To begin the data gathering phase of the study, the researchers develop a checklist of critical thinking indicators, including sub-indicators and descriptions. These indicators are selected based on valid and reliable sources, such as peer-reviewed articles, research studies, and systematic literature reviews. This addresses the theoretical basis of the checklist, as suggested by related studies.

A systematic approach is observed in selecting relevant literature. The researchers conduct an initial broad search of over 50 research articles discussing critical thinking indicators across various disciplines. The selection is then refined by focusing specifically on studies related to mathematics education and learning, narrowing it down to 25 to 30 key articles. These studies serve as the foundation for identifying and categorizing the indicators that are most applicable to mathematical discourse.

The checklist aims to capture when and how critical thinking occurs among students during mathematics discourse. It also serves as a tool to guide observations, which are crucial in fulfilling the objectives of this study. The checklist is reviewed and validated by content experts to ensure that each indicator aligns with the critical thinking skills and knowledge expected in mathematics instruction. Revisions are incorporated as necessary to improve its clarity, relevance, and classroom applicability.

To ensure its validity and reliability, the checklist undergoes multiple stages of expert validation. The initial version, referred to as Checklist 1, includes broad mathematical critical thinking indicators such as problem formulation, analysis, evaluation, and drawing conclusions. Although comprehensive, it is found to be too general and not practical for classroom use.

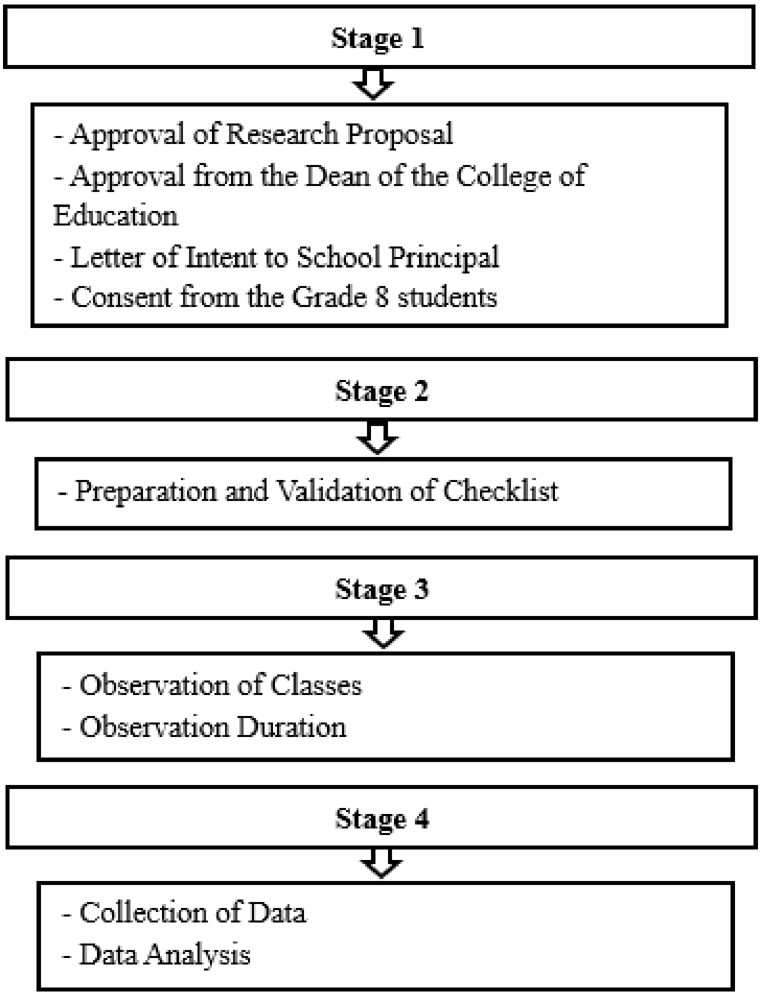
Checklist 2, reviewed by two additional experts, narrows the focus and makes the indicators more specific and actionable. While this version shows improvement, further refinements are necessary to ensure its effective use in actual classroom settings. Checklist 3 is then developed and validated again by another expert. This version emphasizes indicators such as asking relevant questions, analyzing information from multiple perspectives, and synthesizing ideas. However, feedback suggests that the checklist needs better alignment with classroom realities and a more accessible format.

The final version, Checklist 4, results from these iterative revisions, incorporating both expert feedback and insights from additional literature. It is reorganized for ease of use, based on the suggestions of the thesis adviser, to enhance its classroom application. This development process results in a well-validated, researcher-developed instrument intended to guide classroom observations and explore students' critical thinking in mathematics instruction. The finalized checklist reflects both theoretical grounding and practical adaptability. It serves not only as a tool for this study but also as a potential reference for future classroom-based research in mathematics education.

Data Gathering Procedure

Figure 2.

Data Gathering Procedure



The data gathering procedure is carried out in four stages. The first stage involves securing the necessary approvals to conduct the study. This includes the approval of the research proposal, as well as consent from the Dean of the College of Education and the school principal. Consent forms are also distributed to the Grade 8 students to ensure their voluntary participation in the study.

The second stage includes the preparation for classroom observations. This involves the development and validation of a checklist focused on critical thinking skills, with validation provided by expert validators. The final validated checklist is used during classroom observations to systematically track students' critical thinking behaviors. The checklist is used solely for observational purposes and does not involve assessing or grading students' performance. The researchers document instances where students demonstrate analysis, evaluation, synthesis, and logical reasoning during problem-solving discussions. Observations are conducted in a structured manner, analyzing how students engage with mathematical concepts and the types of reasoning they exhibit. For consistency, the researchers record data using predefined codes aligned with the critical thinking indicators from the checklist. Each observed instance of student engagement, problem-solving strategies, and teacher questioning techniques is marked accordingly. This ensures that data collection remains systematic and comparable across different classroom sessions.

Stage three consists of conducting the actual classroom observations over a period of three to four weeks. Class A was observed on Wednesdays from 10:00 AM to 11:00 AM and Thursdays from 10:00 AM to 12:00 PM, while Class B was observed on Wednesdays from 2:00 PM to 4:00 PM and Thursdays from 7:30 AM to 8:30 AM. Data is recorded using the validated checklist to monitor students’ critical thinking skills and the strategies employed during instruction.

The fourth and final stage involves analyzing the collected data to identify recurring patterns in students’ critical thinking behaviors and to describe the instructional strategies that appear to trigger these responses. The analysis focuses on how students engage with mathematical tasks and how teacher prompts influence their reasoning and problem-solving approaches. All ethical protocols are strictly observed, including obtaining informed consent and ensuring participant confidentiality throughout the data collection process.

Data Analysis

The researchers used thematic analysis to interpret the data collected during classroom observations. Thematic analysis is a qualitative approach that focuses on identifying and interpreting implicit and explicit patterns of meaning within the data (Greg et al., 2012). Codes represent identified themes and are applied to raw data as summary markers for further analysis. Data from observations of both Class A and Class B are analyzed to determine how and when critical thinking is stimulated during mathematics discourse. To deepen the analysis, the recorded checklist data is categorized into thematic patterns, identifying which instructional strategies trigger critical thinking most effectively. The analysis focuses on patterns such as student questioning, peer interactions, and teacher scaffolding, which reveal recurring themes related to critical thinking development. The checklist is used solely as an observation tool and does not involve assessing or grading student performance. Its purpose is to guide the researchers in documenting instances where students demonstrate critical thinking behaviors during instruction. This allows for a more objective and consistent interpretation of observed classroom interactions. Thematic analysis enables the researchers to organize qualitative data into meaningful categories and draw insights relevant to mathematics education. These themes are cross-checked with expert recommendations to ensure alignment with validated instructional practices.

CHAPTER IV

RESULTS AND DISCUSSION

This chapter presents the results of the study and discusses the findings in relation to the development and validation of a critical thinking checklist in mathematics education. It describes how the critical thinking indicators were identified from existing literature, the process of selecting relevant studies, and the phases involved in validating the checklist. The discussion also interprets the results in connection with the research questions, offering insights into how the checklist can assist educators in encouraging and identifying critical thinking during mathematics instruction.

Systematic Literature Review

The primary objective of this systematic literature review is to identify critical thinking indicators relevant to mathematics education, addressing the research question: What are the critical thinking indicators that can foster students' critical thinking skills in mathematics? Critical thinking is a foundational skill that allows students to analyze, evaluate, and construct ideas through mathematical reasoning. This review focuses on how specific indicators of critical thinking contribute to effective teaching and learning practices in mathematics. By identifying these indicators, educators are better equipped to promote and support the development of students' critical thinking skills in the classroom.

To gather relevant literature, the researchers conduct a comprehensive search using academic databases such as Google Scholar, ERIC, and JSTOR. Strategically selected keywords and phrases include “critical thinking indicators in mathematics education," "aspects of critical thinking," and "mathematical problem-solving." The initial search yields nearly 500 literature sources, studies, and articles. A systematic approach is applied to refine the list, beginning with a screening of titles and abstracts to identify studies aligned with the focus of the review. A checklist developed during the research process is also validated by field experts to ensure the relevance and quality of the selected literature. This methodical selection process ensures that the final pool of studies effectively addresses the research question and provides meaningful insights into critical thinking indicators in mathematics education.

To further refine the candidate studies, stringent inclusion and exclusion criteria are established. The inclusion criteria cover peer-reviewed articles published within the last two decades that focus on high school students and explicitly address critical thinking in mathematics education. Studies are excluded if they do not directly pertain to mathematics education, lack a focus on critical thinking, or are not peer-reviewed. Following this screening and evaluation process, 27 articles and studies meet the established criteria.

This review categorizes the identified critical thinking indicators into five key areas: asking insightful questions, analyzing information from multiple perspectives, evaluating evidence, demonstrating logical reasoning, and applying knowledge to real-world situations. The synthesis of findings from these selected studies highlights a connection between these indicators and the development of students' problem-solving abilities in mathematics. It underscores the role of critical thinking in effective mathematics instruction. These insights provide a solid foundation for the development of the classroom observation checklist used in this study.

Table 1.

List of Citations.

Critical Thinking Indicators				
Asking Insightful Question	Analyzing Information from Multiple Perspectives	Evaluating Evidence	Demonstrating Logical Reasoning	Applying Knowledge to Real-World Applications
1. Hmelo-Silver (2024)	Moonma & Kaweera (2022)	Duncan et al., 2022	Ongesa (2020)	Thaikam et al., 2024

Sub-Indicators				
1. Krebs et al., 2018	1. Lamaro et al., 2024	1. Waluyo (2018)	1. Tee et al., 2018	1. Dinglasan et al., 2023
2. Lesh et al., 2018	2. Polya (2014)	2. Kurasei & Aditomo (2019)	2. Tee et al., 2018	2. Artuz & Roble (2021)
3. Biehler et al., 2013	3. Calkins et al., 2019		3. Ononiwu (2023)	3. Selba (2024)
4. Krebs et al., 2018	4. Alcantara & Basca (2017)		4. Can (2020)	4. Pentang et al., 2024
5. Zandri et al., 2017	5. Calkins et al., 2019		5. Skagenholt et al., 2023	5. Cahyono et al., 2019
6. Flavell (2016)				6. Lee et al., 2021
7. Koedinger et al., 2012				

Table 2.

Initial Copy of the Critical Thinking Checklist

Critical Thinking Indicators		Remarks
1. Asking Insightful Questions	Questions are directly related to the current mathematical concept or problem being discussed. ● **Does the question relate directly to the topic or problem at**	

- Discovery learning through questioning.	**hand?**	
	Questions seek to resolve misunderstandings or errors in reasoning. ● **Is the question intended to resolve misunderstandings?**	
	Questions challenge the assumptions underlying a problem or a solution. ● **Does the question challenge the assumptions behind a problem?**	
	Questions consider alternative methods for solving a problem ● **Does the question consider alternative solutions or methods?**	
	Questions prompt further investigation. ● **Does the question encourage further investigation?**	
	Questions reflect on the learning process and personal understanding. ● **Does the question reflect on the learning process?**	
	Questions seek to understand the underlying principles or theories behind. ● **Does the question seek to understand the reasoning or theory behind a concept?**	
2. Analyzing information from multiple perspectives - Examine a math problem or concept in different ways or using methods and representations.	Recognizes that there are multiple ways to approach a mathematical problem. ● **Does the student recognize multiple approaches to the problem?**	
	Compares the outcomes of using various strategies to solve the same problem. ● **Does the student compare outcomes of various strategies for the same problem?**	
	Examines alternative solutions and explains why they work or don't work. ● **Does the student examine and explain alternative solutions?**	
	Synthesizes information from various perspectives to form a comprehensive understanding. ● **Does the student synthesize insights from various perspectives for a comprehensive understanding?**	
	Reflects on how considering multiple perspectives enhances understanding. ● **Does the student reflect on how multiple perspectives**	

	enhance understanding?	
3. Evaluating Evidence - Judging the validity of the information/ arguments used to solve a math problem	Selects evidence that directly supports a mathematical argument or solution. ● **Does the student select evidence that directly supports the argument or solution?**	
	Verifies the accuracy of calculations and provides enough evidence. ● **Does the student verify the accuracy of calculations and the provided evidence?**	
4. Demonstrating logical reasoning - Showing a clear, step-by-step thought process in solving math problems connecting mathematical concepts	Ensures each step of the reasoning process is clear and follows from the previous step. ● **Does the student ensure each step of the reasoning process is clear and follows logically?**	
	Supports claims with appropriate mathematical evidence, examples, theorems and principles. ● **Does the student support claims with appropriate mathematical evidence, examples, theorems and principles?**	
	Avoids contradictions in reasoning and calculations. ● **Does the student avoid contradictions in reasoning and calculations?**	
	Applies general principles to specific cases accurately. ● **Does the student apply general principles to specific cases accurately?**	
	Uses patterns and examples to form generalizations. ● **Does the student use patterns and examples to form generalizations?**	
5. Applying knowledge to real-world applications - Using mathematical concepts and techniques to solve practical problems encountered in everyday	Demonstrates how mathematical theories and principles can be used to solve practical problems. ● **Does the student demonstrate how mathematical theories and principles solve practical problems?**	
	Justifies the selection of specific methods based on the problem context. ● **Does the student justify the selection of specific methods based on the context?**	
	Develops mathematical models to represent real-world situations. ● **Does the student develop mathematical models to represent real-world situations?**	

life, demonstrating in addressing real-world situations	Interprets the results of mathematical models in the context of the real-world problem. ● **Does the student interpret the results of models in the context of the real-world problem?**	
	Explains the application of mathematical concepts and solutions clearly. ● **Does the student explain the application of concepts and solutions clearly?**	
	Reflects on the effectiveness of applying mathematical knowledge to real-world problems. ● **Does the student reflect on the effectiveness of applying knowledge to real-world problems?**	

Table 3.

Final Copy of Critical Thinking Checklist.

Critical Thinking Indicators		Remarks
1. Asking Relevant Questions to Open Critical Thinking Skills - Discovery learning through questioning.	Questions are directly related to the current mathematical concept or problem being discussed. ● **Does the question relate directly to the topic or problem at hand?**	
	Questions seek to resolve misunderstandings or errors in reasoning. ● **Is the question intended to resolve misunderstandings?**	
	Questions challenge the assumptions underlying a problem or a solution. ● **Does the question challenge the assumptions behind a problem?**	
	Questions consider alternative methods for solving a problem ● **Does the question consider alternative solutions or methods?**	
	Questions prompt further investigation. ● **Does the question encourage further investigation?**	
	Questions reflect on the learning process and personal understanding. ● **Does the question reflect on the learning process?**	

	Questions seek to understand the underlying principles or theories behind. ● **Does the question seek to understand the reasoning or theory behind a concept?**	
2. Analyzing information from multiple perspectives - Examine a math problem or concept in different ways or using methods and representations.	Recognizes that there are multiple ways to approach a mathematical problem. ● **Does the student recognize multiple approaches to the problem?**	
	Compares the outcomes of using various strategies to solve the same problem. ● **Does the student compare outcomes of various strategies for the same problem?**	
	Examines alternative solutions and explains why they work or don't work. ● **Does the student examine and explain alternative solutions?**	
	Synthesizes information from various perspectives to form a comprehensive understanding. ● **Does the student synthesize insights from various perspectives for a comprehensive understanding?**	
	Reflects on how considering multiple perspectives enhances understanding. ● **Does the student reflect on how multiple perspectives enhance understanding?**	
3. Evaluating Multiple Perspectives with Evidence - Judging the validity of the information/arguments used to solve a math problem	Selects evidence that directly supports a mathematical argument or solution. ● **Does the student select evidence that directly supports the argument or solution?**	
	Verifies the accuracy of calculations and provides enough evidence. ● **Does the student verify the accuracy of calculations and the provided evidence?**	
4. Demonstrating logical reasoning - Showing a clear, step-by-step thought process in solving math problems connecting	Ensures each step of the reasoning process is clear and follows from the previous step. ● **Does the student ensure each step of the reasoning process is clear and follows logically?**	
	Supports claims with appropriate mathematical evidence, examples, theorems and principles. ● **Does the student support claims with appropriate mathematical evidence, examples, theorems and principles?**	

mathematical concepts	Avoids contradictions in reasoning and calculations. ● **Does the student avoid contradictions in reasoning and calculations?**	
	Applies general principles to specific cases accurately. ● **Does the student apply general principles to specific cases accurately?**	
	Uses patterns and examples to form generalizations. ● **Does the student use patterns and examples to form generalizations?**	
5. Application of Concepts to Real-World Problems - Using mathematical concepts and techniques to solve practical problems encountered in everyday life, demonstrating in addressing real-world situations	Demonstrates how mathematical theories and principles can be used to solve practical problems. ● **Does the student demonstrate how mathematical theories and principles solve practical problems?**	
	Justifies the selection of specific methods based on the problem context. ● **Does the student justify the selection of specific methods based on the context?**	
	Develops mathematical models to represent real-world situations. ● **Does the student develop mathematical models to represent real-world situations?**	
	Interprets the results of mathematical models in the context of the real-world problem. ● **Does the student interpret the results of models in the context of the real-world problem?**	
	Explains the application of mathematical concepts and solutions clearly. ● **Does the student explain the application of concepts and solutions clearly?**	
	Reflects on the effectiveness of applying mathematical knowledge to real-world problems. ● **Does the student reflect on the effectiveness of applying knowledge to real-world problems?**	

The checklist used in this study was developed to systematically observe and document the presence of critical thinking indicators during mathematics discourse. The indicators and sub-indicators included in the instrument are derived from an in-depth review of literature, which identifies specific cognitive behaviors associated with critical thinking in mathematical contexts. These behaviors align with essential competencies in mathematical literacy, problem-solving, and reasoning, as emphasized by scholars such as Paul & Elder (2014), Brookhart (2010), and Santos-Reyes & Coutinho (2017).

The expert validation process for the checklist follows an iterative approach, involving multiple stages of feedback and revision to ensure classroom practicality. Checklist 1 is the initial version developed by the researchers, based on the indicators and sub-indicators identified from the literature review. This version emphasizes broad critical thinking indicators such as problem formulation, analysis, evaluation, and conclusion drawing in mathematics discourse.

Validator 1 reviewed checklist 1 and provided the first set of feedback. Although comprehensive, it was considered too general for an effective classroom application. Based on these comments, the researchers revise the checklist, resulting in checklist 2, which narrows the focus and defines indicators in more specific and actionable terms. Validator 2 then reviewed checklist 2 and suggested further refinements, particularly in selecting indicators more directly aligned with classroom realities in mathematics education.

Validator 3 reviewed checklists 2 through 4 and contributed significantly to the refinement process by ensuring that the indicators are clearly defined and relevant to real-world classroom scenarios. This validator also recommends reorganizing the checklist into a table format to improve feasibility and ease of use. Validator 4 conducted the final round of validation and recommended key revisions to enhance clarity and instructional relevance. For example, the indicator “Asking Insightful Questions” was revised to “Asking Relevant Questions to Open Critical Thinking Skills” to emphasize purposeful questioning. “Evaluating Evidence” became “Evaluating Multiple Perspectives with Evidence” to highlight the importance of diverse viewpoints. Likewise, “Applying Knowledge to Real-World Applications” was changed to “Application of Concepts to Real-World Problems” to better reflect practical application. In addition, the rating process was simplified into two categories: “Observed” and “Not Observed,” making the instrument more practical for classroom observation. Each version of the checklist is developed in response to expert comments, gradually improving in clarity, usability, and relevance for the classroom setting.

The checklist is organized into five main indicators, each accompanied by a set of sub-indicators to capture nuanced expressions of student thinking during classroom instruction and discourse.

1. **Asking Relevant Questions to Open Critical Thinking Skills**

This indicator captures students’ engagement in metacognitive inquiry, demonstrating curiosity, reflection, and the ability to explore mathematical ideas more deeply. According to Hmelo-Silver (2018), purposeful questioning is essential for discovery learning and the construction of understanding. The sub-indicators, including questioning assumptions, identifying errors, and proposing alternative methods, are based on the works of Biehler et al. (2013), Lesh et al. (2016), and Zandri et al. (2017), who emphasize that students’ questions provide insight into their reasoning processes and critical engagement with mathematical concepts.

2. Analyzing Information from Multiple Perspectives

This indicator focuses on the students' capacity to examine mathematical problems using various strategies, representations, and viewpoints. It encourages flexible thinking and supports a deeper understanding of mathematical relationships (Brookhart, 2010; Moonma & Kaweera, 2022). The subindicators, such as comparing solutions, synthesizing insights, and reflecting on different approaches, are drawn from the works of Cahyono et al. (2019) and Alcantara & Basca (2017), who emphasize that considering diverse perspectives enhances comprehension and fosters creativity in mathematical problem-solving.

3. Evaluating Multiple Perspectives with Evidence

This component addresses the critical evaluation of data, arguments, and procedures. Students are expected to assess the validity, relevance, and accuracy of mathematical information (Paul & Elder, 2008). The sub-indicators, such as selecting appropriate evidence and verifying calculations, reflect students’ analytical thinking and attention to precision, both of which are essential to rigorous mathematical reasoning (Duncan et al., 2022; Kurasei & Aditomo, 2019).

4. Demonstrating Logical Reasoning

Logical reasoning represents the structured, step-by-step articulation of thought processes. It is considered a core component of critical thinking in mathematics (Polya, 2014; Ongesa, 2020). The checklist includes sub-indicators such as following a coherent sequence, using valid principles, and avoiding contradictions, based on works by Tee et al. (2018) and Ononiwu (2023). These items aim to capture students' ability to build sound arguments and justify their conclusions.

5. Application of Concepts to Real-World Problems

This indicator fosters the students' ability to transfer mathematical knowledge to practical, everyday problems. It highlights the importance of mathematical literacy beyond academic settings (Halpern & Dunn, 2021; Thaikam et al., 2024). Sub-indicators like developing models, interpreting results contextually, and reflecting on application are based on literature by Dinglasan et al. (2023) and Selba (2024), emphasizing the role of mathematics in solving real-life challenges and fostering informed decision-making.

This table summarizes observed classroom scenarios aligned with each critical thinking indicator and sub-indicator from the developed checklist. Each scenario is matched to a specific sub-indicator to show how critical thinking was manifested during instruction. Appendix R presents a more detailed context of each scenario, including full dialogues and classroom interactions. Use the indicator and sub-indicator labels to locate the corresponding detailed entries in the appendix.

Table 4.

Scenarios of Critical Thinking Sub-Indicators During Observations.

Indicator & Sub-indicator	Indicator & Sub-indicator	Short Description	Actual Interaction (Summary)
Indicator A. Asking Relevant Questions to Open Critical Thinking Skills			
Sub-indicator A. Questions are directly related to the current mathematical concept or problem being discussed.	Discovery learning through questioning	A student solved a system using intercepts and graphing. Another student asked about identifying the point	Teacher asked students to graph a system. A student found the solution, but another asked how to verify the

		of intersection, prompting a teacher explanation.	intersection point. Teacher explained using slope-intercept form.
Sub-indicator B. Questions seek to resolve misunderstandings or errors in reasoning.	Clarifying graphing inequalities	Group 2 misunderstood the ≥ symbol during a graphing task. Through guided questions, the teacher helped them understand its graphical representation.	Students questioned the meaning of '≥'. Teacher led them to test various points, clarifying how to graph the inequality.
Sub-indicator C. Questions challenge the assumptions underlying a problem or a solution.	Questioning the necessity of graphing	A student asked why graphing was needed if the algebraic solution was already known.	Teacher explained how graphing verifies and visually supports the algebraic answer.
Sub-indicator D. Questions consider alternative methods for solving a problem.	Substitution vs. Graphing	Students asked if they could use substitution instead of graphing in a problem-solving activity.	Teacher confirmed substitution as valid. Students explained their approach and verified using substitution.
Sub-indicator E. Questions prompt further investigation.	Exploring implications of inequality graphing	Students raised follow-up questions while analyzing inequality graphs, prompting a deeper verification exercise.	Student asked about using broken lines for '<'. Teacher reviewed solid vs. broken lines based on inequality symbols.
Sub-indicator F. Questions reflect on the learning process and personal understanding.	Reflecting on graphing linear equations	Students solved a point system problem and reflected on strategies to reach exactly 45 points.	Teacher asked students to graph solutions. Group shared combinations of x and y that satisfied $5x+3y=45$

			and reflected on their understanding.
Sub-indicator G. Questions seek to understand the underlying principles or theories behind.	Clarifying substitution method	Students forgot how substitution works. The teacher reviewed the method with the class.	Students asked what to substitute in substitution. Teacher reviewed previous lessons to reinforce concepts. They also ask to understand the underlying principles behind.
Indicator B. Analyzing information from multiple perspectives **Sub-indicator A.** Recognizes that there are multiple ways to approach a mathematical problem.	Understanding combinations in inequalities	Group 2 explored different combinations to meet a target score and realized multiple valid solutions exist.	Teacher presented a math quiz scenario. Students tested various point combinations like (0,9), (7,14), and (2,2) and learned that different combinations can still satisfy the equation $3x + 5y \geq 45$.
Sub-indicator B. Compares the outcomes of using various strategies to solve the same problem.	Comparing solution strategies across groups	Groups used different points and graphing strategies to solve an inequality and compared outcomes.	The teacher modified the problem from "exactly 45 points" to "at least 45." Each group chose unique points like (9,9) or (5,9), compared results, and validated if they satisfied the inequality graphically.
Sub-indicator C. Examines alternative	Interpreting graphs for accuracy	Groups A, B, and C explained different	Students discussed whether their graphs

solutions and explains why they work or don't work.		point combinations for an inequality and the logic behind their graphing choices.	showed the correct shaded region and explained how they used test points to confirm their results. Group C clarified the reason for two lines in the graph to verify the inequality condition.
Sub-indicator D. Synthesizes information from various perspectives to form a comprehensive understanding.	Collaborative graphing and synthesis	Students worked in groups to develop and interpret graphs based on changing inequality conditions, synthesizing various approaches.	Groups solved real-world problems, tested values, used different graphing approaches, and compared results. Discussions included boundary lines, test points, and graph behavior, leading to a synthesized understanding of inequalities.
Sub-Indicator E. Reflects on how considering multiple perspectives enhances understanding.	Not Observed	No instances were observed where students explicitly reflected on how different perspectives deepened their mathematical understanding.	It was assessed, but no instances were found. The classroom dialogues and activities did not include scenarios where students verbalized reflections or realizations about the value of multiple strategies or perspectives. This sub-indicator was not observed during the data collection.
Indicator C. Evaluating Multiple Perspectives with Evidence			

Sub-indicator A. Selects evidence that directly supports a mathematical argument or solution.	Supporting solutions through substitution	A student used substitution to solve a system of linear equations and confirmed accuracy by checking the solution in both original equations.	The student solved a system using substitution and calculated $x = 6$, $y = 8$. They substituted the values back into the equations to verify correctness, explaining each step clearly and earning full marks.
Sub-indicator B. Verifies the accuracy of calculations and provides enough evidence.	Elimination method verification	A student solved a system using elimination, then checked accuracy by substitution.	The student explained step-by-step elimination to solve $x + y = 14$ and $y = x + 2$, resulting in $x = 6$ and $y = 8$. To verify, they plugged the values into both original equations, confirming the solution (6,8) was correct and supported their answer with complete evidence.
Indicator D. Demonstrating Logical Reasoning			
Sub-indicator A. Ensures each step of the reasoning process is clear and follows from the previous step.	Explaining slope and intercept	Group 1 clearly explained how they solved for slope and intercept from given points using formulas.	Group 1 used the slope formula $(y_2-y_1)/(x_2-x_1)$ to find $m = -\frac{1}{2}$, then substituted a point into $y = mx + b$ to solve for b. Their steps were explained logically, leading to the correct equation $y = -\frac{1}{2}x - \frac{1}{2}$.
Sub-indicator B. Supports claims with appropriate	Graphical validation of inequality	Group 1 provided evidence for satisfying	They used test points like (9,0) and (3,10) to show these

mathematical evidence, examples, theorems and principles.		inequalities using graphs and test points.	satisfied $3x + 5y \geq 45$. Graphs were shaded accordingly, and additional points like (8,8) were used to further confirm their reasoning.
Sub-indicator C. Avoids contradictions in reasoning and calculations.	Correct use of inequality symbols	During a group activity, students clarified proper line types for inequalities and avoided contradictions.	Students discussed whether to use solid or broken lines depending on the inequality symbol. Teacher reinforced that '≥' means solid line while '>' means broken line, ensuring consistency in reasoning.
Sub-indicator D. Applies general principles to specific cases accurately.	Farm animal word problem	Group 1 solved a real-world word problem using algebraic equations and elimination method.	Students translated "10 chickens and pigs" and "28 total legs" into equations: $c + p = 10$ and $2c + 4p = 28$. Using elimination, they found $c = 6$, $p = 4$ and verified accuracy.
Sub-indicator E. Uses patterns and examples to form generalizations.	Not Observed	There were no observed instances of students using patterns or examples to make generalizations during the lessons.	This sub-indicator was not observed in the collected classroom data. None of the classroom dialogues or activities explicitly demonstrated students forming generalizations based on patterns or repeated examples.

Indicator E. Application of Concepts to Real-World Problems			
Sub-indicator A. Demonstrates how mathematical theories and principles can be used to solve practical problems.	Applying inequalities in real-life math quiz	Students modeled a scoring problem using inequalities and graphed different solutions.	Using a scenario about quiz scores, students created the inequality $3x + 5y \geq 45$ and graphed combinations like (3,10), (9,0), and others to find valid solutions that meet the requirement.
Sub-indicator B. Justifies the selection of specific methods based on the problem context.	Strategizing point combinations	Group 6 justified using a specific equation and shared combinations that matched the given target.	Students selected $5x + 3y = 45$ to model combinations for scoring 45 points. They justified their values and equation based on the context of the activity.
Sub-indicator C. Develops mathematical models to represent real-world situations.	Modeling scoring with inequality	Group 1 modeled a real-world math problem using inequalities and graphed valid point combinations.	They developed $3x + 5y \geq 45$ to represent the scoring rules. Students graphed and tested combinations like (9,9), and interpreted their meaning in the problem context.
Sub-indicator D. Interprets the results of mathematical models in the context of the real-world problem.	Solving animal count through equations	Group 1 interpreted results of a system of equations to solve a real-world problem involving chickens and pigs.	They formed $c + p = 10$ and $2c + 4p = 28$, solved using elimination, and interpreted that the farmer had 6 chickens and 4 pigs based on their model.
Sub-indicator E. Explains the application of	Clear explanation of inequality solutions	Group 1 explained how they selected points, validated	They described how points like (9,0) and (3,10) met the

mathematical concepts and solutions clearly.		them with inequalities, and visualized them on a graph.	condition $3x + 5y \geq 45$. Their graph was shaded correctly and included verbal validation using test points.
Sub-indicator F. Reflects on the effectiveness of applying mathematical knowledge to real-world problems.	Not Observed	There were no observed instances of students reflecting on how effective their mathematical knowledge was when applied to real-life problems.	During classroom discussions and activities, students applied concepts to real-world problems but did not demonstrate reflective thinking about the effectiveness or impact of their solutions.

Throughout five days of observation, the teacher demonstrates instructional strategies that appear to stimulate critical thinking behaviors among students. While the teacher does not use the checklist, the researchers utilized it as an observation tool to document how students respond and engage during instruction. The checklist also helped capture moments when students exhibit reasoning, analysis, and reflection based on the teacher's prompts.

For example, the teacher posed open-ended questions such as "What does 'at least' mean?" and "How do we solve the intersection of two lines?" These questions encouraged students to think critically about inequalities and graphing. The teacher also introduced multiple solution strategies and invited students to compare methods like substitution and graphing, allowing them to weigh the advantages and limitations of each approach.

Students evaluated their answers using substitution and test points, verifying accuracy and strengthening their reasoning. The teacher provided step-by-step demonstrations that guided students through solving equations and graphing inequalities. Real-world contexts, such as quiz games and farm problems, were also incorporated to help students apply mathematical concepts in practical situations. These observed moments were documented using the checklist, showing how instructional strategies can lead to visible expressions of critical thinking in the classroom.

The teacher's strategies effectively fostered and stimulated critical thinking skills based on the five critical thinking indicators.

Asking Insightful Questions:

The teacher used open-ended questions to encourage students to engage more deeply with the lesson content. For instance, by prompting students to explain the meaning of terms like “at least” in inequalities or to determine how to graph the intersection of two lines, the teacher guided them to clarify their understanding and consider alternative approaches. These types of questions reflected the critical thinking indicator related to asking relevant questions and contributed to students’ deeper exploration of mathematical concepts.

Analyzing Information from Multiple Perspectives:

The teacher encouraged the use of multiple solution methods, such as substitution and graphing, allowing students to approach problems from different perspectives. This strategy promoted flexibility in problem-solving and helped students recognize the strengths and limitations of each method. For instance, classroom discussions comparing the efficiency of substitution versus elimination led students to critically evaluate which approach was more appropriate for a given problem. These activities reflect the critical thinking indicator of analyzing information from multiple perspectives by fostering comparative reasoning and adaptability in mathematical thinking.

Evaluating Evidence:

The teacher’s emphasis on verifying results through substitution and test points reinforced the importance of validating answers. This encouraged students to double-check their work, ensuring accuracy in their reasoning. These practices not only promoted self-monitoring but also helped students recognize errors and correct them independently. The act of testing points to verify inequalities and solutions aligns with the critical thinking indicator of evaluating evidence, which helps ensure the correctness of students' answers and strengthens their reasoning skills.

Demonstrating Logical Reasoning:

By guiding students step-by-step through problem-solving processes, the teacher helped students develop logical reasoning skills. Whether it was in solving equations or graphing inequalities, the teacher’s clear explanations allowed students to understand the logical sequence behind each method. This clarity enabled students to build confidence in their reasoning and justify each step with greater precision. This approach reinforced the importance of following a structured process and demonstrated how logical reasoning is essential in mathematics.

Applying Knowledge to Real-World Applications:

The teacher's use of real-world scenarios, such as the quiz game and farm problems, helped students apply mathematical concepts in practical situations. This not only reinforced the relevance of mathematics but also allowed students to see the value of what they were learning. By connecting abstract concepts to real-life contexts, the teacher triggered critical thinking by encouraging students to think beyond the classroom. Overall, the teacher's strategies not only promoted critical thinking but also ensured that students engaged with the material on a deeper level, fostering skills that they can apply both in and out of the classroom.

The researchers focused on the development of a checklist to foster critical thinking skills in students, drawing from literature, classroom observations, and expert validation. The first three versions of the checklist prove less effective: the first was too broad, the second required reorganization for classroom practicality, and the third remained too general in defining critical thinking indicators (see Appendices G to M). In contrast, the fourth and final version was well-developed, integrating insights from both research literature and classroom observations (see Appendix M). It includes clearly defined indicators and subindicators, arranged in a user-friendly table format. The final version is also simplified for classroom use, using "Observed" and "Not Observed" as categories to help teachers and researchers document student behaviors more efficiently. It is designed not only for research purposes but also for practical classroom application. As such, it serves as a valuable tool for promoting and identifying critical thinking in mathematics instruction.

CHAPTER V

SUMMARY OF FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

The study aimed to develop a critical thinking checklist for use in mathematics classrooms. The process began with a systematic review of related literature, which leads to the identification of five major critical thinking indicators: asking relevant questions, analyzing information from multiple perspectives, evaluating evidence, demonstrating logical reasoning, and applying knowledge to real-world problems. More specifically,

1. Asking Relevant Questions to Open Critical Thinking Skills;
2. Analyzing Information from Multiple Perspectives;
3. Evaluating Multiple Perspectives with Evidence;
4. Demonstrating Logical Reasoning; and
5. Application of Concepts to Real-World Problems.

These indicators were then used to develop a comprehensive checklist designed for application in classroom settings. The checklist underwent expert validation, with feedback from multiple educators helping to refine its structure and content. It was ultimately tested in real-world classroom scenarios with grade 8 students. Observations made during the lessons demonstrate how students exhibit critical thinking behaviors such as asking relevant questions, analyzing mathematical problems from different perspectives, and applying knowledge to real-world contexts.

The results indicate that students who actively engage in behaviors aligned with the checklist's indicators demonstrate stronger problem-solving skills and a deeper understanding of mathematical concepts. This suggests that integrating critical thinking indicators into lesson planning can enhance student learning outcomes in mathematics by promoting deeper cognitive engagement.

Conclusions

The following conclusions are drawn based on the findings of the study:

Critical thinking is essential for problem-solving in mathematics. The study reinforces the importance of critical thinking in mathematics education. Students who actively engage in critical thinking behaviors such as evaluating evidence and demonstrating logical reasoning show stronger problem-solving skills and a deeper understanding of mathematical concepts.

The checklist is an effective tool for promoting critical thinking. The developed checklist proves to be a valuable tool for both educators and students. It provides a clear structure for observing, fostering, and identifying critical thinking behaviors during instruction. The checklist helps teachers recognize areas where students struggle with critical thinking and allows for timely instructional support.

Expert validation enhances the quality of the checklist. The expert validation process strengthens the checklist by ensuring its practicality and relevance in classroom settings. Feedback from mathematics educators and critical thinking experts plays a key role in shaping and refining the final version.

Classroom Application Promotes Deeper Engagement. The use of the checklist during instruction encourages students to engage more thoughtfully with mathematical problems. Students are prompted to question their methods, consider alternative strategies, and justify their reasoning, leading to improved problem-solving skills and deeper conceptual understanding.

Recommendations

Based on the study's findings and conclusions, the following recommendations are provided:

- Incorporate the checklist into regular classroom practice. Teachers are encouraged to integrate the critical thinking checklist into their regular instructional routines, particularly in mathematics where problem-solving is essential. By using the checklist during lessons, teachers can systematically monitor students' critical thinking behaviors and adjust instruction to address areas of need.
- Encourage student self-reflection. Students are encouraged to use the checklist for self-assessment. By reflecting on their own thinking and problem-solving processes, students can become more aware of their strengths and areas for improvement. This self-reflection can enhance their metacognitive skills and contribute to more independent learning.
- Conduct further research on critical thinking in education. Future research is recommended to explore the effectiveness of critical thinking checklists in various educational contexts and across different grade levels. Additional studies may also investigate the long-term impact of using such checklists on

students' academic performance and their ability to apply critical thinking in real-world situations.

- Adapt the checklist for diverse learning environments. The checklist developed in this study should be adapted for use in diverse learning environments, including those with students who have varying levels of proficiency in mathematics. Modifications may be needed to accommodate different learning styles and cultural contexts, ensuring that the checklist is inclusive and applicable to all students.

The development of the critical thinking checklist contributes to enhancing classroom instruction in mathematics. By incorporating critical thinking into daily lessons, teachers help students strengthen their problem-solving skills and deepen their understanding of concepts. This study shows that structured tools like the checklist support teaching practices and promote the development of learners who think critically and work independently. The checklist is flexible and practical, making it suitable for various classroom settings. It offers teachers a clear means of observing and responding to students' cognitive processes. The indicators are grounded in literature and refined through expert feedback, ensuring their relevance to classroom practice. Its use may also encourage a more intentional focus on critical thinking during lesson planning and instruction. The findings may inform curriculum adjustments and professional development focused on critical thinking. As educational needs evolve, tools that support deeper cognitive engagement remain essential. Future efforts may explore how similar instruments can be adapted across subjects to promote higher-order thinking in diverse learning environments. The checklist serves as a foundation for integrating critical thinking into instructional design and classroom interaction. Continued application and feedback from educators can further refine its structure and increase its effectiveness.

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APPENDIX A
THESIS ADVISORY FORM

4/1

COLLEGE OF EDUCATION
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CPE198 – Research Methods
Instructor: JONEIL B. MEDINA

THESIS ADVISER TOPIC AGREEMENT

This is to signify that I MARY JOY F. LUGA (Name of Adviser), approve of the *tentative* **Research Topic, Problem, and Purpose** of the *tentative* Undergraduate Thesis Proposal entitled Identifying Students' Challenges on the Application of Inductive Reasoning in Algebra

written by (Name of Student/Authors):

1. Sumili, Chrisper Anton T.
2. Tagalogon, Mariaje Fhey B., and
3. —NOTHING FOLLOWS—.

And I understand that this is only for the purpose of ensuring that these students will have reduced effort to revise their thesis proposals for **EDM199/SED199 – Thesis Writing** course.

Name and Signature of Adviser: MARY JOY F. LUGA

Date: 10-18-2023

Dear Colleague,
This will serve as the preliminary exam score of my students in CPE198, as agreed upon by the class. This agreement hopefully ensures that even in this course, feedback maybe given to them even only upon the research problem.

Sincerely, JONEIL B. MEDINA

APPENDIX B
PROPOSAL THESIS

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Republic of the Philippines Mindanao State University
ILIGAN INSTITUTE OF TECHNOLOGY
College of Education
Department of Science and Mathematics Education

Date: JAN 24, 2024

THESIS PROPOSAL APPROVAL FORM

Names: SUMILI, CHRISPER ANTON T. & TAGALOGON, MARIATE THEY B.

Degree: BSED Specialization: MATHEMATICS

Thesis Title: ENHANCING THE CRITICAL THINKING SKILLS AMONG GRADE 8 STUDENTS THROUGH PROBLEM POSING IN MATHEMATICS EDUCATION

Comments:

APPROVED:

Thesis Guidance Committee

Thesis Adviser	JAN 24, 2024 Date
Panel Member	JAN 24, 2024 Date
Grace P. Diwanag Panel Member	JAN 24, 2024 Date

APPENDIX C.1
PROPOSAL HEARING

COLLEGE OF EDUCATION

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Republic of the Philippines Mindanao State University
ILIGAN INSTITUTE OF TECHNOLOGY
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Department of Science and Mathematics Education

PROPOSAL HEARING

Names: SUMLI, CHRISPER ANTON T. & TAGALOGON, MARIAJE ~~THEY~~ B.

Thesis Title: ENHANCING THE CRITICAL THINKING SKILLS AMONG GRADE 8 STUDENTS THROUGH PROBLEM POSING IN MATHEMATICS EDUCATION

Recommendations:

See manuscript.

MARY JOY F. LUGA
Panel Member
(Signature over printed Name)

(063) 223-2349 | (loc) 4128 | 4228

Influencing the Future

APPENDIX C.2
PROPOSAL HEARING

COLLEGE OF EDUCATION

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Republic of the Philippines Mindanao State University
ILIGAN INSTITUTE OF TECHNOLOGY
College of Education
Department of Science and Mathematics Education

PROPOSAL HEARING

Names: SUMILI, CHRISPER ANTON T. & TAGALOGON, MARIAJE FHEY B.

Thesis Title: ENHANCING THE CRITICAL THINKING SKILLS AMONG GRADE 8 STUDENTS THROUGH PROBLEM POSING IN MATHEMATICS EDUCATION

Recommendations:

AMELIA T. BUAN
Panel Member
(Signature over printed Name)

APPENDIX C.3
PROPOSAL HEARING

COLLEGE OF EDUCATION

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Republic of the Philippines Mindanao State University
ILIGAN INSTITUTE OF TECHNOLOGY
College of Education
Department of Science and Mathematics Education

PROPOSAL HEARING

Names: SUMILI, CHRISPER ANTON T. & TAGALOGON, MARIAM PHEY B.

Thesis Title: ENHANCING THE CRITICAL THINKING SKILLS AMONG GRADE 8 STUDENTS THROUGH PROBLEM POSING IN MATHEMATICS EDUCATION

Recommendations:

See comments in the manuscript.

Explore / investigate how critical thinking is enhanced in the classroom.

Look for tools / instruments which includes attributes that indicates the "presence" of critical thinking.

Try to establish the status or level of critical thinking abilities of students; take note of how teachers give opportunities to students to exercise their thinking abilities

Grace P. Liwanag
Panel Member
(Signature over printed Name)

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APPENDIX D
LETTER TO THE SCHOOL PRINCIPAL

COLLEGE OF EDUCATION

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Republic of the Philippines
Mindanao State University
ILIGAN INSTITUTE OF TECHNOLOGY
College of Education
Department of Science and Mathematics Education

February 14, 2024

AMELIA T. BUAN, Ph.D.
School Principal
MSU-IIT Integrated Developmental School
Tibanga, Iligan City

Dear Ma'am:

Greetings!

The undersigned, are BSEd Mathematics students of the College of Education (CED), MSU-IIT. As one of the partial fulfillments in the requirement for the degree Bachelor of Secondary Education major in Mathematics, we are going to conduct a study entitled **"Investigating Critical Thinking Levels of Grade 8 Students in a Mathematics Classroom"** . The purpose of this study is to investigate the effectiveness of Problem Posing in enhancing the Critical Thinking Skills of the Grade 8 students. With this, we humbly request permission from your office to implement our developed lesson guide and assessment of the said study for the Grade 8 students under one IDS Math Teacher.

The following activities will be conducted from February 19, 2024 to March 22, 2024.

Activity	Date	Day and Time Schedules
Observation	**February 19, 2024 to March 08, 2024**	**-Wednesdays, 10:00 AM - 11:00 AM & 2:00-4:00 PM** **-Thursdays, 7:30 AM**
Interview and Assessment	**March 11, 2024- March 22, 2024**	**-Wednesdays, 10:00 AM - 11:00 AM & 2:00-4:00 PM** **-Thursdays, 7:30 AM**

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Influencing the Future

APPENDIX D (Cont'd)
LETTER TO THE PRINCIPAL

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Thus, students are given the freedom to participate or not in the study. If the students want to participate, rest assured that the identity and responses of the participants will be kept with utmost respect and confidentiality.

We are hoping for your positive response and consideration regarding this matter.
Thank you so much!

Respectfully yours,

CHRISPER ANTON T. SUMILI
Researcher

MARIAJE FHEY B. TAGALOGON
Researcher

Noted by:

MARY JOY F. LUGA
Thesis Adviser

Approved by:

AMELIA T. BUAN, PhD
School Principal

APPENDIX E
CONSENT FORM

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CONSENT FORM

I, ____, hereby give my permission to **CHRISPER ANTON T. SUMILL and MARIAJE FHEY B. TAGALOGON** to allow me to answer this questionnaire and use the responses as data for their research studies entitled ***"Enhancing Critical Thinking Skills Of Grade 8 Students Through Problem Posing in Mathematics Education".***

I am aware that their work is intended for academic and research purposes. I also acknowledge that, should the researchers publish this information in a peer-reviewed journal or online in electronic form, I renounce any claim to copyright in it. I am also aware that my responses to the questions will remain anonymous and confidential, and the researchers will be accountable for any data leakage. Therefore, I entrust my physical and mental safety as well as my data privacy through this consent form.

I hereby give my permission in my participation to this study.

____

PARTICIPANT

(Signature over printed name)

APPENDIX F
CONSENT FORM FOR VALIDATION

COLLEGE OF EDUCATION

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Subject: Invitation to Serve as Validator for the Constructed Checklist

February 20, 2024

ALEXIS MICHAEL B. OLEDAN, Ph.D.
Chairperson
College of Education-Integrated Developmental School
Mindanao State University - Iligan Institute of Technology
A.Bonifacio Avenue, Tibanga, 9200 Iligan City

Dear Sir:

Greetings!
The undersigned, are BSEd Mathematics students of the College of Education (CED), MSU-IIT. As one of the partial fulfillment in the requirement for the degree Bachelor of Secondary Education major in Mathematics, we are going to conduct a study entitled **"Development of Critical Thinking Checklist for Mathematics Education".** We would be honored to have you as **one of the validators** for our constructed checklist or rubric, including the indicators of the said reasoning skill.

Your expertise and your contributions will surely help to enhance the academic review of our constructed tool for our study.

We are hoping for your positive response. Thank you for taking the time to consider our invitation. We are excited about the potential of your participation in such an important step in our academic journey. Please contact us if you have any queries before the event.

Respectfully yours,

CHRISPER ANTON T. SUMILI
Researcher

MARIAJE FHEY B. TAGALOGON
Researcher

Noted by:

MARY JOY F. LUGA
Thesis Adviser

(063) 223-2349 | (loc) 4128 | 4228

Influencing the Future

APPENDIX G
TABLE 5: CHECKLIST 1

Mathematical Critical Thinking Indicators		Sub-Indicators	Comments/Observation/Remarks:
1. Formulating the problem		1.1. Clarity of Expression: ● Clearly articulating the problem statement. ● Using precise and appropriate mathematical language.	
		1.2. Identification of Relevant Information: ● Recognizing and selecting relevant data or information needed to solve the problem. ● Distinguishing between essential and non-essential information.	
		1.3. Problem Decomposition: ● Breaking down complex problems into smaller, more manageable parts. ● Identifying sub-problems that contribute to the overall problem.	
		1.4. Definition of Variables: ● Defining and labeling variables appropriately. ● Ensuring consistency in the use of symbols and terms throughout the problem.	

APPENDIX G (Cont'd)
TABLE 5: CHECKLIST 1

		1.5. Recognizing Patterns: ● Identifying patterns or structures within the problem. ● Noticing relationships and connections between different elements.	
		1.6. Problem Generalization: ● Attempting to generalize the problem to a broader mathematical concept or principle. ● Exploring if the same problem-solving approach can be applied to similar scenarios.	
		1.7. Questioning Assumptions: ● Critically examining assumptions made while formulating the problem. ● Being aware of any implicit assumptions that might influence the problem-solving process.	
		1.8. Reflective Thinking: ● Demonstrating thoughtful consideration of the problem formulation process. ● Reflecting on the choices made in defining the problem and considering alternative perspectives.	
2. Analyzing and solving the problem		2.1. Understanding the Problem: ● Demonstrating comprehension of the problem statement. ● Restating the problem in one's own words to ensure understanding.	

APPENDIX G (Cont'd)
TABLE 5: CHECKLIST 1

		2.2. Identification of Relevant Concepts: ● Recognizing and applying relevant mathematical concepts and principles to the problem. ● Avoiding the application of irrelevant or unnecessary ideas.	
		2.3. Developing a Systematic Approach: ● Establishing a well-organized and systematic method for solving the problem. ● Clearly outlining the steps involved in the solution process.	
		2.4. Selection of Appropriate Strategies: ● Choosing suitable problem-solving strategies (e.g., trial and error, pattern recognition, algebraic manipulation). ● Considering multiple approaches and selecting the most effective one.	
		2.5. Critical Evaluation of Solutions: ● Evaluating the correctness and validity of intermediate and final solutions. ● Checking for errors and inconsistencies throughout the problem-solving process.	
		2.6. Efficient Calculation and Computation: ● Demonstrating accuracy and efficiency in mathematical calculations. ● Minimizing errors and optimizing computational processes.	

APPENDIX G (Cont'd)
TABLE 5: CHECKLIST 1

		2.7. Flexibility in Problem Solving: ● Being adaptable to changes or unexpected complexities in the problem. ● Adjusting strategies as needed when initial approaches prove unsuccessful.	
		2.8. Logical Reasoning: ● Employing logical reasoning to justify each step of the solution process. ● Providing clear and coherent explanations for the chosen methods.	
		2.9. Verification of Results: ● Checking the validity of the solution against the original problem statement. ● Verifying that the solution makes sense in the given context.	
3. Evaluatin g		3.1. Accuracy of Solutions: ● Assessing the correctness and precision of the final solution. ● Identifying and correcting any computational errors.	
		3.2. Consistency in Reasoning: ● Ensuring logical consistency in the reasoning and steps taken during the problem-solving process. ● Verifying that each step logically follows from the previous one.	

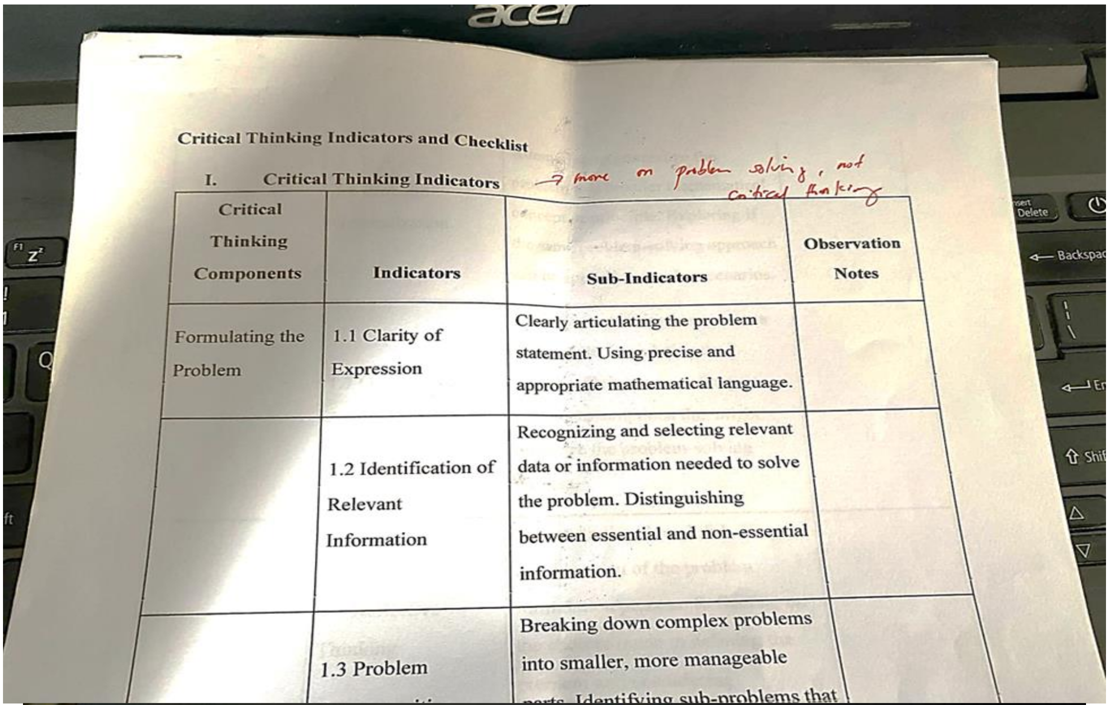
APPENDIX G (Cont'd)
TABLE 5: CHECKLIST 1

		3.3. Assessment of Assumptions: ● Reflecting on any assumptions made during the problem-solving process. ● Evaluating the impact of these assumptions on the accuracy of the solution.	
		3.4. Comparison of Multiple Solutions: ● Considering alternative approaches to solving the problem. ● Comparing and contrasting different solutions for efficiency and effectiveness.	
		3.5. Relevance of Supporting Details: ● Examining the relevance and appropriateness of supporting details provided in the solution. ● Ensuring that all information presented contributes to the overall solution.	
		3.6. Justification of Methods: ● Providing clear and concise justifications for the chosen problem-solving methods. ● Explaining why specific strategies were employed over others.	
		3.7. Reflection on Problem-Solving Process: ● Reflecting on the overall problem-solving process. ● Analyzing the effectiveness of the chosen strategies and potential areas for improvement.	

APPENDIX G (Cont'd)
TABLE 5: CHECKLIST 1

4. Drawing Conclusion		4.1. Connection to Problem Statement: ● Ensuring that the drawn conclusion directly addresses the original problem statement. ● Demonstrating a clear link between the solution and the problem presented.	
		4.2. Logical Inference: ● Making logical inferences based on the information provided in the solution. ● Deriving conclusions that logically follow from the established facts and reasoning.	
		4.3.Identification of Key Insights: ● Identifying and articulating key insights gained from the problem-solving process. ● Highlighting important observations or discoveries made during the analysis.	
		4.4. Clarity in Communication: ● Communicating the drawn conclusion clearly and effectively. ● Using appropriate mathematical language and notation to express the final result.	

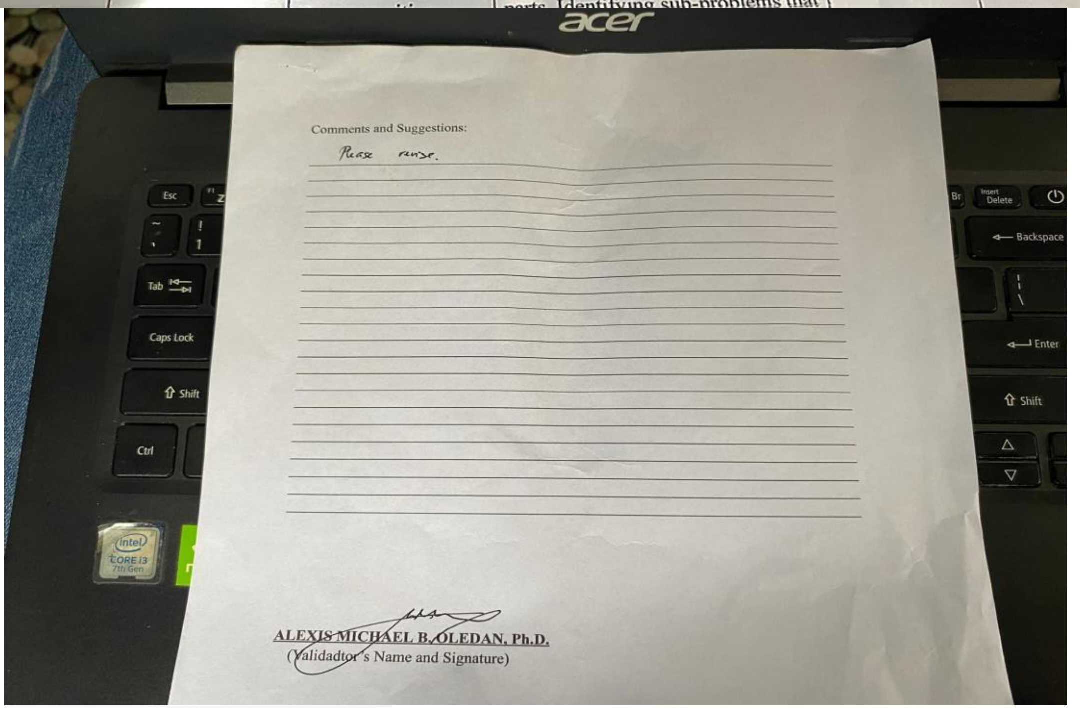
APPENDIX H
COMMENTS AND SUGGESTIONS FOR CHECKLIST 1



Critical Thinking Indicators and Checklist

I. **Critical Thinking Indicators** → more on problem solving, not critical thinking

Critical Thinking Components	Indicators	Sub-Indicators	Observation Notes
Formulating the Problem	1.1 Clarity of Expression	Clearly articulating the problem statement. Using precise and appropriate mathematical language.	
	1.2 Identification of Relevant Information	Recognizing and selecting relevant data or information needed to solve the problem. Distinguishing between essential and non-essential information.	
	1.3 Problem	Breaking down complex problems into smaller, more manageable parts. Identifying sub-problems that	

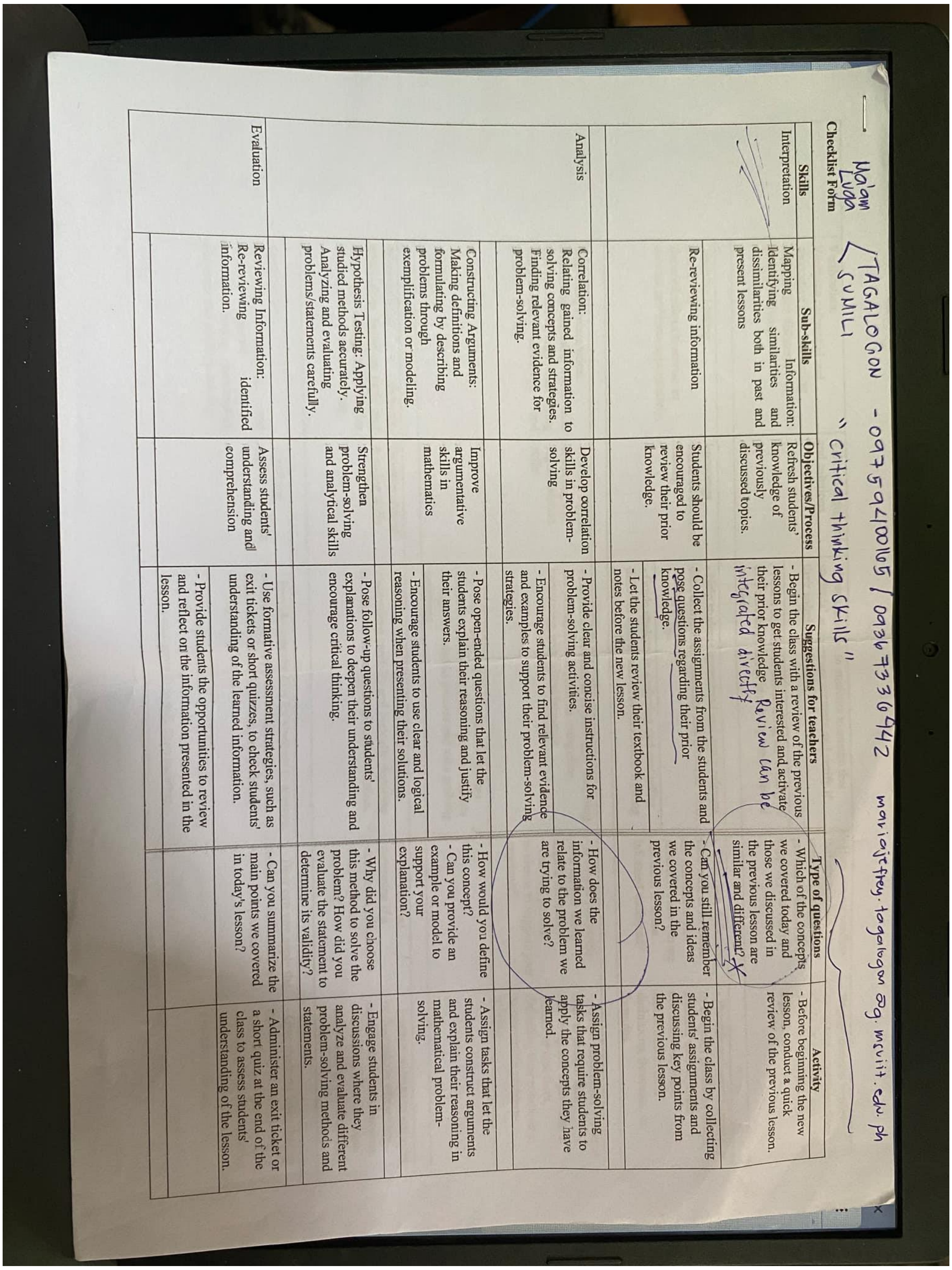


Comments and Suggestions:

Please revise.

ALEXIS MICHAEL B. OLEDAN, Ph.D.
(Validadtor's Name and Signature)

APPENDIX I
CHECKLIST 2 WITH COMMENTS AND SUGGESTIONS



Ma'am Luga ⟨TAGALOGON SUMILI - 09759410165 / 09367336942 mariajefrey.tagalogon@g.msuiit.edu.ph

" critical thinking skills "

Checklist Form

Skills	Sub-skills	Objectives/Process	Suggestions for teachers	Type of questions	Activity
Interpretation	Mapping Information: Identifying similarities and dissimilarities both in past and present lessons	Refresh students' knowledge of previously discussed topics.	- Begin the class with a review of the previous lessons to get students interested and activate their prior knowledge Review can be integrated directly	- Which of the concepts we covered today and those we discussed in the previous lesson are similar and different?	- Before beginning the new lesson, conduct a quick review of the previous lesson.
	Re-reviewing information	Students should be encouraged to review their prior knowledge.	- Collect the assignments from the students and pose questions regarding their prior knowledge.	- Can you still remember the concepts and ideas we covered in the previous lesson?	- Begin the class by collecting students' assignments and discussing key points from the previous lesson.
			- Let the students review their textbook and notes before the new lesson.		
Analysis	Correlation: Relating gained information to solving concepts and strategies. Finding relevant evidence for problem-solving.	Develop correlation skills in problem-solving	- Provide clear and concise instructions for problem-solving activities.	- How does the information we learned relate to the problem we are trying to solve?	- Assign problem-solving tasks that require students to apply the concepts they have learned.
			- Encourage students to find relevant evidence and examples to support their problem-solving strategies.		
	Constructing Arguments: Making definitions and formulating by describing problems through exemplification or modeling.	Improve argumentative skills in mathematics	- Pose open-ended questions that let the students explain their reasoning and justify their answers.	- How would you define this concept? - Can you provide an example or model to support your explanation?	- Assign tasks that let the students construct arguments and explain their reasoning in mathematical problem-solving.
			- Encourage students to use clear and logical reasoning when presenting their solutions.		
	Hypothesis Testing: Applying studied methods accurately. Analyzing and evaluating problems/statements carefully.	Strengthen problem-solving and analytical skills	- Pose follow-up questions to students' explanations to deepen their understanding and encourage critical thinking.	- Why did you choose this method to solve the problem? How did you evaluate the statement to determine its validity?	- Engage students in discussions where they analyze and evaluate different problem-solving methods and statements.
Evaluation	Reviewing Information: Re-reviewing identified information.	Assess students' understanding and comprehension	- Use formative assessment strategies, such as exit tickets or short quizzes, to check students' understanding of the learned information.	- Can you summarize the main points we covered in today's lesson?	- Administer an exit ticket or a short quiz at the end of the class to assess students' understanding of the lesson.
			- Provide students the opportunities to review and reflect on the information presented in the lesson.		

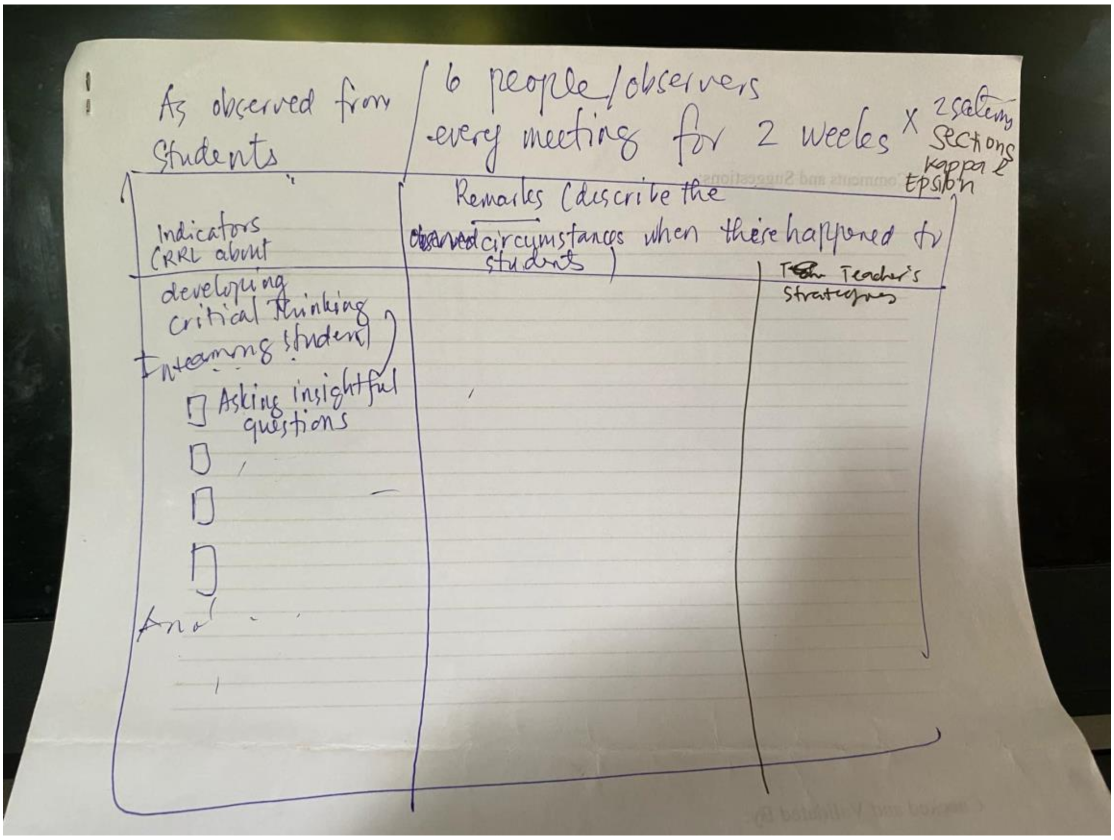
APPENDIX I (Cont'd)
CHECKLIST 2 WITH COMMENTS AND SUGGESTIONS

Verification: Verifying referential and supportive evidence during mathematics discourse and problem solving	Validate arguments and solutions	- Pose questions to students to ensure that students' answers are accurate and verify if their solutions are valid. - Assist students in determining the validity of evidence and sources in solving mathematical problem.	- How can we confirm that our solution is correct? Can you provide evidence to support your claim?	- Engage students in peer discussions or presentations where they validate and verify each other's solutions and arguments.
Decision Making: Disclosing data/definitions/theorems in solving problems appropriately.	Encourage informed decision-making	- Help students understand and apply relevant data, definitions, theorems, and formulas when solving problems. - Guide students in analyzing and evaluating different options and strategies before making a decision.	- What data, definitions, theorems, or formulas are relevant to this problem? How can we use them to make informed decisions?	- Provide real-world scenarios or complex problems where students need to make decisions based on mathematical data, definitions, theorems, or formulas.
Reasoning Presentation: Presenting reasoning within valid and convincing arguments during mathematics discourse and problem solving.	Develop logical reasoning and argumentation skills	- Encourage students to explain their reasoning and present their arguments using clear, convincing, and logical language. - Provide opportunities for teacher-student interaction, where the teacher guides students through the solution process and asks probing questions.	- How can you justify your answer using logical reasoning? - Can you provide evidence to support your argument?	- Assign tasks where students need to present their reasoning and arguments in written or oral form, defending their solutions in mathematical problem-solving.
Distinguishing between conclusions based on logic and reasoning during mathematics discourse and problem solving.	Develop critical thinking skills	- Emphasize the importance of following instructions carefully and logically deducing conclusions based on the given information.	- How can you determine if a conclusion is based on solid logic and reasoning?	- Engage students in activities or discussions where they need to distinguish between conclusions based on logic and reasoning and those that are not.
Application: Analyzing, evaluating, and applying gained solutions thoroughly during mathematics discourse and problem solving.	Reinforce application skills	- Provide opportunities for students to analyze, evaluate, and apply the solutions they have learned in real-world or complex problem-solving scenarios. - Encourage students wo work collaboratively in problem-solving skills, where they can discuss and apply their solutions together.	- How can you apply the concepts we learned to solve this problem?	- Give students tasks that let them analyze, assess, and apply the concepts they have learned in various scenarios or situations that involves problem-solving.

APPENDIX J
TABLE 6: CHECKLIST 3

Critical Thinking Indicators		Remarks
Asking insightful questions - Discovery Learning through the art of questioning -		
Analyzing information from multiple perspectives		
Synthesizing complex ideas - Problem solving through the utilization of prior knowledge.		
Evaluating evidence		
Demonstrating logical reasoning		
Proposing alternative solutions - Peer learning experience		
Challenging assumptions - Higher order thinking skills		
Making connections between concepts		
Applying knowledge to real-world situations		
Communicating effectively and persuasively - Giving students guide questions to analyze the scenarios presented.		

APPENDIX K
COMMENTS AND SUGGESTIONS FOR CHECKLIST 3



APPENDIX L
TABLE 7: CHECKLIST 4

Critical Thinking Indicators		Remarks
1. **Asking Insightful Questions** - Discovery learning through questioning.	Questions are directly related to the current mathematical concept or problem being discussed. ● **Does the question relate directly to the topic or problem at hand?**	
	Questions seek to resolve misunderstandings or errors in reasoning. ● **Is the question intended to resolve misunderstandings?**	
	Questions challenge the assumptions underlying a problem or a solution. ● **Does the question challenge the assumptions behind a problem?**	
	Questions consider alternative methods for solving a problem ● **Does the question consider alternative solutions or methods?**	
	Questions prompt further investigation. ● **Does the question encourage further investigation?**	
	Questions reflect on the learning process and personal understanding. ● **Does the question reflect on the learning process?**	
	Questions seek to understand the underlying principles or theories behind. ● **Does the question seek to understand the reasoning or theory behind a concept?**	

APPENDIX L (Cont'd)
TABLE 7: CHECKLIST 4

2. Analyzing information from multiple perspectives - Examine a math problem or concept in different ways or using methods and representations.	Recognizes that there are multiple ways to approach a mathematical problem. ● **Does the student recognize multiple approaches to the problem?**	
	Compares the outcomes of using various strategies to solve the same problem. ● **Does the student compare outcomes of various strategies for the same problem?**	
	Examines alternative solutions and explains why they work or don't work. ● **Does the student examine and explain alternative solutions?**	
	Synthesizes information from various perspectives to form a comprehensive understanding. ● **Does the student synthesize insights from various perspectives for a comprehensive understanding?**	
	Reflects on how considering multiple perspectives enhances understanding. ● **Does the student reflect on how multiple perspectives enhance understanding?**	
3. Evaluating Evidence - Judging the validity of the information/ arguments used to solve a math problem	Selects evidence that directly supports a mathematical argument or solution. ● **Does the student select evidence that directly supports the argument or solution?**	

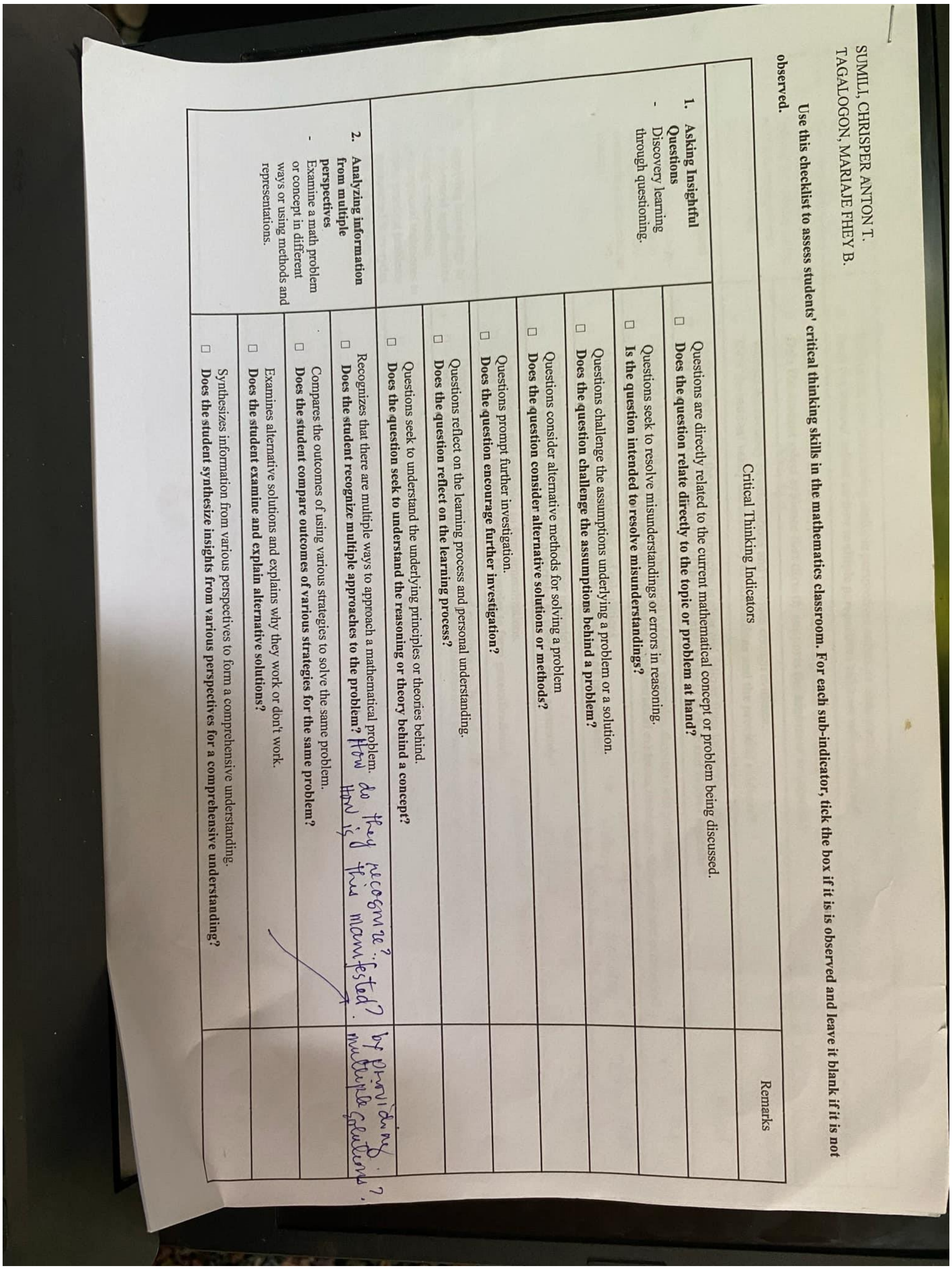
APPENDIX L (Cont'd)
TABLE 7: CHECKLIST 4

	Verifies the accuracy of calculations and provides enough evidence. ● **Does the student verify the accuracy of calculations and the provided evidence?**	
4. **Demonstrating logical reasoning** - Showing a clear, step-by-step thought process in solving math problems connecting mathematical concepts	Ensures each step of the reasoning process is clear and follows from the previous step. ● **Does the student ensure each step of the reasoning process is clear and follows logically?**	
	Supports claims with appropriate mathematical evidence, examples, theorems and principles. ● **Does the student support claims with appropriate mathematical evidence, examples, theorems and principles?**	
	Avoids contradictions in reasoning and calculations. ● **Does the student avoid contradictions in reasoning and calculations?**	
	Applies general principles to specific cases accurately. ● **Does the student apply general principles to specific cases accurately?**	
	Uses patterns and examples to form generalizations. ● **Does the student use patterns and examples to form generalizations?**	

APPENDIX L (Cont'd)
TABLE 7: CHECKLIST 4

5. Applying knowledge to real-world applications - Using mathematical concepts and techniques to solve practical problems encountered in everyday life, demonstrating in addressing real-world situations	Demonstrates how mathematical theories and principles can be used to solve practical problems. ● **Does the student demonstrate how mathematical theories and principles solve practical problems?**	
	Justifies the selection of specific methods based on the problem context. ● **Does the student justify the selection of specific methods based on the context?**	
	Develops mathematical models to represent real-world situations. ● **Does the student develop mathematical models to represent real-world situations?**	
	Interprets the results of mathematical models in the context of the real-world problem. ● **Does the student interpret the results of models in the context of the real-world problem?**	
	Explains the application of mathematical concepts and solutions clearly. ● **Does the student explain the application of concepts and solutions clearly?**	
	Reflects on the effectiveness of applying mathematical knowledge to real-world problems. ● **Does the student reflect on the effectiveness of applying knowledge to real-world problems?**	

APPENDIX M
COMMENTS AND SUGGESTIONS FOR CHECKLIST 4

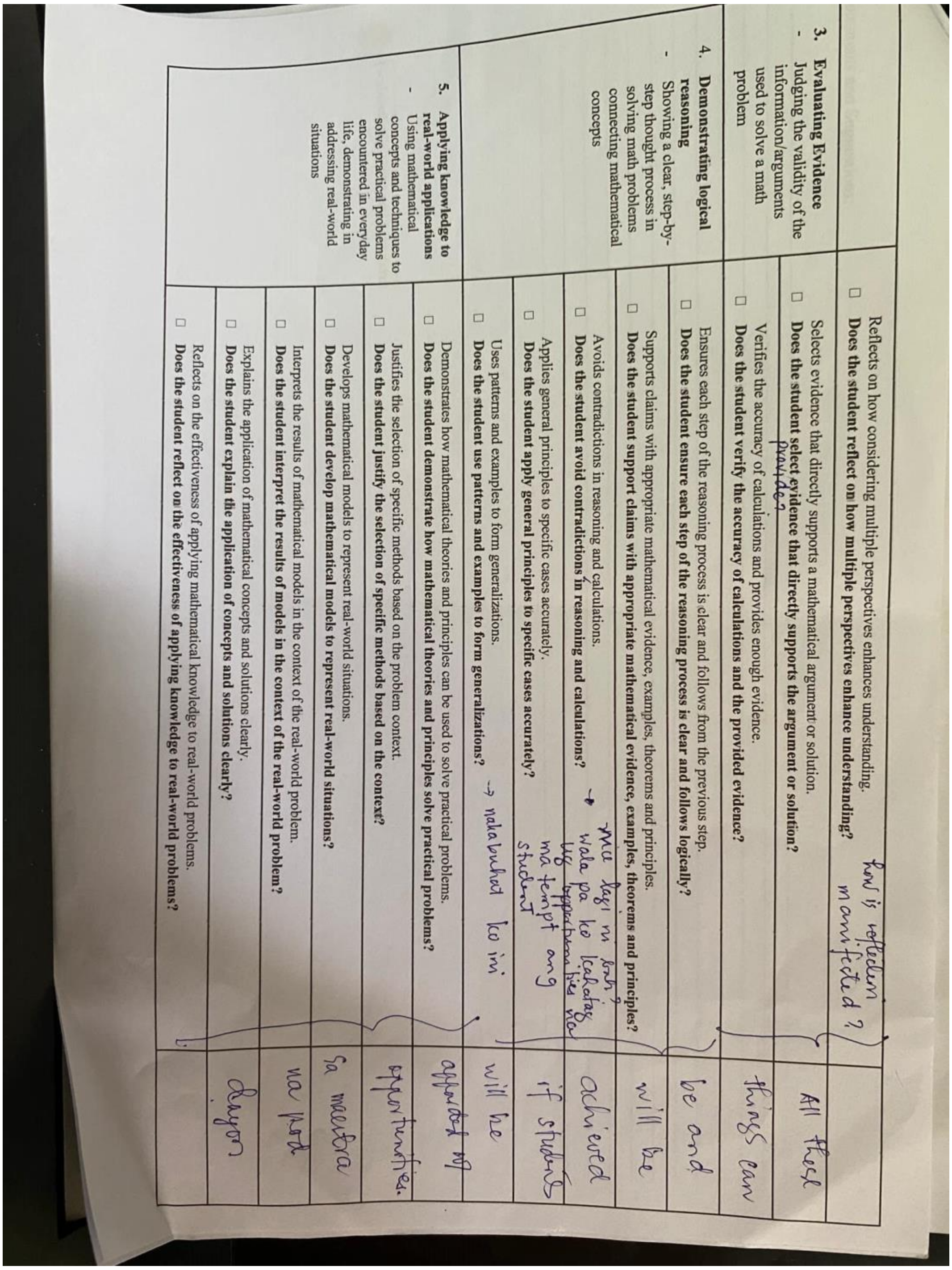


SUMILI, CHRISPER ANTON T.
TAGALOGON, MARIAJE FHEY B.

Use this checklist to assess students' critical thinking skills in the mathematics classroom. For each sub-indicator, tick the box if it is is observed and leave it blank if it is not observed.

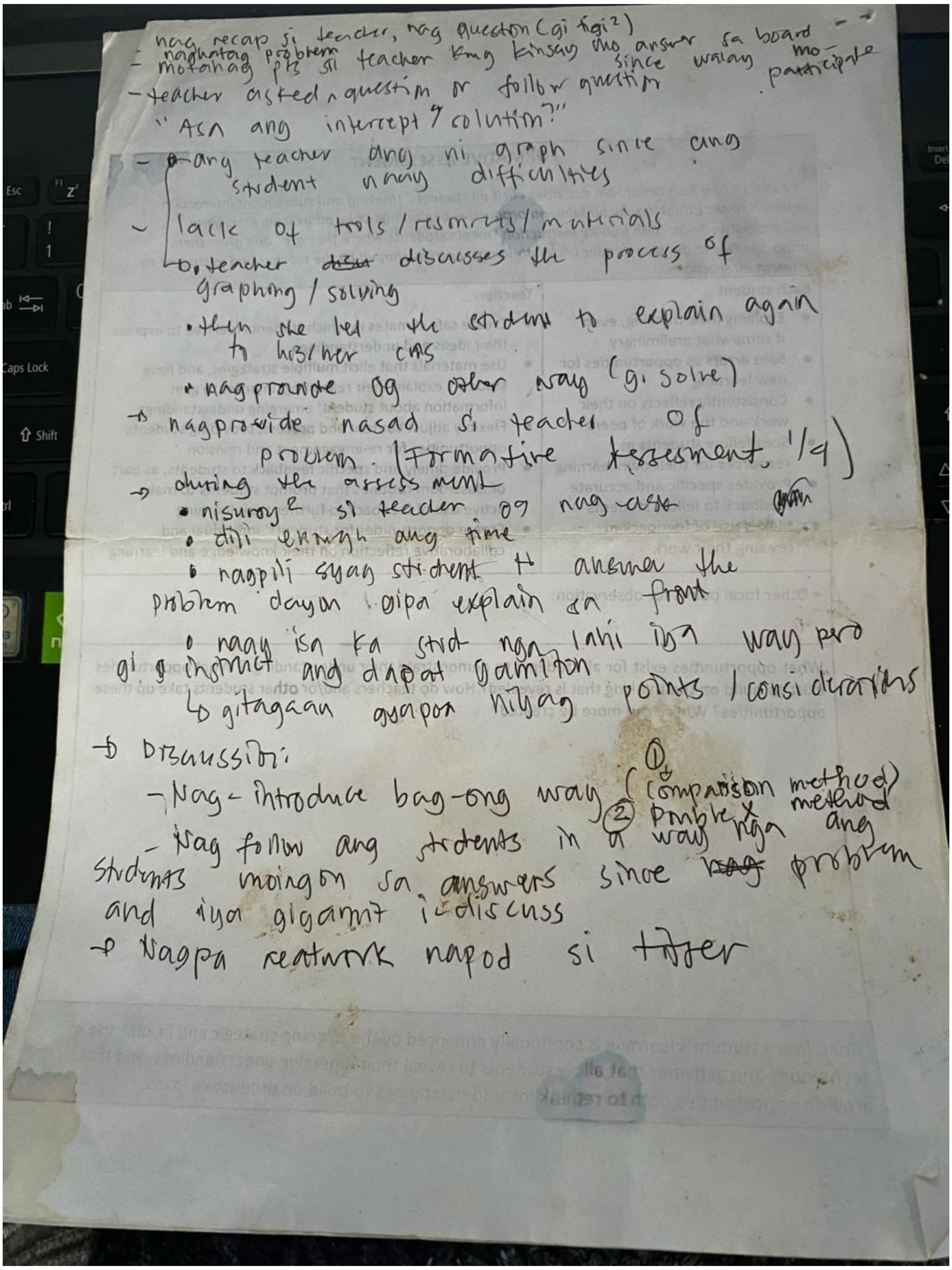
Critical Thinking Indicators		Remarks
1. Asking Insightful Questions - Discovery learning through questioning.	Questions are directly related to the current mathematical concept or problem being discussed. ☐ **Does the question relate directly to the topic or problem at hand?**	
	Questions seek to resolve misunderstandings or errors in reasoning. ☐ **Is the question intended to resolve misunderstandings?**	
	Questions challenge the assumptions underlying a problem or a solution. ☐ **Does the question challenge the assumptions behind a problem?**	
	Questions consider alternative methods for solving a problem ☐ **Does the question consider alternative solutions or methods?**	
	Questions prompt further investigation. ☐ **Does the question encourage further investigation?**	
	Questions reflect on the learning process and personal understanding. ☐ **Does the question reflect on the learning process?**	
	Questions seek to understand the underlying principles or theories behind. ☐ **Does the question seek to understand the reasoning or theory behind a concept?**	
2. Analyzing information from multiple perspectives - Examine a math problem or concept in different ways or using methods and representations.	Recognizes that there are multiple ways to approach a mathematical problem. How do they recognize? ☐ **Does the student recognize multiple approaches to the problem?** How is this manifested?	by providing multiple solutions?
	Compares the outcomes of using various strategies to solve the same problem. ☐ **Does the student compare outcomes of various strategies for the same problem?**	
	Examines alternative solutions and explains why they work or don't work. ☐ **Does the student examine and explain alternative solutions?**	
	Synthesizes information from various perspectives to form a comprehensive understanding. ☐ **Does the student synthesize insights from various perspectives for a comprehensive understanding?**	

APPENDIX M (Cont'd)
COMMENTS AND SUGGESTIONS FOR CHECKLIST 4

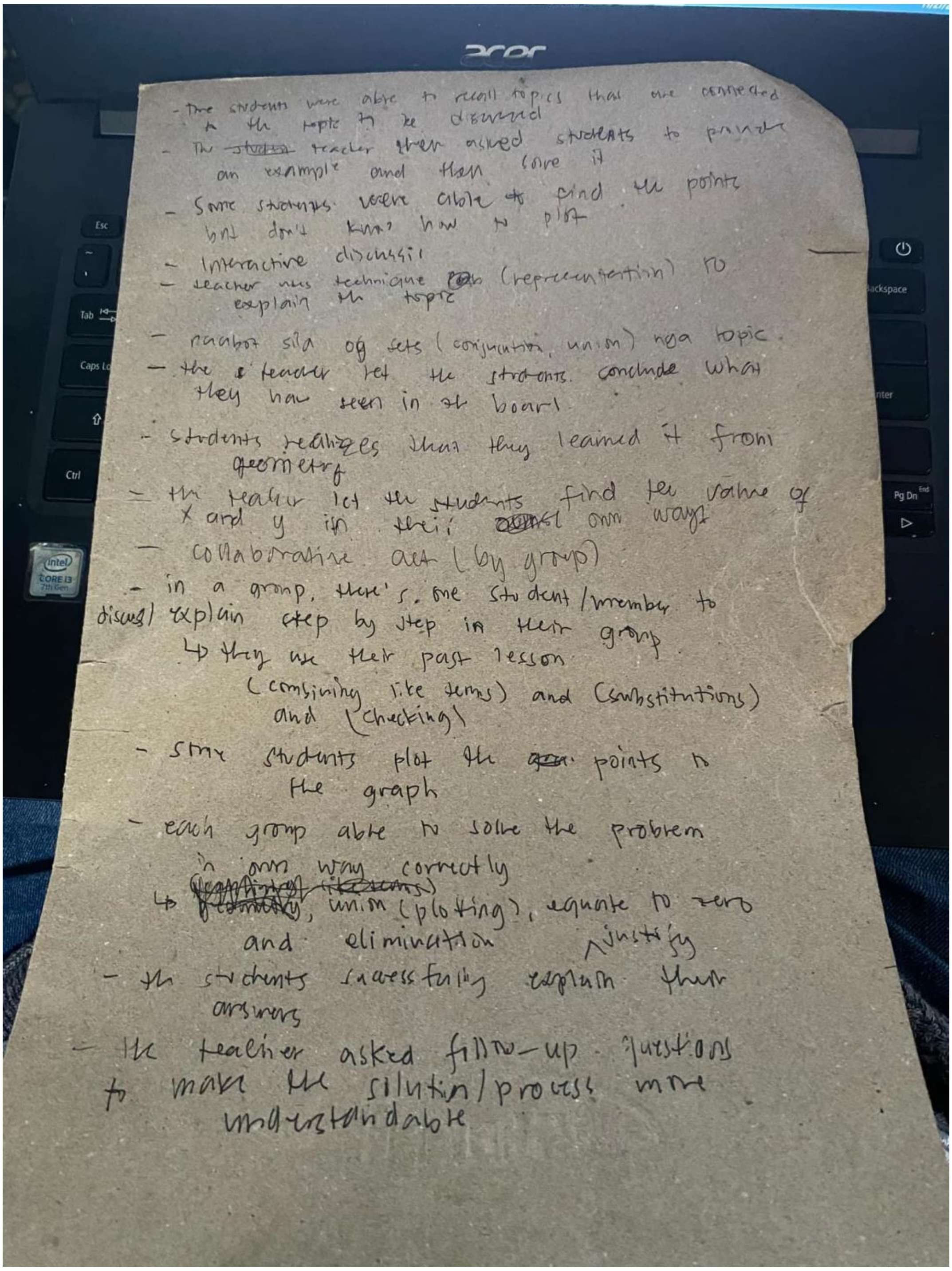


	Reflects on how considering multiple perspectives enhances understanding. ☐ **Does the student reflect on how multiple perspectives enhance understanding?** how is reflection manifested?	
3. Evaluating Evidence - Judging the validity of the information/arguments used to solve a math problem	Selects evidence that directly supports a mathematical argument or solution. ☐ **Does the student select evidence that directly supports the argument or solution?** provide?	All these
	Verifies the accuracy of calculations and provides enough evidence. ☐ **Does the student verify the accuracy of calculations and the provided evidence?**	things can
4. Demonstrating logical reasoning - Showing a clear, step-by-step thought process in solving math problems connecting mathematical concepts	Ensures each step of the reasoning process is clear and follows from the previous step. ☐ **Does the student ensure each step of the reasoning process is clear and follows logically?**	be and
	Supports claims with appropriate mathematical evidence, examples, theorems and principles. ☐ **Does the student support claims with appropriate mathematical evidence, examples, theorems and principles?**	will be
	Avoids contradictions in reasoning and calculations. ☐ **Does the student avoid contradictions in reasoning and calculations?** → Ma lagi ni bah? wala pa ko kahatag ug opportunities na	achieved
	Applies general principles to specific cases accurately. ☐ **Does the student apply general principles to specific cases accurately?** ma tempt ang student	if students
	Uses patterns and examples to form generalizations. ☐ **Does the student use patterns and examples to form generalizations?** → nakabuhat ko ini	will be
5. Applying knowledge to real-world applications - Using mathematical concepts and techniques to solve practical problems encountered in everyday life, demonstrating in addressing real-world situations	Demonstrates how mathematical theories and principles can be used to solve practical problems. ☐ **Does the student demonstrate how mathematical theories and principles solve practical problems?**	afforded of
	Justifies the selection of specific methods based on the problem context. ☐ **Does the student justify the selection of specific methods based on the context?**	opportunities.
	Develops mathematical models to represent real-world situations. ☐ **Does the student develop mathematical models to represent real-world situations?**	Sa maestra
	Interprets the results of mathematical models in the context of the real-world problem. ☐ **Does the student interpret the results of models in the context of the real-world problem?**	na pod
	Explains the application of mathematical concepts and solutions clearly. ☐ **Does the student explain the application of concepts and solutions clearly?**	dayon
	Reflects on the effectiveness of applying mathematical knowledge to real-world problems. ☐ **Does the student reflect on the effectiveness of applying knowledge to real-world problems?**	

APPENDIX N
RAW OBSERVATIONS NOTE (SECTION EPSILON)

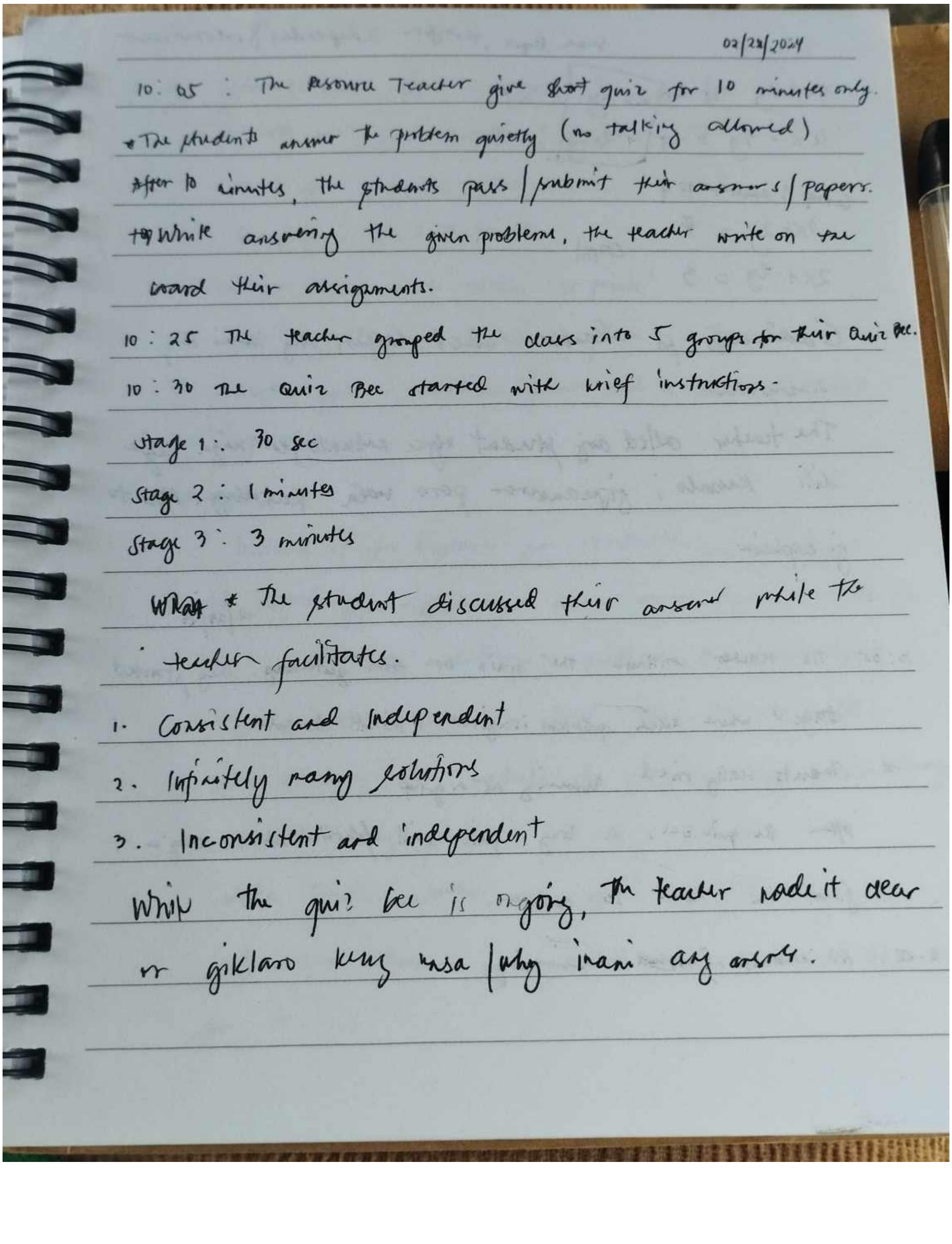

- nag recap si teacher, nag question (gi tigi2)
- naghatag problem si teacher kung kinsay mo answer sa board
- motahag pts si teacher since walay mo-participate.
- teacher asked a question or follow question
"Asa ang intercept & solution?"
- ang teacher ang ni graph since ang student naay difficulties
- lack of tools / resources / materials
- o. teacher ~~disc~~ discusses the process of graphing / solving
• then she let the student to explain again to his/her cms
• nag provide og other way (gi solve)
→ nagprovide nasad si teacher of problem. (Formative Assessment. 1/4)
→ during the assessment
• nisuroy2 si teacher og nag ~~ask~~
• dili enough ang time
• nagpili syag student to answer the problem dayon gipa explain sa front
• naay isa ka stud nga lahi iya way pero gi instruct ang dapat gamiton
↳ gitagaan gyapon niya points / considerations
→ Discussion:
- Nag-introduce bag-ong way (① comparison method) ② problem method
- Nag follow ang students in a way nga ang students moingon sa answers since ~~nag~~ problem and iya gigamit i-discuss
→ Nagpa seatwork napod si ~~teacher~~

APPENDIX N (Cont'd)
RAW OBSERVATIONS NOTE (SECTION EPSILON)



- The students were able to recall topics that are connected to the topic to be discussed
- The ~~student~~ teacher then asked students to provide an example and then solve it
- Some students were able to find the points but don't know how to plot
- Interactive discussion
- teacher uses technique ~~[illegible]~~ (representation) to explain the topic
- naabot sila og sets (conjunction, union) nga topic.
- the teacher let the students conclude what they have seen in the board
- students realizes that they learned it from geometry
- the teacher let the students find the value of x and y in their ~~[illegible]~~ own ways
- collaborative act (by group)
- in a group, there's one student/member to discuss/explain step by step in their group
  - → they use their past lesson (combining like terms) and (substitutions) and (checking)
- some students plot the ~~[illegible]~~ points to the graph
- each group able to solve the problem in own way correctly
  - → ~~[illegible]~~, union (plotting), equate to zero and elimination
- the students successfully justify explain their answers
- the teacher asked follow-up questions to make the solution/process more understandable

APPENDIX N (Cont'd)
RAW OBSERVATIONS NOTE (SECTION EPSILON)



02/28/2024

10:05 : The Resource Teacher give short quiz for 10 minutes only.

* The students answer the problem quietly (no talking allowed)

After 10 minutes, the students pass / submit their answers / papers.

~~to~~ While answering the given problems, the teacher write on the board their assignments.

10:25 The teacher grouped the class into 5 groups for their Quiz Bee.

10:30 The Quiz Bee started with brief instructions.

Stage 1: 30 sec

Stage 2: 1 minutes

Stage 3: 3 minutes

~~What~~ * The student discussed their answer while the teacher facilitates.

1. Consistent and independent
2. Infinitely many solutions
3. Inconsistent and independent

While the quiz bee is ongoing, the teacher made it clear or giklaro kung nasa / why inani ang answer.

APPENDIX N (Cont'd)
RAW OBSERVATIONS NOTE (SECTION EPSILON)

T: How to solve intersection from the two lines?

S: By substitution

The teacher tries to answer the students' queries kung naay wala pasabtan sa students.

Other students kay wala kasabot sa answer or sa solution

Nahuman nang collaborative activity kay ga discuss sa pila sa ilang tapad

10:30 - Exchange paper for checking

2 students volunteered to answer the problem by substitution method and elimination method. on the board

The students explained their answers.

Some students did not follow the instruction instead of substitution method, elimination method ilang gigamit.

The teacher introduced new method which is comparison Method.

Gi explain sa teacher with example.

"Pwede ba daw mata-matahon pag solve"

APPENDIX N (Cont'd)
RAW OBSERVATIONS NOTE (SECTION EPSILON)

Another method is introduced "Double X Method"

The teacher give seatwork for 10 mins.

02/22/24

10 : 05 - The students start checking their quiz given yesterday

2 students volunteered to answer the problems.

10 : 12 students explained their answers

"What is elimination method" - Teacher (nagtawag ug student ang teacher para muparticipate)

"Eliminating one variable to get the value of other variable" - student

" what is substitution method"

" Basically, example X

The teacher explained the Double X Method because students kay dili kabalo.

10 : 35 Groupings

10 : 40 After giving the instructions, the students start making their answers.

11 : 00 Students start writing their answers on the board

APPENDIX N (Cont'd)
RAW OBSERVATIONS NOTE (SECTION EPSILON)

Realizations : students have variety of solutions. Through their brainstorming, they come up different types of answers.

Students need practice in graphing, and using the methods in solving systems of equation.

Teacher needs more knowledge so that she can produce a lot of ways or solutions to the given lesson.

students have a lot of questions but not answered. Still in question that means wala konsabot ang students sa main point sa lessons.

APPENDIX N (Cont'd)
RAW OBSERVATIONS NOTE (SECTION EPSILON)

02/28/2024

10:05 : The Resource Teacher give short quiz for 10 minutes only.

* The students answer the problem quietly (no talking allowed)

After 10 minutes, the students pass / submit their answers / papers.

While answering the given problems, the teacher write on the board their assignments.

10:25 The teacher grouped the class into 5 groups for their Quiz Bee.

10:30 The Quiz Bee started with brief instructions.

Stage 1: 30 sec

Stage 2: 1 minutes

Stage 3: 3 minutes

* The student discussed their answer while the teacher facilitates.

1. Consistent and Independent
2. Infinitely many solutions
3. Inconsistent and independent

While the quiz bee is ongoing, the teacher made it clear or giklaro kung unsa / why inani ang answer.

APPENDIX N (Cont'd)
RAW OBSERVATIONS NOTE (SECTION EPSILON)

same slope, therefore independent & inconsistent

$4x + 2y = 18 \to \boxed{2x - y} = -4$

$4x - 3y = -9 \to \boxed{2x - y} = -3$

Group 1 answer #4

$3x + 2y = 4$ COIN

$2x + 2y = 3$

Gadiscuss si teacher what happen, why wala ang answer

The teacher called ang student nga nabantayan niya nga dili kabalo; gipaanswer pero wala katubag. Mao to gi explain

02/29/24

10:05 The teacher continue the quiz bee from yesterday. They started stage 2 where each problem is given 1 minute to solve.

* Students really tried answering as a group.

After the quiz bee, a long quiz will follow where they're given an hour to answer.

11:05 All students finished answering.

APPENDIX N (Cont'd)
RAW OBSERVATIONS NOTE (SECTION EPSILON)

08/04/24

10:25 students were asked to get 1/2 crosswise

students were given problem to answer (TTP)

Go to your groups after 3 mins.

Groupings : Gr. 1 to Gr. 11.

"What are the values to obtain 45 points"

Plot your answers in a cartesian plane - Teacher

The teacher gave a cartesian plane and a chalk for them to plot points.

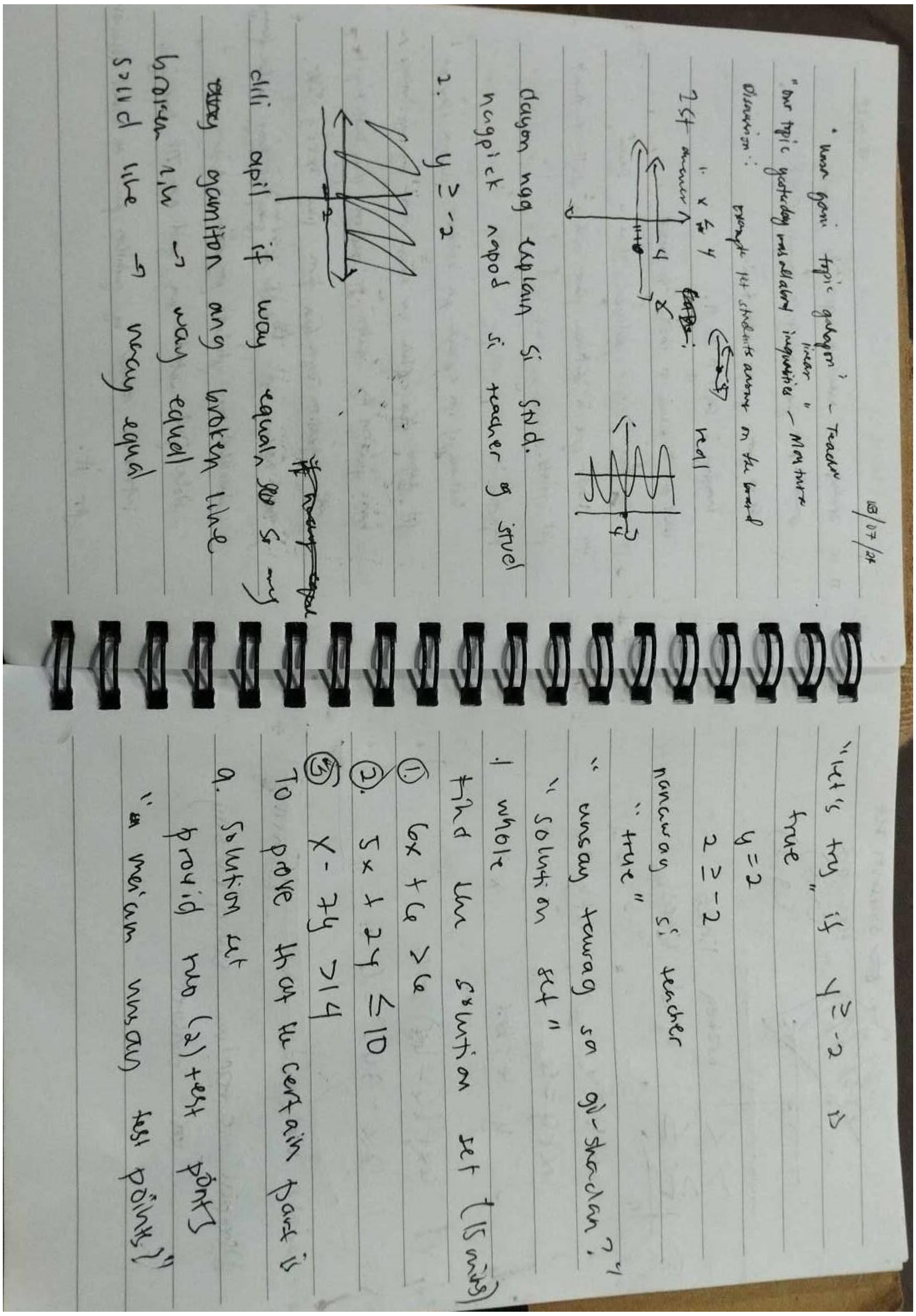
Reflection:

Instead of ipa explain sa students unsa ilang na plot, dapat gipa explain sa daan unsa pag ango values sa basic questions ug challenging questions then dadto hungoton ang equation nga ma form like $3x+5y = 45$.

Dako kaayog time nakuha for groupings kay wala kaayo nakasabot ang students sa main problem.

Wala jud nakuha ang goal nga TTP kay ga introduce raman ug problem pero no exact discussion for it.

APPENDIX N (Cont'd)
RAW OBSERVATIONS NOTE (SECTION EPSILON)



13/07/24

"unsa gani topic gahapon" – Teacher

"our topic yesterday was all about linear inequalities" – Montura

Discussion:
example 1st students answer on the board

2st answer: 1. $x \leq 4$ real

dayon nag explain si stud.
nagpick napod si teacher og stud

2. $y \geq -2$

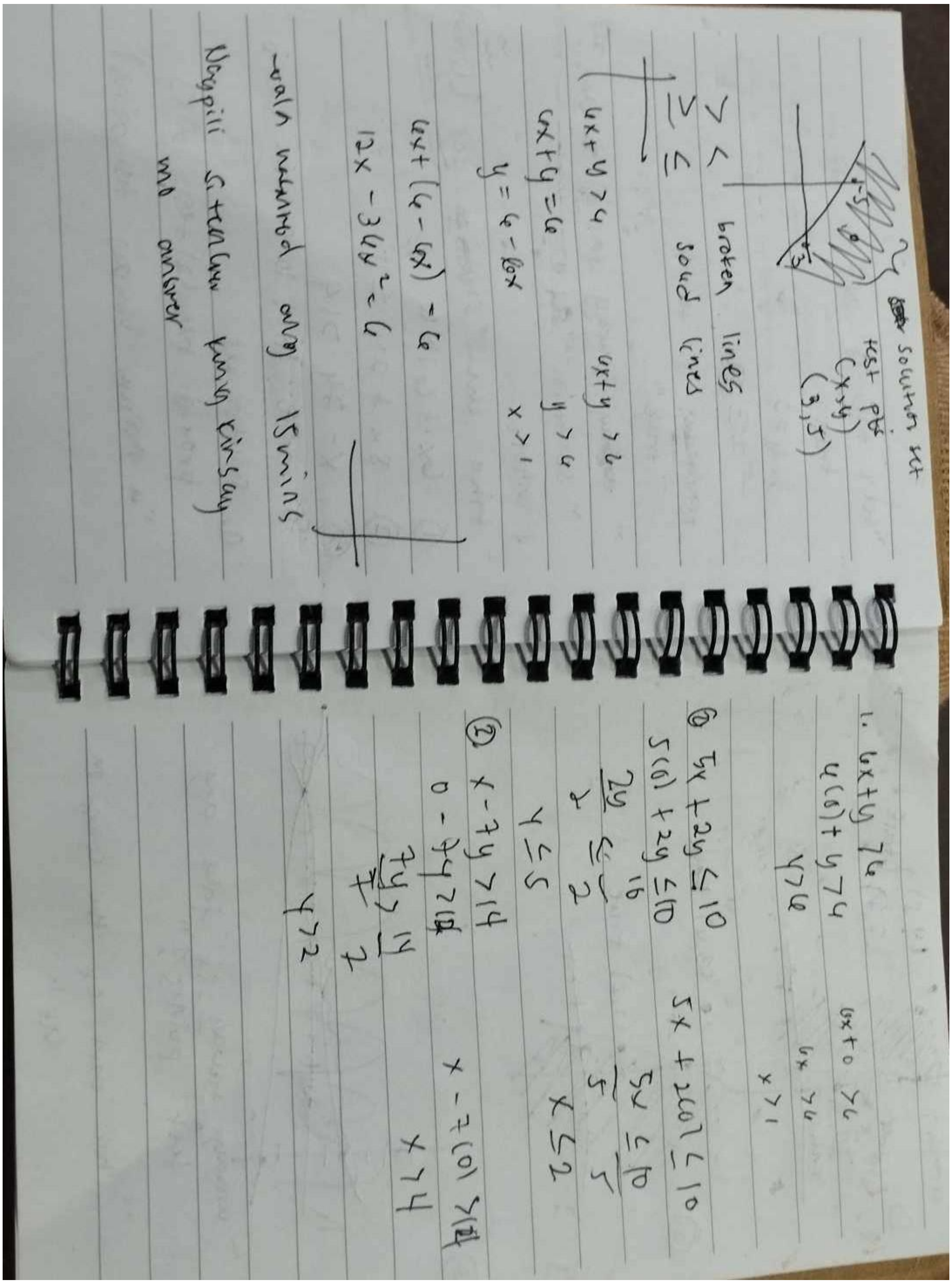
dili apil if way equal, so si ang ~~way~~ gamiton ang broken line
broken line → way equal
solid line → naay equal

"let's try if $y \geq -2$ is true"
$y = 2$
$2 \geq -2$
nanawag si teacher
"true"
"unsay tawag sa gi-shadan?"
"solution set"

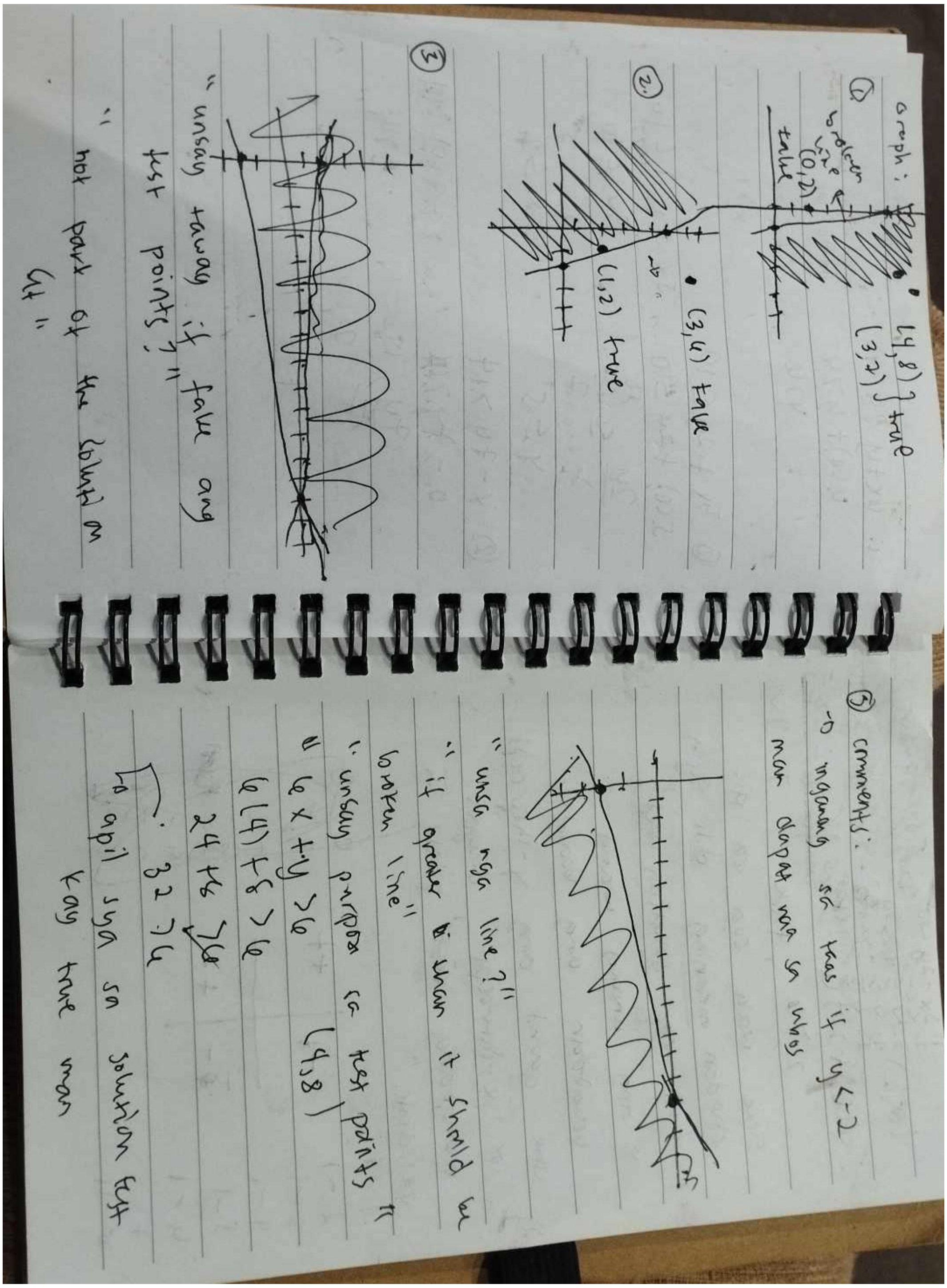
1 whole
find the solution set (15 mins)
① $6x + 6 > 6$
②. $5x + 2y \leq 10$
③ $x - 7y > 14$

To prove that the certain part is
a. solution set
provide two (2) test points
"mei'am unsay test points?"

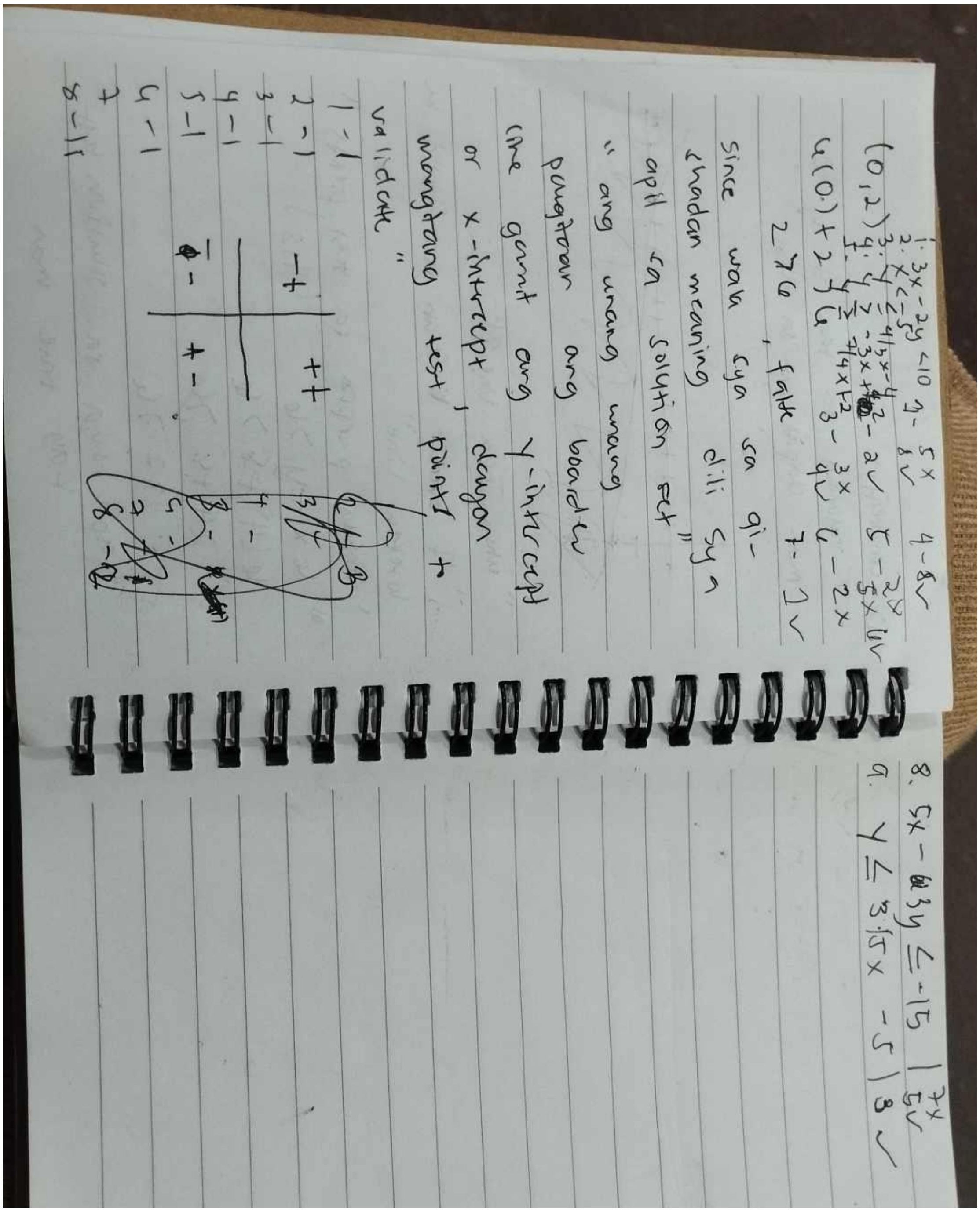
APPENDIX N (Cont'd)
RAW OBSERVATIONS NOTE (SECTION EPSILON)



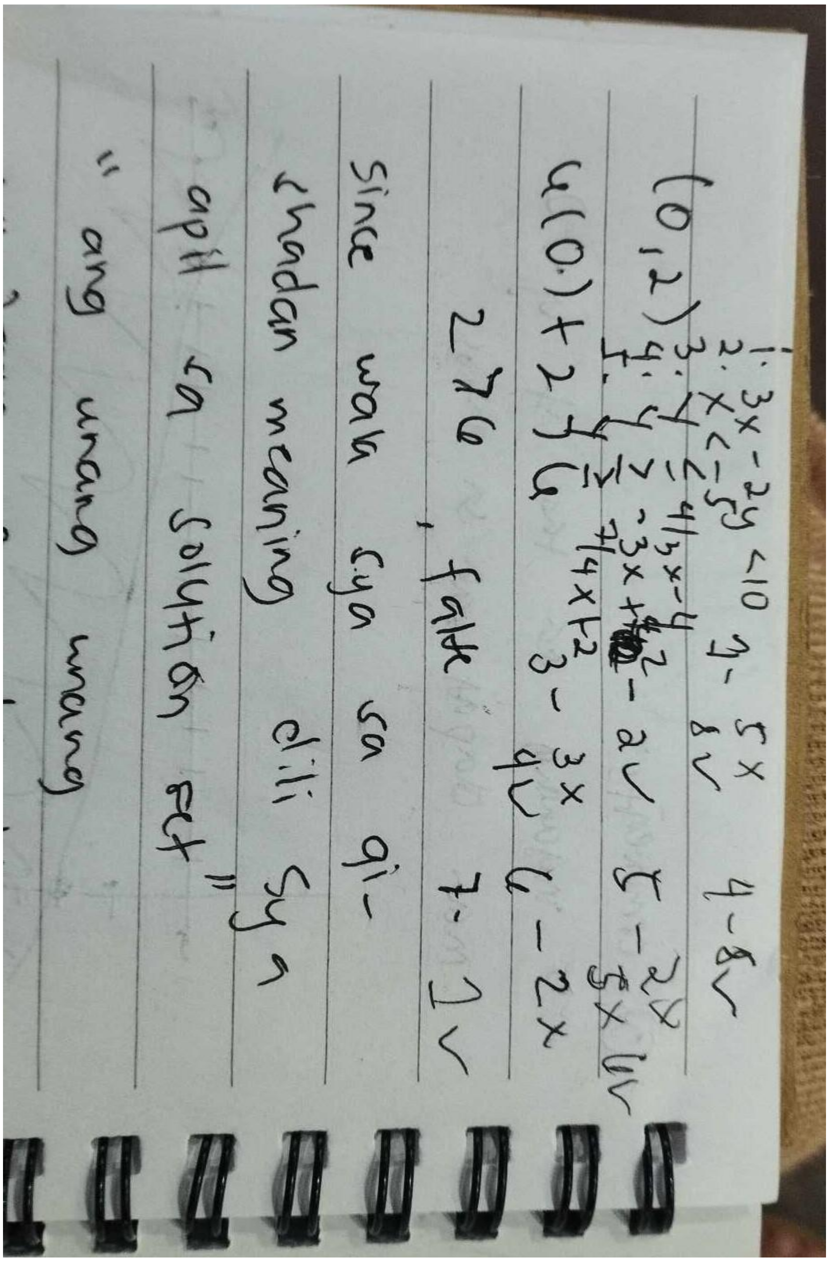
APPENDIX N (Cont'd)
RAW OBSERVATIONS NOTE (SECTION EPSILON)



APPENDIX N (Cont'd)
RAW OBSERVATIONS NOTE (SECTION EPSILON)



APPENDIX N (Cont'd)
RAW OBSERVATIONS NOTE (SECTION EPSILON)



1. $3x - 2y < 10$
2. $x < -5$
3. $y \leq 4/3x - 4$
4. $y \geq -3x + 2$
5. $y \geq 7/4x + 2$

3- 5 x 4- 8 ✓

8 ✓

2- 2 ✓ 5- 2 x

5 x 6 ✓

3- 3 x 6- 2 x

4 ✓

7- 1 ✓

(0, 2)

$4(0) + 2 > 6$

$2 > 6$, false

since wala sya sa gi-
shadan meaning dili sya
apil sa solution set"
" ang unang unang

APPENDIX O
ENCODED OBSERVATTONS (SECTION EPSILON)

Pre-Service Teacher: Rushel May Diola
Day of observations: Day 1
Date: Feb 21, 2024 Hour/s: 1
Facilitated by the Pre-Service Teacher

What content?	What happened?	Reflection and Observations
Recap: Graphing, Elimination and Substitution	The teacher did recap what was their topic last discussion.	Students often lack the energy to begin a class at the start. Good thing, there was a recap to refresh the students.
Find the solution using the graphing method. {2x + 4 = 4 and 4x - y = 2	Teacher: Kabalo naba mo graph ang tanan? Then the teacher wrote a system of equations on the board.	In the question raised by the teacher, it seems that the students are uncertain about their answer. To ensure that students understand how to graph, the teacher's initiative in posing a question is commendable.
	After the given period of time, the teacher asked someone who will answer on board but no one participated yet. Teacher: Tagaan nakog points ang mo answer sa board. Then someone participated.	Because no one wants to participate, it is evident that some students are still unfamiliar with graphing. To encourage participation, the teacher implemented a strategy of awarding points to those who contribute. This has helped students become more active.
	While the student was answering on the board the teacher follow-up some questions because there was an error to the plotting of the student. After the student got the correct answer, the teacher then explained.	Raising open-ended questions can enhance understanding and clarity within the class. Following up with an explanation by the teacher is also beneficial. *The open-ended questions posed by the teacher were not noted by the observers.*
Quiz: 1/2 crosswise 1. {x + y = 14 and y = x + 2 Using Substitution Method 2. {x - 2y = -6 and 5x - 3y = -30 Using Elimination Method	During the given period of time, the teacher roams around. There were some inquiries asked by the students and as much as possible the teacher tried to answer it. Teacher: How to solve the intersection from the two lines? Students: By substitution	It is good that the teacher moves around the class, observing students' answers to problems. The teacher's ability to notice something in students' methods leads them to ask the entire class.
	After the given period of time, the teacher picked two students to answer on the board. Then after answering, students will explain their answers to the class.	During the students' explanations of their answers, the teacher follows up with relevant questions. However, the observers were unable to take notes of both the questions and answers simultaneously.
	Some students did not not follow the instruction, instead of using the substitution method they used elimination method. Checking.	The instructions provided by the teacher are concise, which is a positive aspect. Nevertheless, the students have not followed them properly. The teacher should emphasize the instructions and ensure that students fully comprehend and adhere to them, as they are crucial.

The teacher introduced new techniques which are the Comparison Method and Double X Method. *Formative Assessment used:* 1. *Probing Questions* 2. *Probing Problem* 3. *Exit Ticket: Seatwork* 4. *Think-Pair Share*	Then the after provides another seatwork.	In my opinion, discussing all techniques at once would have allowed students to better identify their similarities, differences, strengths, and weaknesses. However, this might be the teacher's strategic approach. Using formative assessment, such as an exit ticket, is a good way to quickly check students' understanding and comprehension.

Day of observations: Day 2
Date: Feb 22, 2024
Hour/s: 2
Facilitated by the Pre-Service Teacher

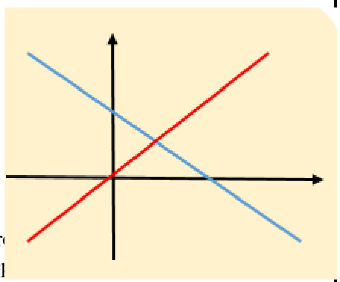
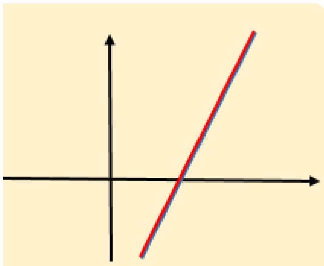
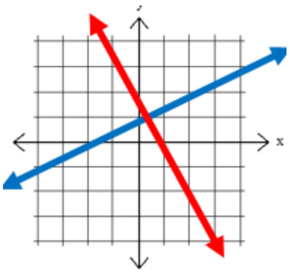
What content?	What happened?	Reflection and Observations
	The class started by checking their last seatwork yesterday.	It is good that the teacher checks the last seatwork completed by the students. This initiative ensures that all students' efforts are assessed.
	Two students participated to write their answers on the board and explain their answers to the class. After checking and discussion, the teacher asked some questions regarding their seatwork.	During the explanation of their answers, the teacher posed some follow-up questions. Unfortunately, the observers were unable to take notes of both the students' answers on the board and the questions raised by the teacher simultaneously.
	Teacher: What is the elimination method? Student A: Eliminating one variable to get the value of other variable	Recap questions are beneficial as they help students remember the process and better understand the concepts.
	Teacher: What about the substitution method? Student B: The value of one variable from one equation is substituted in the other equation.	Clearly, the students have remembered and understood the concepts.
	The teacher explained again the Double X Method to the class as the teacher seems that some of the students did not understand the method.	It is commendable that the teacher observes something about a student and takes action to address the issue at hand.
	After the given period of time, the teacher picks students per group to write their answer and explain/share how they come up with that equation.	During the given time, each group engaged in their own discussions.

Group Activity: Find the system of equations of a solution (2, 4). Solve as many ways as you can.	Group 1: {4x + 2y = 16 and 9x - 2y = 10 13x = 26 x= 2 4(2) + 2y = 16 8 + 2y = 16 2y = 16-8 2y = 8 y = 4 Therefore, (2,4) Checking: a. 4x + 2y = 16 4(2) + 2(4) = 16 8 + 8 = 16 16 = 16 b. 9x - 2y = 10 9(2) - 2(4) = 10 18 - 8 = 10 10 = 10 Group 2: {2x - y = 0 and -x + 3y = 10 Checking using (2,4) a. 2x - y = 0 2(2) - 4 = 0 4 - 4 = 0 0 = 0 b. -x + 3y = 10 -2 + 3(4) = 10 -2 + 12 = 10 10 = 10 Group 3: {2x - 4y = -12 and 6x - 4y = - 4 Checking using (2,4) a. 2x - 4y = -12 2(2) - 4(4) = -12 4 - 16 = -12 -12 = -12 b. 6x - 4y = -4 6(2) - 4(4) = -4 12 - 16 = -4 -4 = -4 Group 4: {2x + 4y = 20 and -2x + 6y = 20 Checking using (2,4) a. 2x + 4y = 20 2(2) + 4(4) = 20 4 + 16 = 20 20 = 20 b. -2x + 6y = 20 -2(2) + 6(4) = 20 -4 + 24 = 20 20 = 20	There was sharing among students as they tried to solve problems using slope formulas, creating their own equations, or utilizing their previous knowledge. This demonstrates that each student or group has a variety of approaches to solving or creating a system of equations. The answers provided by each group were correct. However, the assumed answer by the teacher was not given by the students. The teacher recognized this and asked questions about the methods or steps involved in creating a system of equations using ordered pairs or points. This led to teacher-student interaction, as the teacher guided a student through the solution process on the board.

Formative assessment used: 1. Probing questions 2. Probing problem 3. Think-Pair Share: Collaborative problem-solving 4. Think-Pair Share: Sharing mathematical reasoning with peers	Group 5: {2y - 2x = 4 and 2y + 2x = 12 4y = 16 y = 4 2(4) - 2x = 4 8 - 2x = 4 -2x = 4 - 8 -2x = - 4 x = 2	

Day of observations: Day 3
Date: Feb 28, 2024
Hour/s: 1
Facilitated by the Pre-Service Teacher

What Content?	**What happened?**	**Reflection and Observations**
Seatwork: 1. $l_1 \,\|\,\|\, l_2$. If l_1 is given by 2x - 3y = 6 and l_2 passes through origin. Find the equation of l_2. 2. Consider, { x - y = 4 and 3x - 2y = 0 Find the solution to the system. Assignment: Write your solutions in a whole sheet of paper. 1. Find the equation of the line parallel to the line x - y = 5 perpendicular to its x-intercept. 2. A line passes through the point (1/2,-1/4) and (3/5,1/5). What is the equation of the line? 3. Find the solution set. a. {x - 3y = 5 and x =4 b. {2x + y = 3 and 3x - 4 = y c. {2x + y = 1 and y + 2x = 1 d. {3 = 2(x-y) + y and x -2 (x-y) = 0 4. There are pigs and chicken in a form. Tonyo counted the legs in total and there are 20. He counted the heads and there were 6. How many pigs and chickens are in the farm? Activity: Quiz Bee (By Group) - Students are grouped into 5	*The teacher begins to facilitate the class by giving the students a seatwork where they need to answer the given seatwork in just 10 mins.* *When the given time was about to finish, the teacher wrote their assignment on the other side of the board.* *After the given period of time, the papers were collected and no checking of the seatwork (choosing students to answer it on the board and discuss).*	During the given period, the entire class remained silent, with no interaction between students and teachers. They were focused on taking an exam. If the teacher aims to challenge the students, this situation could be one way to do so. It also serves as a beneficial exercise for their future activities that will aid them in the long run.

groups. - Each group are assigned to a specific white board to where their answers should written. - There will be 3 stages namely Stage 1 where students answer it in 30 seconds, Stage 2 where students answer it in 1 min and Stage 3 where students answer it in 3 mins. Points will be based on the problem.		
Stage 1: Question 1: What type of system of lines is portrayed in the illustration?  Corr Inde	Group 1: Consistent and Independent Group 2: Consistent and Independent Group 3: Consistent and Independent Group 4: Consistent and Intersection Group 5: Consistent and Independent Group 1, 2, 3, and 5 got the correct answer while Group 4 got only 1 point. Teacher: “It is consistent and independent because the two lines intersect at?” Student A: “One point maam”	Open-ended questions can help make the questions and answers more relatable, fostering better communication and understanding among students. This ensures that every student is attentively listening to the teacher.
Question 2: How many solutions does this system of equations have?  Correct Answer: Infinitely Many Solutions	Group 1: Infinite Solutions Group 2: Infinite Solutions Group 3: Infinite Solutions Group 4: Infinite Solutions Group 5: Infinite Solutions Teacher: “It should be Infinitely many solutions” Students: “Pwede 1 point maam?” Teacher: “Okay” Group 1-5 will have one point each.	
Question 3: Determine the type of the system shown.  Correct Answer: Independent	Group 1: Consistent and independent Group 2: *No answer* Group 3: Consistent and Independent Group 4: *No answer* Group 5: Consistent *Teacher did recall and illustrate it to the board through drawing.*	The teacher's strategies, such as

Question 4: Create a system of equations and identify if it is COIN, CODE, or INN. Since everybody creates a COIN. Teacher decided to have bonus questions. Question 5(Bonus): Create a system of equations that is CODE.	Teacher: "Pag consistent nag intersect but different slopes and pag inconsistent naman kay same slopes but different y intercept" Group 1:{3x + 2y = 4 and 2x + 2y = 3 COIN Group 2: {x + y = 4 and 2x - y = 2 COIN Group 3: {2y + 3x = 4 and 5y - x = 5 COIN Group 4: {2y + 3x = 18 and -2y + 6x = 0 COIN Group 5: {2x + 4y = 8 and 3x + y = 7 COIN *Teacher let explains to each group about their answer to the class.* The following questions are asked during the explanation: 1. Nganong COIN man sya? 2. What is the standard form? 3. What is the y-intercept? Everybody provides the correct equations.	illustrating concepts through graphing or drawing on the board and providing cohesive explanations, contribute to students fully understanding the context. Encouraging thoughts and mathematical problem-solving skills, as well as reasoning skills, within the class fosters a collaborative environment. This includes student-to-student interactions, both within groups and through discussions. Probing open-ended questions further enhances the discourse's clarity.
	Group 1: {4x + 3y = 6 and 8x + 6y = 12 Group 2: {2x - 3y = 4 and 3x - y = 0 Group 3: {6y +3x = 12 and 2x + 4y = 8 Group 4: {3x - 2y = 4 and 6x - 4y = 8 Group 5: {x - y = 1 and x- y = 1 *As the teacher checked the equations, she then asked each group to explain their answers but she also let Group 2 to be the last one to explain.* (After the Group 1,2,3 and 5 to explain) Teacher: "Naay gamay mali ang sa Group 2 ay, sige daw tan awa if asa ang mali dayon isili" Then Group 2 discussed with each other if where does error exist. Student A (G2): Dapat ang coefficient sa y kay divisible sa 3 og pati napod ang 0 ilisdan." Group 2 final answer: {2x - 3y = 4 and 4x - 6y = 8 Which is correct and then the teacher let the Group 2 explain their answer. And so everyone got points.	For Question No. 4, the teacher asked students to form a system of equations, and the answer from all groups was a "COIN." The teacher provided an opportunity for each group to earn bonus points by creating a system of equations that was a "CODE." This demonstrates the teacher's preparedness for a diverse set of answers. When the teacher noticed an error in the answer of Group 2, they did not directly point it out. Instead, they created a situation that allowed G2 to identify the error themselves.
Stage 2: Question 1: What is the slope of the line with points (-3,2) and (5,-3). Correct Answer: $-\frac{5}{8}$	Group 1: m = $-\frac{5}{8}$ Group 2: m = $-\frac{8}{5}$ Group 3: m = $-\frac{5}{8}$ Group 4: m = $\frac{5}{8}$	

Question 2: *(Wasn't able to write down the question)* Correct answer: $-\frac{1}{2}x + -\frac{1}{2}$ Formative assessment used: 1. Probing problem 2. Probing questions 3. Think-Pair Share: Collaborative problem-solving 4. Think-Pair Share: Sharing mathematical reasoning with peers 5. Exit Tickets: Assignment 6. Seatworks	Group 5: m = $-\frac{5}{8}$ Teacher: "Unsa gali ang formula sa slope of the line? Diba naa man pod tay y-intercept form and standard form. So unsa may formula sa slope of the line?" Student B: "Katong y sub 2 minus sub 1, maam?" Teacher: "Yes, unsay complete formula?" Student C: "m = y sub 2 minus y sub 1 over x sub 2 minus x sub 1." ($m = \frac{y_2 - y_1}{x_2 - x_1}$) *Teacher wrote the formula on the blackboard and then solved the slope of the line using the formula.* Group 1, 3 and 5 got the correct answer. (Overtime) Group 1: y = $-\frac{1}{2}x - 3$ Group 2: y = $-\frac{1}{2}x + b$ Group 3: no answer Group 4: y = $-\frac{1}{2}x - \frac{1}{2}$ Group 5: no answer Teacher: "Unsay formula sa y-intercept napod?" Student D: "y = mx + b" Teacher: "Dayon kuhaon sa nimo ang slope of the line and so on na dayon" Pre-service teacher flashes the process or solution of the problem. Only group 4 got the correct answer. *Quiz bee wasn't able to go to Stage 3 because of the lack of time.*	Recalling questions is crucial to ensure that everyone catches up and can fully comprehend the connections between questions and answers. Ensuring that students can visually see the content on the board, rather than just hearing it, is important for better understanding. Teachers should be mindful of time constraints during activities to avoid any interruptions. But, it is understandable since they did seatwork at the beginning.

Day of observations: Day 4
Date: March 6, 2024
Hour/s: 1
Facilitated by the Pre-Service Teacher

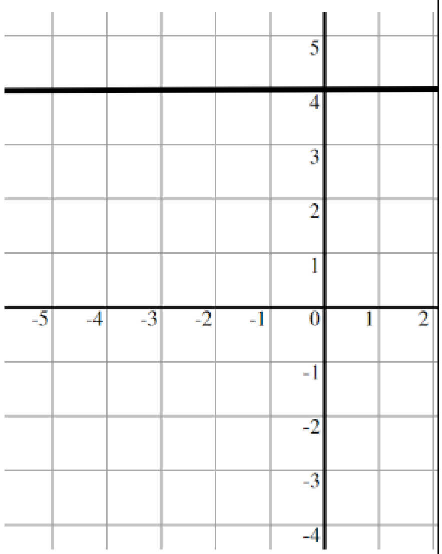
What content?	**What happened?**	**Reflection and Observations**
Problem: Imagine you and your group mates are participating in the national mathematics quiz bee. The quiz consists	Teacher: So, the problem is "how many easy questions and challenging questions so that your group will	I believe it would be more beneficial if the problem's questions were displayed on the screen as well.

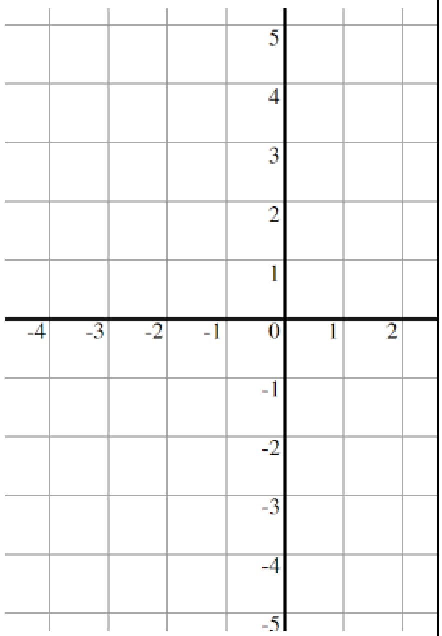
of basic questions worth 3 points and challenging questions worth 5 points each. To achieve a high level performance, your group must obtain a total of 45 points.	obtain a total of 45 points"? Solve the problem in 15 mins in your way.	Although it is commendable that the teacher mentioned the problem's question, it cannot be considered a problem without the visual context.
	(After 15 mins) The students are not yet done solving the questions in 15 mins, so the teacher gives an extra 5 mins. Teacher roaming around and asking students about their answers as well as she asks her students something about their answer.	It is good that the teacher considers providing extra time for students to solve the problem. However, this approach might consume significant time, potentially leading to insufficient time for subsequent discussions.
	(After 5 mins) Teacher: Done everyone? So, I already grouped you into 11 groups. (she presented the members of the group via screen) Go to your group and in 3 mins, discuss your answers with each other and plot the values/points in the cartesian plane (she then gives the student a cartesian plane and a chalk-each group).	The teacher's approach of encouraging students to initially work on the problem individually before engaging in group discussions is praiseworthy. Having 3 members per group seems more advantageous, as it allows for effective communication and collaboration among the students. This smaller group size may prevent a few individuals from dominating the conversation, ensuring that everyone has a chance to contribute their insights and ideas.
	(After 3 mins) Teacher: Done naba class? Students: Wala pa ma'am. (Teacher gives another 1 min extension) (After 1 min) Teacher: Class, let's now discuss. Finish or not finish. "What is your observation based on your answers?"	Presenting questions to establish a common foundation for discussions among groups is an effective strategy. This approach allows for a more comprehensive comparison and evaluation of various answers and insights.
	Group A: ("A" don't represent group 1 and so on) (While raising their cartesian plane) They defined "x" as an easy question and "y" as a challenging question. "Nangita mig line para maconnect og maka create og system of linear equations. Group B: "Gibuhat namo syag equation, so nakabuhat mi $3x + 4y = 45$ tas gichange namo sya into standard para makita namo ang y-intercept and gigamit namo ang y-intercept para makuha ang x-intercept dayon nakita namo ang points sa cartesian plane." Group C: "Same lang with the last group. Gihimo sa namog equation and then gi standard form. So nakakuha mig 10 ka easy questions og 3 ka challenging questions: $3(10) + 5(3) = 45$. Tas naa pod another values: $3(5) + 5(6) = 45$. Overall, naa mi 4 ka values/points.	Selecting diverse groups to present their answers to the class can provide a well-rounded perspective. The teacher can choose groups with a mix of lack of answers, somewhat correct answers, and more accurate answers. This method encourages other groups to reflect on their own answers, identify areas for improvement, and appreciate the differences in thought processes and solutions. The teacher's approach of not labeling answers as "wrong" or "incorrect" but rather motivating students to discuss and explain is commendable. But then again, teachers should open opportunities to all students to speak in the class, to share their thoughts/insights about their answers to the class.

	Group D: “Same lang mig points or values sa ubang group. Naa mi 10 ka easy and 3 ka challenging questions so $3(10) + 3(5) = 45$.	*Note: Observations may lack such as a documentary of the cartesian plane presented by each group in the class. The happenings were just so fast, that we can’t even note the conversation of the teacher-student. Thus, some of the students have low voices and we are a little bit far away from him/her. We just put here the least that we had observed/noted.*
From $3x + 5y = 45$ to $3x + 5y \geq 45$. Find 3 combinations to get at least or equal to 45 points.	Teacher: “So, most of your answers are correct. So now, what if I’ll change the question of the problem? From a total of 45 points to at least or equal to 45 points? Can you find a combination or targets (3) to get at least or equal to 45 points using your cartesian plane. I’ll give you 5 mins” (After 5 mins) Teacher: “Post your cartesian plane on the board and explain to the class your answers.”	Based on the answers provided by the students, most of them already know how to plot a line in the Cartesian plane. It is good that they have this foundation. Using the problem to let students first create a line for a given equation and then relate it back to the day's topic is a good building block for learning. By slightly modifying the equation (from = 45 to $\geq$45), a new lesson can be derived.
	Group A: (“A” don’t represent group 1 and so on) “Give me points that are above the line? (He asked his classmates and his classmates responses 9 and 9) Now, let’s try, $3x + 5y \geq 45$ using (9,9) $3(9) + 5(9) \geq 45$ $27 + 45 \geq 45$ $72 \geq 45$ Which is correct, so magpili ramog points nga lapas sa line since at least or equal to 45 man.” Group B: “Among gipili nga points ma’am kay 5 and 9 so (5,9). Now, itry nato, $3x + 5y \geq 45$ $3(5) + 5(9) \geq 45$ $9 + 45 \geq 45$ $54 \geq 45$ So maskig unsa nga points ang kuhaon basta kay above the line ma satisfy ra ang inequality. Example, sa last group and amoa, we didn’t have the same values but na satisfy ra namo respectively. Which is correct”	The explanation from Group A was correct, as the student asked their classmates to choose points from the shaded part of their Cartesian plane or a shaded part of the line ($3x + 5y = 45$). This was a nice tactic used by the student to explain their answer. If a student is explaining in front of the class, they should face their classmates, not the teacher, as observed. And this should be noted by the teachers to say to the class that whenever students speak in front they should face their classmates. Commend the teacher for allowing the different group to explain their answer, as they approached the problem uniquely and still arrived at the correct solution.
Formative Assessment used: 1. Think-Pair-Share: Collaborative problem-solving	Teacher: So why are there two lines in your cartesian plane? Please Group C explain this.” Group C: “Kuan maam, ang amoa kay if mangita napod kag points babaw sa line nga $3x + 5y = 45$ kay	Although students did not choose three combinations, they selected one ordered pair that still satisfied the given inequalities. Due to the extra time given to students, the pre-service teacher could not conclude the class and state the topic's main idea. It was the teacher who actually explained

2. Think-Pair Share: Sharing mathematical reasoning with peers 3. Probing Problem 4. Probing Questions	ma satisfy ang $3x + 5y \geq 45$. Pwede pod maam to verify the inequalities kay mo pili kag points nga below sa line if dili ma satisfy ang inequalities meaning correct and representations. In other words, dili ka pwede magpili og values depend on what areas, example kani kay dapat sa above ragud sa line na mga points para ma satisfies ang inequality." Teacher: "So, with the line presented at $3x + 5y = 45$ as the basis. We can satisfy the inequalities $3x + 5y \geq 45$ if we get points above the given line in the equation ($3x + 5y = 45$). This means that our topic for today is about Linear Inequalities."	the topic's context. Overall, the class was productive, but it ran out of time because of the additional time provided to the students, which was necessary.

Day of observations: Day 5
Date: March 7, 2024
Hour/s: 2
Facilitated by the Pre-Service Teacher

What content?	What happened?	Reflection and Observations
(Recap) • $x < 4$	Teacher: "What was our topic yesterday?" Student A: "Our topic yesterday was all about linear inequalities" Teacher: "Can somebody graph this inequality in a cartesian plane?" *Since nobody wants to participate, the teacher picked a student to go to the board.* Student B: (answer)  Teacher: "Tan-awa unsa ang intercept niya." *Student B changed his answer.*	It is good that the teacher did a recap about the previous day's topic, as it adds substance to the discussion and helps in the day's session. Expanding the topic during the recap is beneficial for students' understanding. Identifying if students can graph in the Cartesian plane and the teacher correcting them without labeling answers as "wrong" is commendable. This approach encourages students to think and rethink their answers. As the teacher points out potential errors, students immediately follow the guidance, making the learning process more effective.



This kind of questioning helps students rethink and re-check their work, identifying possible errors and correct answers.

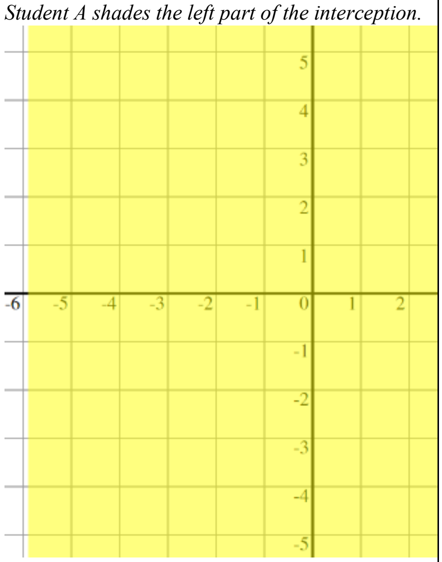
Teacher: "Diba correct na ang interception and value pero unsaon man nato pagkabalo ang x is less than to 4? Asa man diha ang less than 4?"

Students: "Sa left ma'am"

Teacher: "Unsa may buhaton nato niya?"

Students: "I-shade ma'am"

Student A shades the left part of the interception.

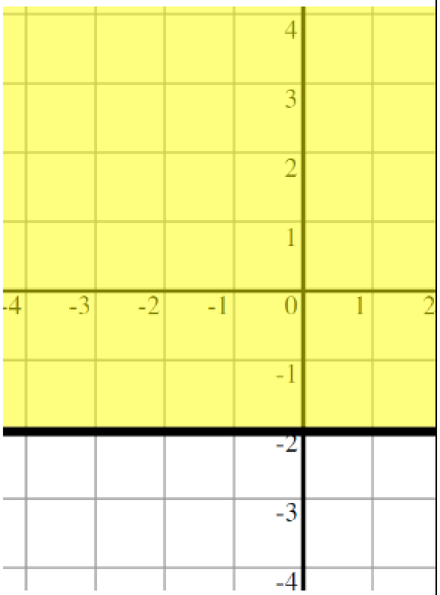


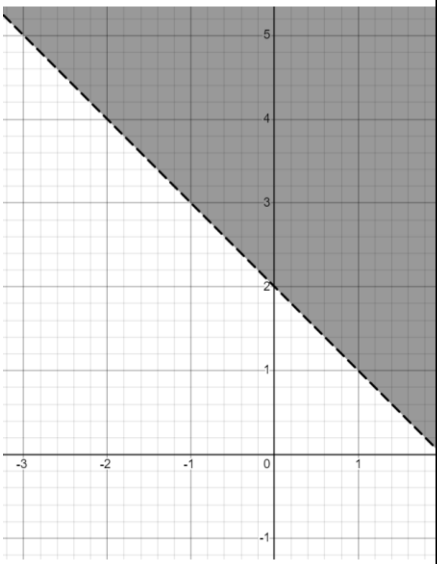
- $y \geq -2$

Providing additional examples during the discussion aids students in better understanding the topic.

Teacher posed another inequality and called another student to plot in the cartesian plane.

Student B:

		
	Teacher: "And take note class, if naay equal ang inequality like this ang line dapat niya kay solid line and if way equal ang inequality like sa first nako gihatag ang line niya is broken line. To prove this inequality, let's try. Mangita tag value nga apil sa shaded part, let say y=2. Let's see if $y \geq -2$ is true if y= 2."	Presenting key concepts about the topic during the discussion enhances students' processing and comprehension of the subject matter.
Find the solution set of the ff. 1. $6x + y > 6$ 2. $5x + 2y \leq 10$ 3. $x - 7y > 14$ To prove that a certain part is a solution set provide two (2) test points.	y=2 $y \geq -2$ $2 \geq -2$ Teacher: "2 is greater than or equal to 2? Correct ba class?" Students: "Yes, ma'am" Teacher: "So, unsay tawag ani nga value or in general sa kaning gishadan nga sa cartesian plane?" Students: "Solution ma'am." Teacher: "Yes, solution set to be exact. So meaning tanang values nga apil anang shaded part kay masatisfy niya ang inequality. Get 1 whole sheet of paper and answer the ff in 15 mins." Students: "Ma'am unsay test points?" Teacher:	Ensuring that students are attentive and listening to the discussion is crucial for effective learning. Posing questions related to the topic gives students the freedom to rethink and evaluate their understanding of the subject. Giving seatwork to students is a good strategy to assess their progress in understanding the topic. Students' inquiries and clarifications should be welcomed and addressed, ensuring no student is left behind.



Explaining concepts with examples helps clear students' doubts and queries.

"Pareha ani, ang test points makuha sya sa shaded part or sa solution set sa imong inequality. For example, in this inequality, your test points are values of x and y respectively. So, let's say x=3 and y=5. From (x,y) to (3,5) and x=3 and y=5 kay apil diba sya sa solution set or shaded part sa inequality?"

Students: "Yes, ma'am."

15 mins was not enough for the students to answer the short quiz. So the teacher gives an extra 10 mins.

(After 25 mins)
Teacher chose 3 students to answer the 3 inequalities on the board and the chosen students will discuss their answers in the front.

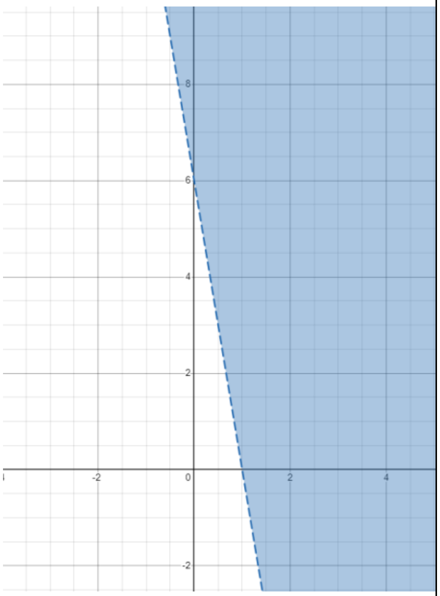
Student C:

1. $6x + y > 6$

$6x + y > 6$
$6(0) + y > 6$
$y > 6$

$6x + 0 > 6$
$6x > 6$
$x > 1$

Allowing students to answer and explain in front of their classmates is a beneficial way to formatively assess them. Follow-up questions from teachers and students should be encouraged for a more engaging discussion.

	 Test points: (4,8) True and (3,7) True a. (4,8) for True 6x + y > 6 6(4) + 8 > 6 24 + 8 > 6 32 > 6 (Check) b. (3, 7) for True 6x + y > 6 6(3) + 7 > 6 18 + 7 > 6 25 > 6 (Check) Student D: 2. 5x + 2y ≤ 10 5x + 2y ≤ 10 5(0) + 2y ≤ 10 2y ≤ 10 y ≤ 5 5x + 2y ≤ 10 5x + 2(0) ≤ 10 5x ≤ 10 x ≤ 2	

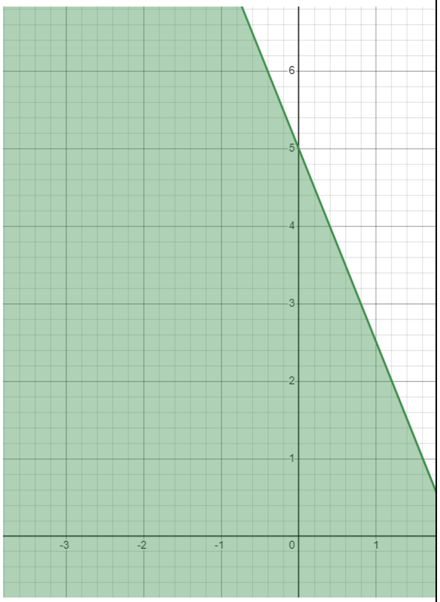
Activity:

- The students grouped into 8 groups consisting of 3-4 members each.
- The activity will take place outside the classroom.
- The place will have a cartesian plane look-like where they plot themselves in the said area to form a line (broken or solid line).
- The teacher will raise a placard with an inequality that each group solves on their own in just 1 min.
- After 1 min, the teacher will count 3 seconds to raise the hand of each group and have a chance to plot themselves in the cartesian plane.
- After that one group plotted themselves in the cartesian plane, the teacher will then ask what line and which boundaries.
- Once the group answers all the questions they will have 1 check. 1 check is 50 points.

Linear Inequalities: (used in the activity)

1. $3x - 2y < 10$
2. $x < -5$
3. $y \leq 4/3x - 4$
4. $y \geq -3x + 4$
5. $y \geq 7/4x + 2$
6. $3x - 2y < 10$
7. $x < -5$
8. $5x - 3y \leq -15$
9. $y \leq 3/5x - 5$

Documentation:



Test points: (1,2) True and (3,6) False

a. (1,2) for True

$5x + 2y \leq 10$

$5(1) + 2(2) \leq 10$

$5 + 4 \leq 10$

$9 \leq 10$ (Check)

b. (3,6) for False

$5x + 2y \leq 10$

$5(3) + 2(6) \leq 10$

$15 + 12 \leq 10$

$27 \leq 10$ (Check)

Student E:

3. $x - 7y > 14$

$x - 7y > 14$

$0 - 7y > 14$

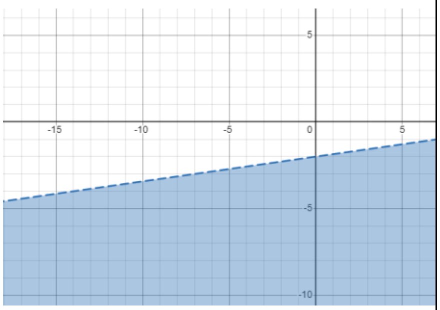
$-7y > 14$

$y > -2$

$x - 7y > 14$

$x - 7(0) > 14$

$x > 14$



Test points: (15, -3)

a. $x - 7y > 14$

$x - 7y > 14$

Most students enjoyed the activity, participated actively, and gave their best efforts. However, a few students were not participating, so it is essential to encourage students to engage fully in the activity. Despite the hot weather, the majority of students had fun during the one-hour activity.

In a corporate game, objectives should be prioritized. Although it is enjoyable, if it does not align with the topic or objectives, it is considered a waste. In this case, the game was well-aligned with the topic and objectives, as students were asked to solve inequalities, form a line, and find test points (proving). The teacher anticipated potential participation issues by ensuring that everyone had a chance to perform, making the game a meaningful learning experience for the students.

Formative assessment used: 1. Think-Pair Share: Collaborative problem-solving 2. Think-Pair Share: Sharing mathematical reasoning with peers 3. Probing questions 4. Exit Tickets	15 - 7(-3) > 14 15 + 21 > 14 36 > 14 (Check) Teacher: "The purpose of test points is to determine whether a certain area/boundary is correct and true." Inequality no. 1: $3x - 2y < 10$ Group 5 was the first one to raise their hand but eventually their line was incorrect. Group 8 steals the chance and was able to line correctly and at the same time able to answer the questions correctly as well. Group 8 earns their 1 check. Questions: 1. What is your line? A broken or solid? 2. Which boundary is the solution set? Inequality no. 2: $x < -5$ Group 2 was the first one to raise their hand. Group 2 was also able to answer follow-up questions. Group 2 earns their 1 check. Questions: 1. What is your line? A broken or solid? 2. Which boundary is the solution set? Inequality no. 3: $y \leq 4/3x - 4$ Group 3 was the first one to raise their hand but eventually they formed a wrong line in the cartesian plane. Group 4 was able to steal the chance and also able to form a correct line and answer the follow-up questions. Group 4 earns their 1 check. Questions: 1. What is your line? A broken or solid? 2. Which boundary is the solution set? Inequality no. 4: $y \geq -3x + 4$ Group 8 was the first one to raise their hand, they were able to form a correct line, and able to answer the follow up questions. Group 8 earns their no. 2 check. Questions: 1. What is your line? A broken or solid? 2. Which boundary is the solution set? Inequality no. 5: $y \geq 7/4x + 2$ Group 2 was the first one to raise their hand but suddenly they formed a line incorrectly. Group 5 steals the chance, they were able to form a line correctly but incorrect of choosing the boundary. Group 6 stole the chance and they were able to perform correctly. Group 6 earns their 1 check. Questions:	

	1. What is your line? A broken or solid? 2. Which boundary is the solution set? Inequality no. 6: $3x - 2y < 10$ Group 2 was the first one to raise their hand but suddenly was able to form the line correctly. *No chance given to other groups since the inequality is repeated. Inequality no. 7: $x < -5$ Group 1 was able to raise their hand first and form a line correctly. They also answer the follow up questions correctly. Group 1 earns their 1 check. Questions: 1. What is your line? A broken or solid? 2. Which boundary is the solution set? Inequality no. 8: $5x - 3y \leq -15$ Group 7 was chosen by the teacher directly to answer since they had no point yet. But, Group 7 was not able to form the line correctly. Teacher chose Group 5 to answer the inequality and they were able to form a line correctly and answer the follow up questions correctly as well. Group 5 earns their 1 check. Questions: 1. What is your line? A broken or solid? 2. Which boundary is the solution set? Inequality no. 9: $y \leq 3/5x - 5$ Group 3 was chosen by the teacher to answer the inequality. Group 3 was able to form a line correctly and able to answer the follow up questions as well. Group 3 earns their 1 check. Questions: 1. What is your line? A broken or solid? 2. Which boundary is the solution set? Final tally: Group 1: 1 check = 50 points Group 2: 1 check = 50 points Group 3: 1 check = 50 points Group 4: 1 check = 50 points Group 5: 1 check = 50 points Group 6: 1 check = 50 points Group 7: Group 8: 2 check = 100 points	

APPENDIX P
RAW OBSERVATION NOTES (SECTION KAPPA)

Practice Teacher : Ma'am Rachelle DATE

Day 1 Observation
February 21, 2024 (Wed)
Grade 8 - Kappa (2 hrs)

- T - teacher , S - student/s

The teacher starts the class by asking the students to pass their assignments.

Formative Assessment 1

T: Diba nagdiscuss na ta about sa systems of linear equations. Unsa man to nga mga methods?

S: . . .

T: Diba naay elimination, substitution.

S: *inserts the teacher, substitution*

T: How about graphing, unsaon gani? If intercept-method, unsay ma zero if x-intercept . . .?

S: y

Formative Assessment 2

Activity : problem solving

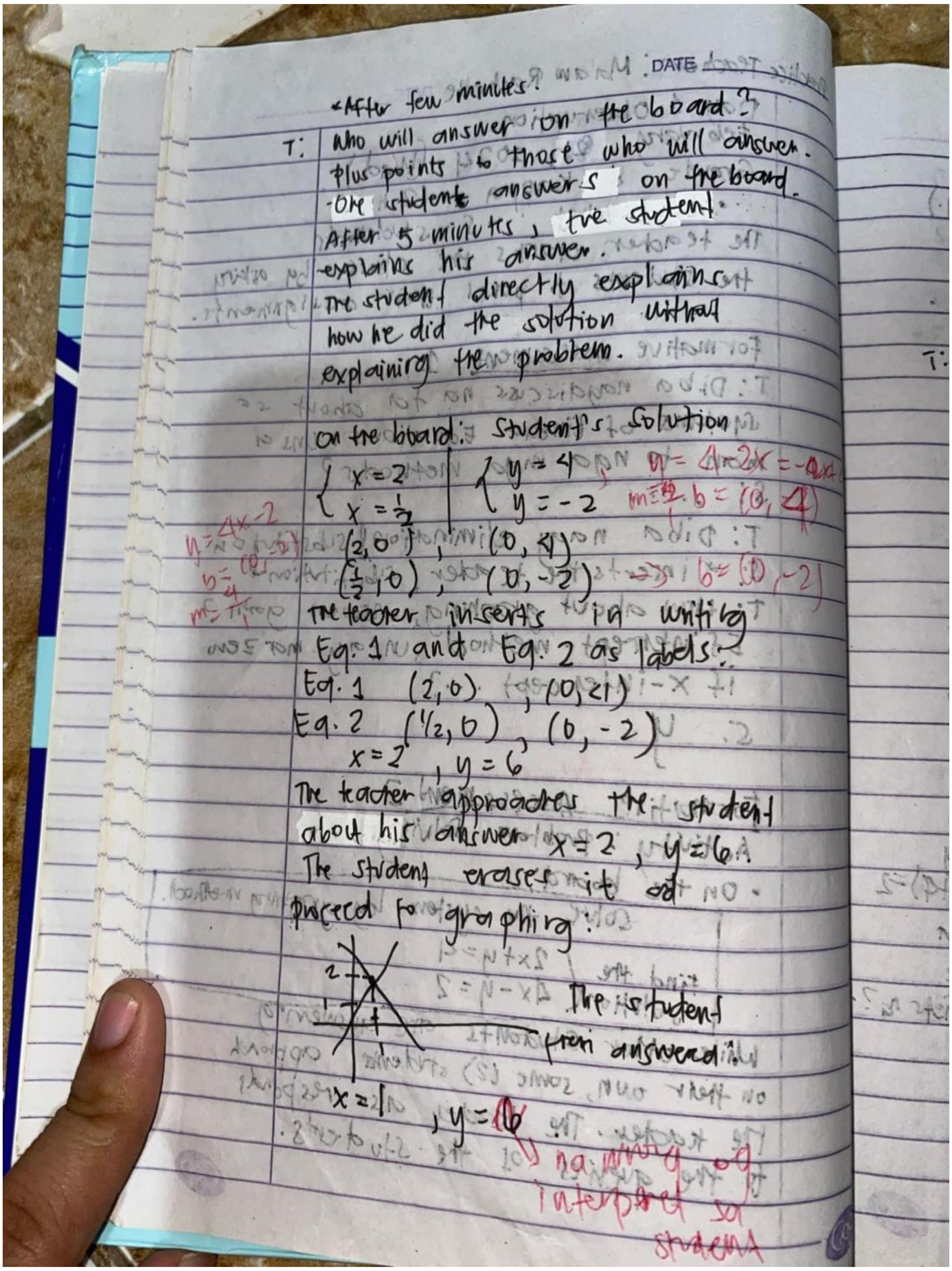
- On the board:

Solve the system by graphing method.

Find the solution
$$\begin{cases} 2x+y=4 \\ 4x-y=2 \end{cases}$$

While other students are answering on their own, some (2) students approach the teacher. The teacher also responds to the queries of the students.

APPENDIX P (Cont'd)
RAW OBSERVATION NOTES (SECTION KAPPA)



After few minutes

T: Who will answer on the board? Plus points to those who will answer.

One student answers on the board.

After 5 minutes, the student explains his answer.

The student directly explains how he did the solution without explaining the problem.

On the board: Student's solution

$\begin{cases} x = 2 \\ x = \frac{1}{2} \end{cases}$ | $\begin{cases} y = 4 \\ y = -2 \end{cases}$

$(2, 0)$, $(0, 4)$

$(\frac{1}{2}, 0)$, $(0, -2)$

The teacher inserts in writing Eq. 1 and Eq. 2 as labels.

Eq. 1 $(2, 0)$, $(0, 4)$

Eq. 2 $(1/2, 0)$, $(0, -2)$

$x = 2$, $y = 6$

The teacher approaches the student about his answer $x = 2$, $y = 6$.

The student erases it and proceed for graphing.

The student then answered.

$x = 1$, $y = 6$

interpret sa student

APPENDIX P (Cont'd)
RAW OBSERVATION NOTES (SECTION KAPPA)

DATE ___________

The t. explained the answer of s.

t: Unsay solution class? First, to get x, we will let y = 0.

$$\therefore\ 2x + 0 = 4$$
$$2x = 4$$
$$x = 2$$

T: From the graph, it satisfies the system of the equation since they intersect. It is the solution to the system: $x = 1$, $y = 2$.

The teacher collects the paper of the students. After collecting,

T: Diba kabalo namo unsay elimination & substitution last meeting?

Assessment

T: Solve these systems of linear equations according to the indicated method.

On the board:

2.) $\begin{cases} x + y = 14 \\ y = x + 2 \end{cases}$ → substitution Method

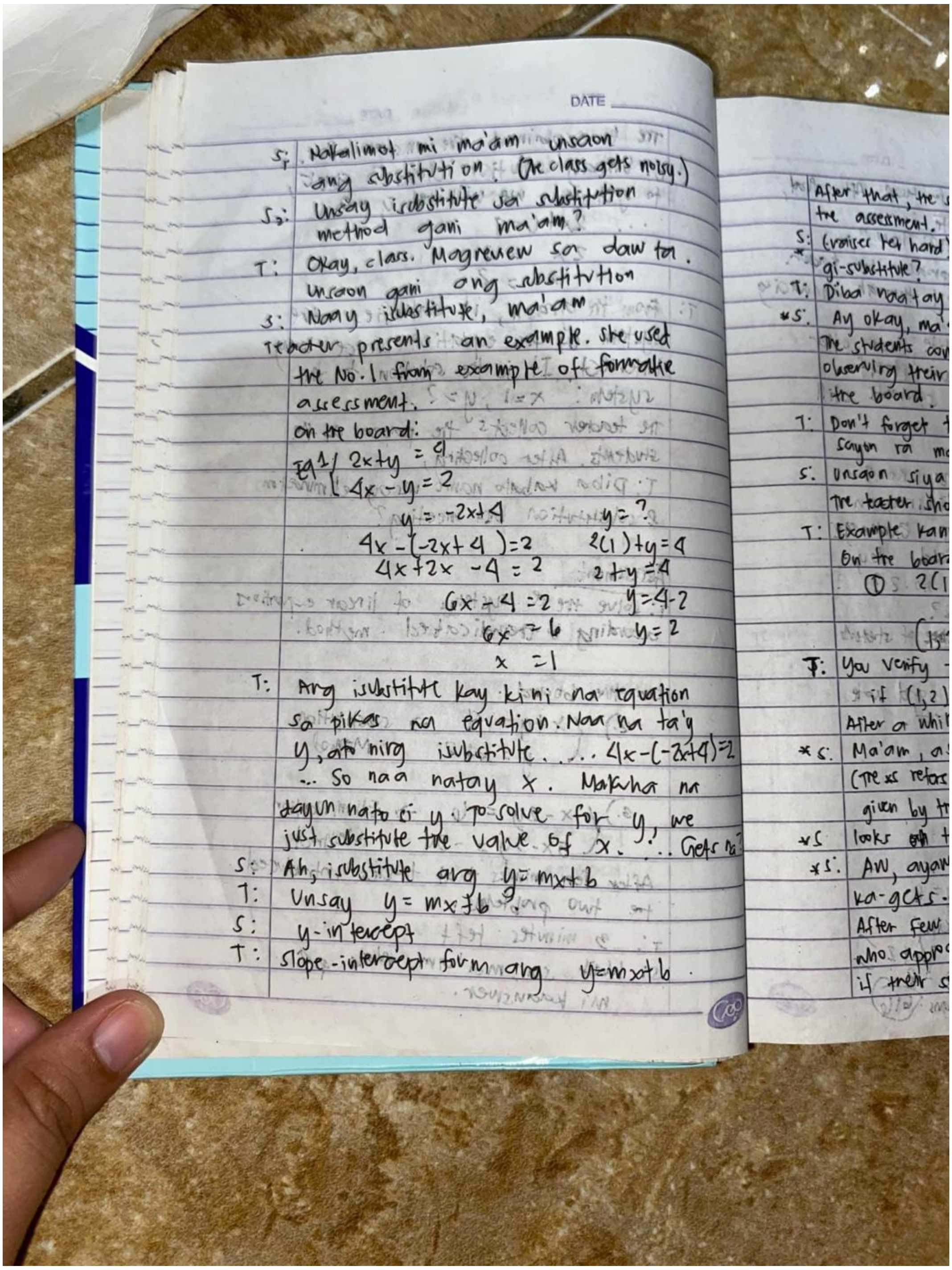
3.) $\begin{cases} x - 2y = -6 \\ 5x - 3y = -30 \end{cases}$ → Elimination Method

After few minutes that teacher introduced the two problems.

T: 3 minutes left

S: Wait sa, ma'am. Wala pa mi kaanswer.

APPENDIX P (Cont'd)
RAW OBSERVATION NOTES (SECTION KAPPA)



DATE

S₁: Nakalimot mi ma'am unsaon ang substitution. (The class gets noisy.)

S₂: Unsay isubstitute sa substitution method gani ma'am?

T: Okay, class. Magreview sa daw ta. Unsaon gani ang substitution

S: Naay isubstitute, ma'am

Teacher presents an example. She used the No. 1 from example of formative assessment.

on the board:

Eq 1/ $\begin{cases} 2x+y=4 \\ 4x-y=2 \end{cases}$

$y=-2x+4 \qquad y=?$

$4x-(-2x+4)=2 \qquad 2(1)+y=4$

$4x+2x-4=2 \qquad 2+y=4$

$6x-4=2 \qquad y=4-2$

$6x=6 \qquad y=2$

$x=1$

T: Ang isubstitute kay kini na equation sa pikas na equation. Naa na ta'y y, ato ning isubstitute. . . . $4x-(-2x+4)=2$ ... So naa natay x. Makuha na dayun nato ni y. To solve for y, we just substitute the value of x. ... Gets na?

S: Ah, isubstitute ang $y=mx+b$

T: Unsay $y=mx+b$?

S: y-intercept

T: slope-intercept form ang $y=mx+b$.

APPENDIX P (Cont'd)
RAW OBSERVATION NOTES (SECTION KAPPA)

DATE ______________

After that, the students continue answering the assessment.

S: (raises her hand) Ma'am unsa among gi-substitute?

T: Diba naa tay equation

*S: Ay okay, ma'am. Kasabot na diay ko.

The students continue answering while observing their teacher's solution on the board.

T: Don't forget to have checking, verification. Sayon ra man.

S: Unsaon siya ma'am?

The teacher shows how to verify.

T: Example kani.

On the board:

① $2(1)+2=4$

$4 \overset{\checkmark}{=} 4$

$(1,2)$ is a solution

T: You verify the two equations to see if $(1,2)$ are solutions.

After a while, *S raises her hand again.

*S: Ma'am, asa ka gikan sa $y=2$?

(The *S refers to the solution on the board given by their teacher about substitution.)

*S looks on the board. She observes it again.

*S: Aw, ayaw na diay ma'am, kabaw pa ko ka-gets.

After few minutes, there are 3-6 students who approached their teacher to confirm if their solutions are correct.

APPENDIX P (Cont'd)
RAW OBSERVATION NOTES (SECTION KAPPA)

DATE

The teacher responds to them. After that, the teacher puts a title in her solution as "SUBSTITUTION". There is one student approaches the teacher. The teacher responds to it through announcing to the class.

T: Class, if magsubstitute, sa other equation na. Dili sa itself.

After a while, many students still approach the teacher.

S: Lisud man pod ning no. 3

S: Nalimot ko sa elimination.

T: Okay, class, Time's up. Exchange your papers. Put corrected by.

T: Who will answer for no. 2?

Okay, How about No. 2?

The selected students are one of students who raised hands. The two students presented and wrote their answers on the board.

On the board:

Student's Answer:

No. 2

$x+y=14$

$y=x+2 \rightarrow y=6+2,\ y=8$

$x+x+2=14$ Checking:

$2x+2=14$ $8=6+2$

$\frac{2x}{2}=\frac{12}{2}$ $8=8$

$x=6$ Teacher assigns: 6/6

Student's explan...

S: To solve for x...

Plug in y so...

Adding these...

We...

Dividing...

Solving for...

$y=6$...

For checking:

$y=$...

The solution...

No. 3 on th...

student's...

(1) $5(x-2y)$...

$5x-3y$...

Teacher assigns: 8/8

For x:

$x-2y$...

$x-2$...

S: using both sid...

and...

We get...

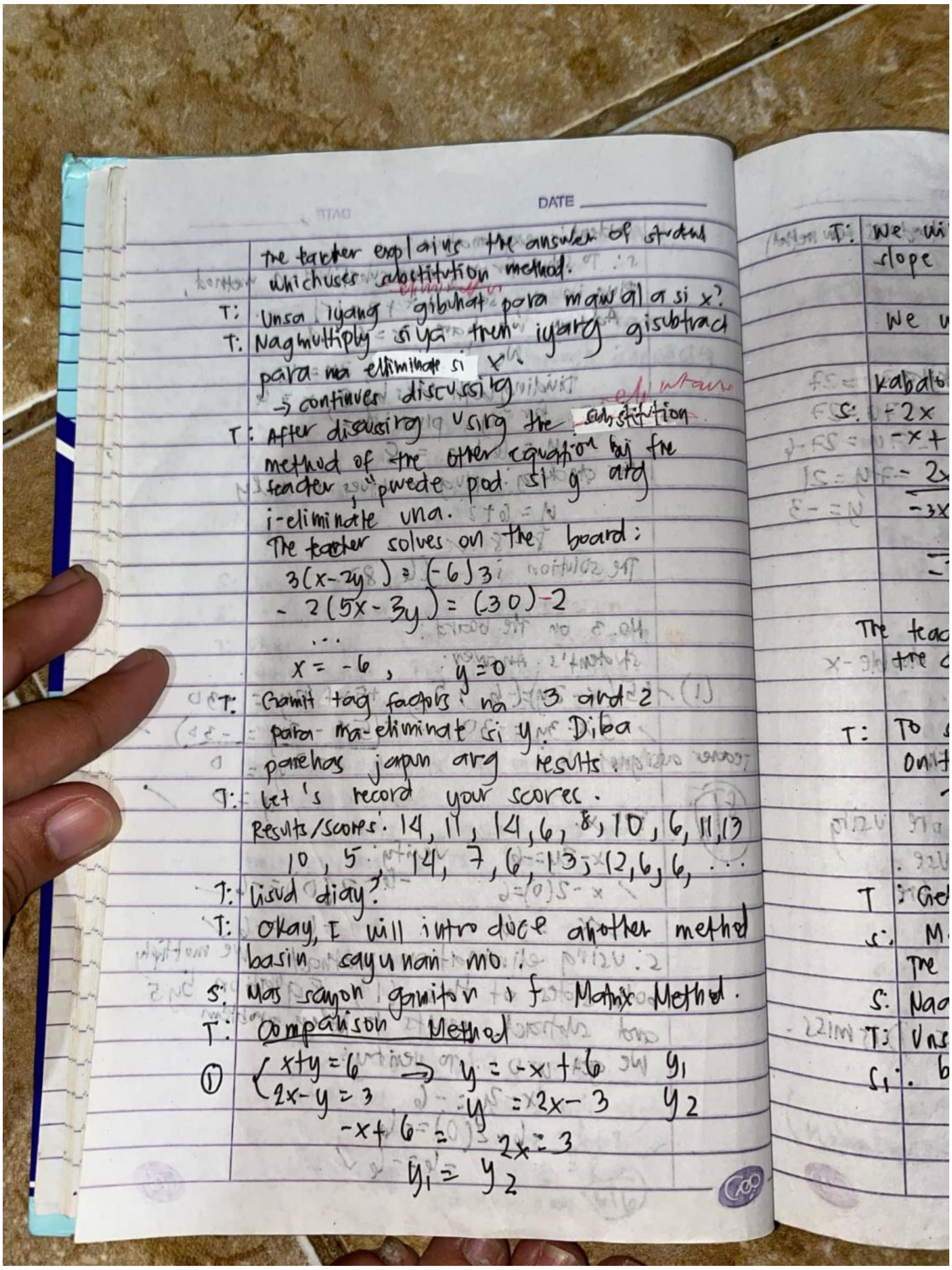
APPENDIX P (Cont'd)
RAW OBSERVATION NOTES (SECTION KAPPA)

DATE ____________

student's explanation:
S: To solve for x, using substitution method,
Plug in y, so $x + x + 2 = 14$
Adding these, so $2x + 2 = 14$
We have now, $2x = 12$
Dividing both sides by 2, $x = 6$
Solving for y, plug in x,
$y = 6 + 2 = 8$
For checking: plug in values of x & y
$y = 6 + 2$
$8 = 8$ ✓
The solution is $(6, 8)$

No. 3 on the board:
student's Answer:
(1) $+5(x - 2y) = (-6)5 \rightarrow +5x - 10y = -30$
$5x - 3y = -30$ $\quad -(5x - 3y = -30)$
$-7y = 0$
$y = 0$
Teacher assigns: 8/8
For x:
$x - 2y = -6$ verify:
$x - 2(0) = 6$ $\quad -6 - 2(0) = -6$
$x = -6$ $\quad -6 = -6$ ✓
S: using elimination method we multiply both sides of this (1) Equation by 5 and subtract results to other problem
We get $y = 0$. To verify:
$x - 2y = -6$
$-6 - 2(0) = -6$
$-6 = -6$ ✓

APPENDIX P (Cont'd)
RAW OBSERVATION NOTES (SECTION KAPPA)



DATE

The teacher explains the answer of student which uses ~~substitution~~ elimination method.

T: Unsa iyang gibuhat para mawala si x?

T: Nagmultiply siya then iyang gisubtract para ma eliminate si x.

→ continues discussing

T: After discussing using the ~~substitution~~ elimination method of the other equation by the teacher, "pwede pod si y ang i-eliminate una.

The teacher solves on the board:

$3(x-2y) = (-6)3$

$-2(5x-3y) = (30)-2$

...

$x = -6, \quad y = 0$

T: Gamit tag factors na 3 and 2 para ma-eliminate si y. Diba parehas japun ang results.

T: Let's record your scores.

Results/Scores: 14, 11, 14, 6, 8, 10, 6, 11, 13, 10, 5, 14, 7, 6, 13, 12, 6, 6, ...

T: Lisud diay?

T: Okay, I will introduce another method basin sayunan mo.

S: Mas sayon gamiton if Matrix Method.

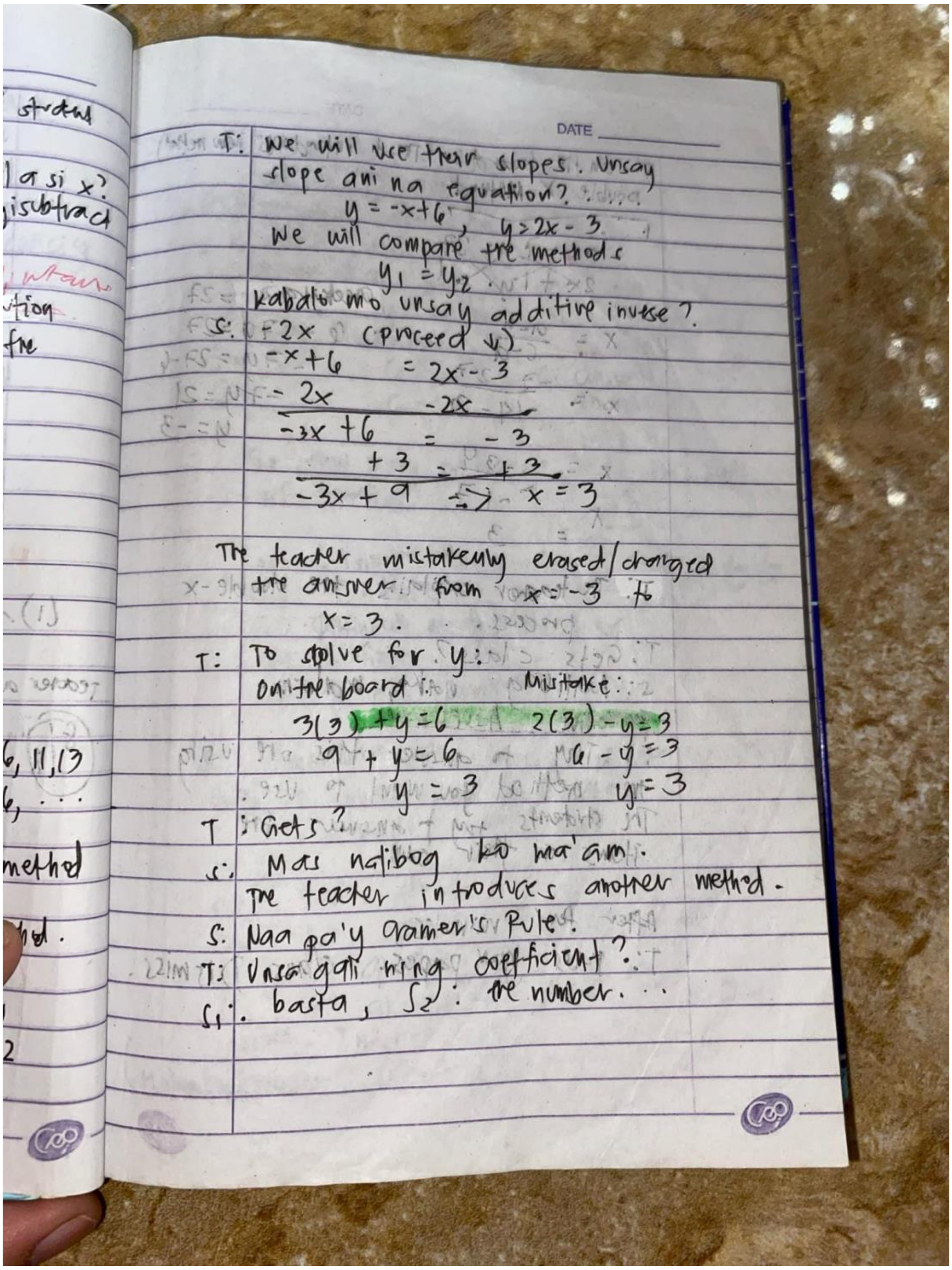
T: Comparison Method

① $\begin{cases} x+y=6 \\ 2x-y=3 \end{cases} \Rightarrow \begin{matrix} y = -x+6 & y_1 \\ y = 2x-3 & y_2 \end{matrix}$

$-x+6 = 2x-3$

$y_1 = y_2$

APPENDIX P (Cont'd)
RAW OBSERVATION NOTES (SECTION KAPPA)



T: We will use their slopes. Unsay slope ani na equation?

$y = -x + 6$, $y = 2x - 3$

We will compare the methods

$y_1 = y_2$.

kabalo mo unsay additive inverse?

S: $-2x$ (proceed ↓)

$-x + 6 = 2x - 3$

$-2x \quad -2x$

$-3x + 6 = -3$

$+3 \quad +3$

$-3x + 9 \rightarrow x = 3$

The teacher mistakenly erased/changed the answer from $x = -3$ to $x = 3$.

T: To solve for y:

On the board: Mistake:

$3(3) + y = 6 \qquad 2(3) - y = 3$

$9 + y = 6 \qquad 6 - y = 3$

$y = 3 \qquad y = 3$

T: Gets?

S: Mas naglibog ko ma'am.

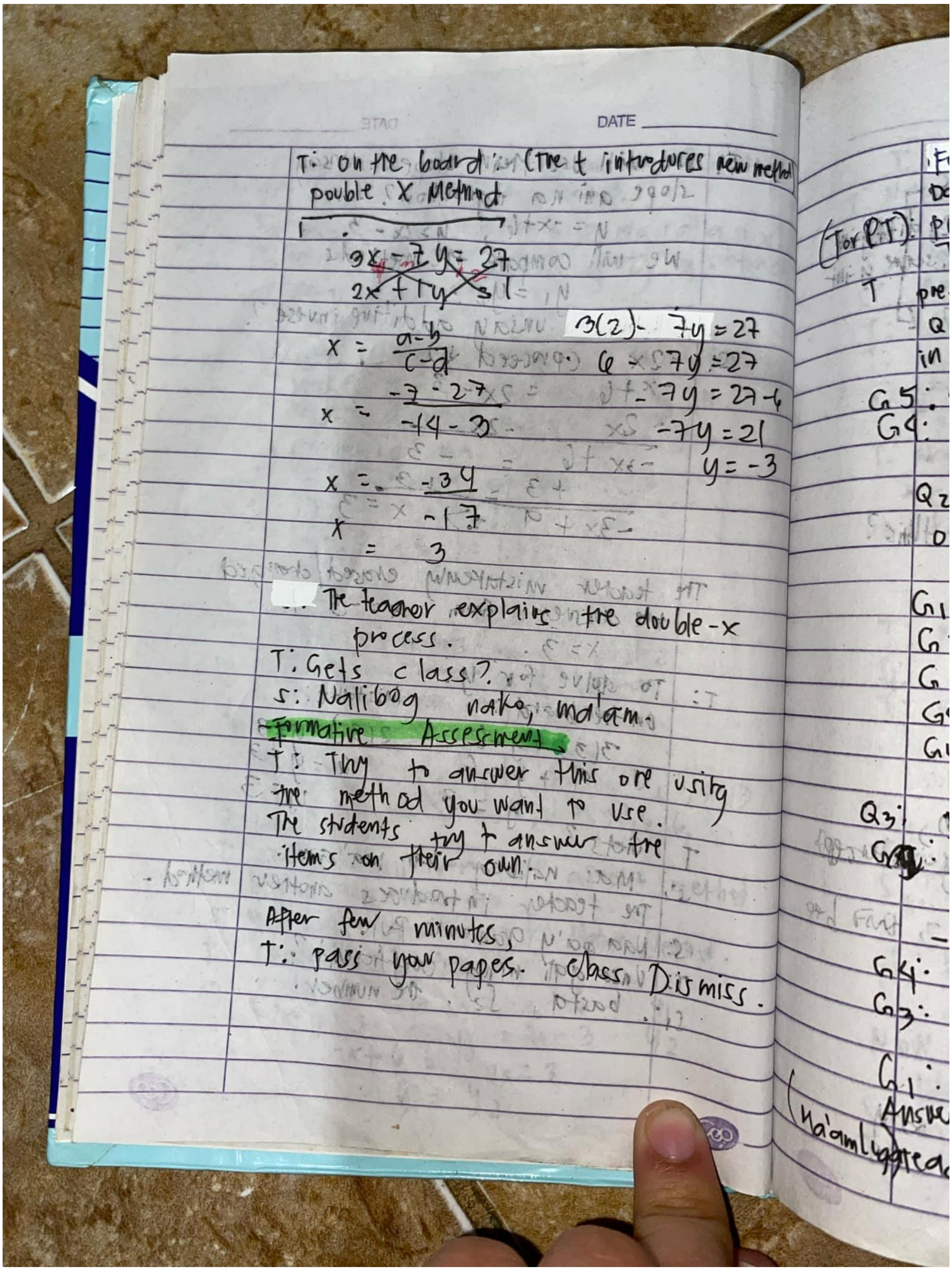
The teacher introduces another method.

S: Naa pa'y Cramer's Rule.

T: Unsa gani ning coefficient?

S_1: basta, S_2: the number...

APPENDIX P (Cont'd)
RAW OBSERVATION NOTES (SECTION KAPPA)



DATE

T: On the board (The t introduces new method)
Double X Method

$3x - 7y = 27$
$2x + 1y = 1$

$x = \frac{a-b}{c-d}$

$x = \frac{-7 - 27}{-14 - 3}$

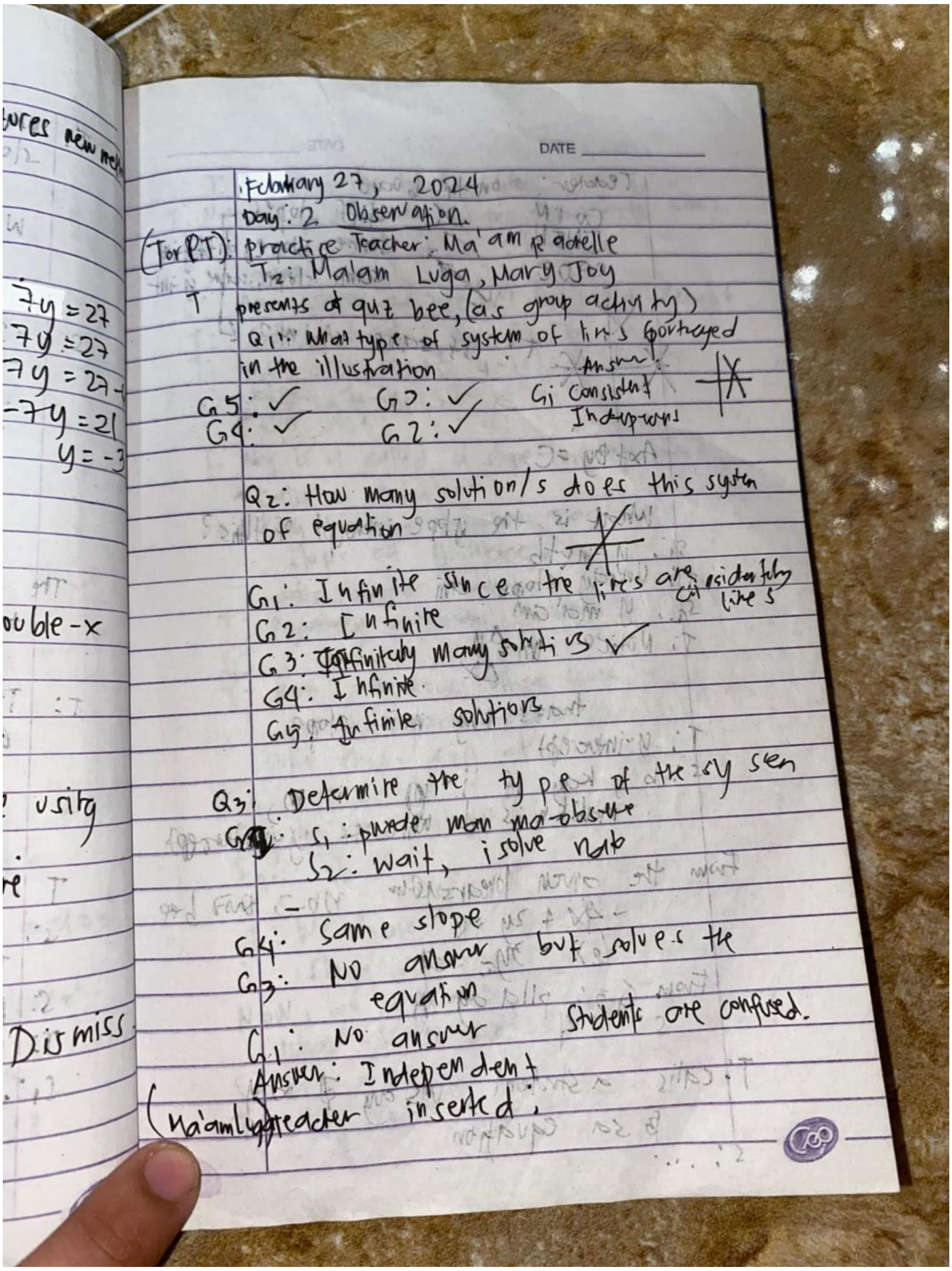
$x = \frac{-34}{-17}$

$x = 3$

$3(2) - 7y = 27$
$6 - 7y = 27$
$-7y = 27 - 6$
$-7y = 21$
$y = -3$

The teacher explains the double-x process.
T: Gets class?
S: Nalibog nako, ma'am.
Formative Assessment
T: Try to answer this one using the method you want to use.
The students try to answer the items on their own.
After few minutes,
T: Pass your papers. Class Dismiss.

APPENDIX P (Cont'd)
RAW OBSERVATION NOTES (SECTION KAPPA)

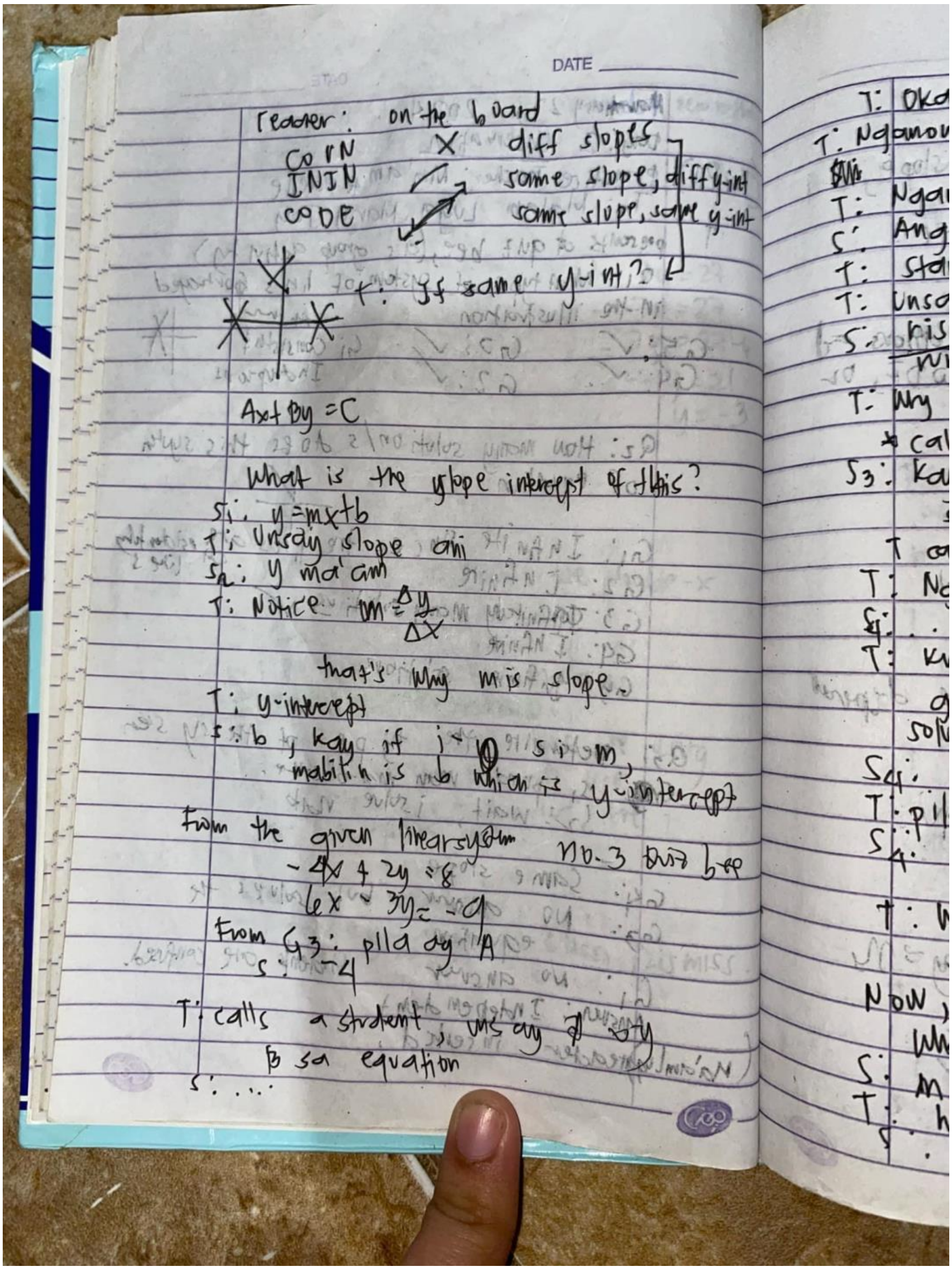


February 27, 2024
Day 2 Observation.
(T or PT): practice Teacher: Ma'am Radelle
T2: Ma'am Luga, Mary Joy
T presents a quiz bee, (as group activity)
Q1: What type of system of lines portrayed in the illustration
G5: ✓ G3: ✓ Answer: Gi Consistent Independent
G4: ✓ G2: ✓

Q2: How many solution/s does this system of equation
G1: Infinite since the lines are coincident lines
G2: Infinite
G3: Infinitely many solutions ✓
G4: Infinite.
G5: Infinite solutions

Q3: Determine the type of the system
G: S1: pwede man ma-observe
S2: wait, i solve nato
— same slope
G4: Same slope
G3: No answer but solves the equation
G1: No answer Students are confused.
Answer: Independent
(Ma'am Luga teacher inserted.)

APPENDIX P (Cont'd)
RAW OBSERVATION NOTES (SECTION KAPPA)


Teacher: on the board
CorN X diff slopes
ININ same slope, diff y-int
CoDE same slope, same y-int
T: If same y-int?

Ax + By = C
What is the slope intercept of this?
S1: y = mx + b
T: Unsay slope ani
S2: y ma'am
T: Notice m = Δy/Δx
that's why m is slope.
T: y-intercept
S: b, kay if i-0 si m, mabilin is b which is y-intercept
From the given linear system no. 3
-4x + 2y = 8
6x - 3y = -9
From G3: pila ay A
S: -4
T: calls a student, unsa ay ... sa equation
S: ...

APPENDIX P (Cont'd)
RAW OBSERVATION NOTES (SECTION KAPPA)

T: Okay, going back. Listen.
T: Nganong gitawag ni og slope-intercept form?
S: $y = mx+b$
T: Ngano?
S: Ang slope gud rise over run, sa y-intercept.
T: Standard form: $Ax + By = C$
T: Unsa ang slope? y-int
S: $\frac{\text{rise}}{\text{run}}$, y-int
T: Why is it called a slope-intercept form?
calls a student
S3: Kay from the equation, naa ang slope og y-intercept
T calls another student.
T: Nganong gitawag y-intercept form?
S: . . .
T: Kung ang registration form kay gamiton para magregister.
solve this: $x+y = 1$
S4: $y = -x+1$
T: pila ang slope?
S4: -1
T: We have an equation of the slope-intercept.
Now, going back.
What is the slope of $-4x+2y = 8$?
S: $m = 2$
T: how about b?
S: 4

APPENDIX P (Cont'd)
RAW OBSERVATION NOTES (SECTION KAPPA)

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APPENDIX P (Cont'd)
RAW OBSERVATION NOTES (SECTION KAPPA)

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APPENDIX P (Cont'd)
RAW OBSERVATION NOTES (SECTION KAPPA)

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APPENDIX P (Cont’d)
RAW OBSERVATION NOTES (SECTION KAPPA)

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APPENDIX P (Cont'd)
RAW OBSERVATION NOTES (SECTION KAPPA)

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APPENDIX P (Cont'd)
RAW OBSERVATION NOTES (SECTION KAPPA)

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APPENDIX P (Cont’d)
RAW OBSERVATION NOTES (SECTION KAPPA)

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APPENDIX P (Cont'd)
RAW OBSERVATION NOTES (SECTION KAPPA)

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APPENDIX P (Cont'd)
RAW OBSERVATION NOTES (SECTION KAPPA)

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RAW OBSERVATION NOTES (SECTION KAPPA)

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RAW OBSERVATION NOTES (SECTION KAPPA)

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RAW OBSERVATION NOTES (SECTION KAPPA)

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APPENDIX P (Cont’d)
RAW OBSERVATION NOTES (SECTION KAPPA)

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RAW OBSERVATION NOTES (SECTION KAPPA)

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RAW OBSERVATION NOTES (SECTION KAPPA)

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RAW OBSERVATION NOTES (SECTION KAPPA)

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APPENDIX P (Cont'd)
RAW OBSERVATION NOTES (SECTION KAPPA)

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APPENDIX Q
ENCODED OBSERVATIONS (SECTION KAPPA)

TEACHER: MA'AM RUSHEL MAY DIOLA (Practice Teacher)
DAY NO: 1 NO. OF HOURS: 2 HOURS DATE: FEBRUARY 21, 2024 (WEDNESDAY)
Topic: Systems of Linear Equations
PT or T as the Pre-service Teacher. Ma'am Luga the **IT** is not present in this session.
Formative Assessment 1: Recalling of the Past Meeting's Discussions through Asking Questions - Here, this F.A. presents that the teacher asks students questions to assess their understanding and retention of past discussions or topics

T: Diba nagdiscuss na ta about sa Systems of Linear Equations. Unsa man to nga mga methods?
S: ….. (no response)
T: Diba naay elimination & substitution..--- S: (inserts the teacher, Substitution*) T: How about ang sa graphing, unsaon gani? Sa intercept-method, unsay ma-zero if x-intercept? S: y ma'am T: Sa pagkuha sa y-intercept, unsay mazero?
S: ang x ma'am

Reflection: The students seem to forget the discussions they had in the past meeting which is about the Methods of Solving Systems of Linear Equations. In the first question where students don't have a response, it seems that the teacher must provide another way of asking the students so that the students can be able to recall their past discussions. Then, the teacher's way of stating the other methods helps students recall the methods.

- **The red highlighted statements are another level type of question being used by the teacher-almost another level. It can be a form of probing question. (Formative Assessment 2)** A probing Question is a formative assessment type also that in this case would be a question that prompts students to recall concepts discussed like asking about methods for solving Systems of Linear Equations. The teacher is trying to delve into students' understanding using prompt recall questions–this does not only assess their understanding but this one also triggers critical thinking which shows the effectiveness of this type of probing question being used.

Critical Thinking: Sighting in the indicator: analysis, the teacher's probing questions trigger students to analyze the methods for solving Systems of Linear Equations. By asking about different strategies in solving S.L.E. and requiring students to recall specific details, the teacher is effective to initially stimulating (since this is just the beginning of the class discussion) critical thinking.

- For example, when the teacher asks about the methods of solving linear equations, the student's response of "ang x ma'am" for determining the y-intercept through the x-intercept method demonstrates analysis as they can identify the relationship between x and y coordinates in the linear equations. This shows the student's ability to analyze and apply concepts to solve problems effectively (when they are given problems).

Insights: The teacher's approach demonstrates an effort to assess student understanding through questioning. However, as we can observe in the student's responses, the students or some students are required to have additional approaches from the teacher so that they can be able to understand (and not forget the discussions) the topic. The teacher could consider reviewing the concepts before proceeding to new topics or maybe have interactive activities. The teacher can also give activities that can help her students practice what they have understood. In that way, it could support student learning, especially retention.

Continuation of the discussion

Formative Assessment 3: Quick Quiz through Problem Solving Activity

- This F.A. is a type where the teacher administers a quick quiz through a problem-solving activity. In this case, students are tasked with solving a system of linear equations using the graphing method within a limited time frame.

T: Okay, let's have a quiz.

- On the board:

Solve the system by graphing method.
Find the solution:
2x+y=4
4x-y=2
While other students are answering on their own, **some students approach the teacher**. The teacher also responds to the queries of the students.
After few minutes:
T: Who will answer on the board? Plus points sa mo-answer.

- S1 answers on the board. After 5 minutes, the student explains his answer: On the

board:

2x+y=4 2x+0=4 2x/2 =4/2 x=2	2(0)+y=4 y=4

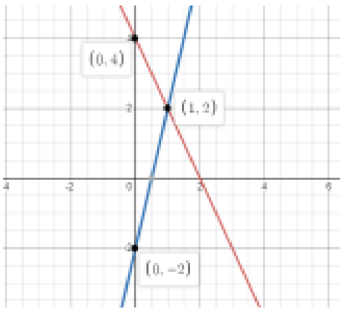
4x-y=2 4x-(0)=2 4x/4=2/4 x=1/2	4(0)-y=2 y=-2

The student has included a separate part on the board for this:

x=2 x=½ (2,0) (½, 0)	y=4 y=-2 (0,4) Eq 1 (0,-2) Eq 2

Take note that the teacher is the one who puts "Eq. 1" and "Eq. 2" as labels.
Then the student answers:
x=2, y=6
The student has an incorrect answer but has the correct solution. The teacher approaches the student about his answer x=2, y=5. The student then erases it and proceeds to graphing.
This is how the graph looks like when the student graph the solution on the board. It does not include the labelling of the points but the student was able to mark the points–the intercepts and the intersection of the line which is the solution to the system.
S1 coninuaton of the solution and graphing:

2x+y=4 y= -2x+4 m= -2/1 b=4 (0,4)	4x-y=2 y=4x-2 m=4/1 b= -2 (0,-2)



S1's answer: x=1, y=2
S1: Nagkuha kog x-intercept and y-intercept. I let x as 0 to get y-intercept. Nag let y=0 pod ko para makuha ang x=intercept on both equations. Mao dayun ni ang mga intercepts and the solution is x=1, y=2.
The student does not include the explanation as to how he got the solution x=1 and y=2. Then, the teacher explains the answer of S1.
T: Unsay solution class? First, to get x, we will let y=0. Same pod, to get y, we let x=0. (The teacher explains the process on what is written on the board by the student's answer about getting the intercepts)
Continuation*
T: Then, we have to get the slopes and the y-intercepts to graph the equations. Naa tay y=mx+b. Sa first equation ang atung slope is -2/1, ang intercept is (0,4). Iplot ang intercept then mag rise/run dayun. Sa kani (referring to the (0,4) point), mag rise/run ta og -2/1. Paubos ang -2 and pa-right and 1. Mao na dayun ni (referring to the (1,2) point.
Sa 2nd equation, ang slope is 4/1 and ang intercept is (0,-2). Iplot napod nato ni.. Ang rise over run is positive. From the point, magcount ta 4 pataas and 1 to the right. Niarrive ta ani na point. (Take note that the teacher refers to the graph of the student)
So sa kani na graph (referring to S1's graph), kani na point diri nag satisfy (x=1, y=2) ang system of the equation since they (the lines) intersect. It is the solution to the system.
The class is noisy or it seems that the students are not paying attention that much. The

teacher then collects the paper from the students.

Reflections: When the students are still answering, I observed that there were some students who approached their teacher and it seems like these students (Or I can say that these are not only students that)-have forgotten the process on how to solve that given system of linear equation.

- When the teacher explains to the class the solution of S1, some students don't pay attention to their teacher. I think the practice teacher must increase the volume of her voice since her voice is covered by the noise of her class. The class may seemed to have just enough of voice but the voice of ma'am Rushel tend to be in low tone that can be covered easily by the noise of her class.
- I think it is necessary also that when discussing the previous topics just like what the teacher did on the S1's solution, as a teacher, we must make sure that the students are engaged in that discussion so that the students can be able to grasp what is the teacher trying to clarify or to teach them again. What happened when the teacher explained the answer of S1, she went straight in explaining the student's answer without processing the students as to how the answer came out. Maybe she can ask questions at the middle or anytime of that discussion to see if students are actively listening.The discussion must be to help students understand well the concepts and process. If the teacher will include, asking of questions during her discussion of the S1's answer, maybe this can enhance the effectiveness of the strategy as well as on the students' learning. I call this **FORMATIVE ASSESSMENT 4: FEEDBACK or Explaining and Clarifying the Answer of the Student.** This FA occurs after the student presents his answer or solution, it might be on the board or a group activity or just a student explaining his/her answer on their seats when asked by the teacher to answer her question.

Insights: It is necessary to embody or to have knowledge about the observed lesson. As a BSEd Math college student, I must always study and visit the topics that I have learned and studied in the past since I will be using my knowledge or the content that I studied from elementary to college will be helpful as I teach math in the future. I realized that it is necessary to be able to teach to the students all the necessary details and that I should be careful when I teach each concept because what I teach to my students will be carried by them for the rest of their academic life (or maybe for the rest of their lives).

- The teacher can give collaborative problem-solving so that students can discuss their thoughts on answering the problem. This can also help the students be engaged in the lesson since some students didn't actively listen to their teacher. I suggest that there may be room for enhancing student engagement and participation in future lessons.

Critical Thinking:
Analysis: The teacher presents a real-world problem that requires students to solve a system of linear equations using the graphing method. In this way, this triggers students to analyze the given problem and apply concepts to find a solution including finding the intercepts and the slopes. The student explains the solution process, including identifying intercepts. S1's way in identifying intercepts and solving the equations contribute to the process of graphing and finding the solution graphically. Therefore, while the student did not explicitly explain the graph, their engagement in the problem solving process still shows critical thinking skills in analyzing the problem.
Evaluation: When the teacher intervened to the student's answer in point (1,2) prompts students to evaluate the correctness of their solutions. By providing corrective feedback and explaining the solution process, the teacher helps students assess the accuracy of S1's answer.
Insight: In the red highlighted part, I think the teacher has a big role on explaining well why they came up with that (1,2) solution. She can ask questions during her discussion of S1's answer.
CONTINUATION
After collecting the papers,
T: Diba kabalo namo unsay elimination and substitution methods? Gidiscuss man ni nato last meeting. Magquiz napod ta.

(2) Formative Assessment 3: Quick Quiz through Problem-Solving Activity - This F.A. is a type where the teacher administers a quick quiz through a problem-solving activity. In this case, students are tasked with solving a system of linear equations using the graphing method within a limited time frame.

T: Solve the systems of linear equations according to the indicated method.
On the board:
2.) Substitution Method

$$\boxed{\begin{aligned} &x+y=14 \\ &y=x+2 \end{aligned}}$$

3.) Elimination Method

$$\boxed{\begin{aligned} &x-2y= -6 \\ &5x-3y= -30 \end{aligned}}$$

The teacher reiterates the instruction. Few minutes later:
T: 3 minutes left.
S2: Wait sa, ma'am. Wala pa mi ka-answer.
S3: Nakalimot mi ma'am unsaon ang substitution. (The class gets noisy again). S4: Unsay i-substitute sa substitution method gani ma'am?
The teacher now realizes that the students can't recall their previous discussion. T:

Okay, class. Magreview sa daw ta. Unsaon gani ang substitution?
S5: Naay isubstitute, ma'am.
The teacher presents an example. She uses the no. 1 problem earlier.
On the board, she writes:

$2x+y=4$
$4x-y=2$
$y= -2x+4$
$4x-(-2x+4)=2$
$4x+2x-4=2$
$6x-4=2$
$6x=6$
$x=1$

T: Ang i-substitute kay kini na equation sa pikas na equation. Naa na tay y= -2x+4, ato ning i substitute… 4x-(-2x+4)=2…(continues the explanation) so naa na tay x.
Makuha na dayun nato si y.

$2(1)+y=4$
$2+y=4$
$y=4-2$
$y=2$

We will substitute what we have in our x. To solve for y, we just substitute the value of x…(explanation)..Gets na?
S6: Ahh, i-substitute ang y=mx+b.
T: Unsay y=mx+b?
S: y-intercept
T: Slope-intercept form ang y=mx+b
Reflection: The student got misconceptions about the slope-intercept form and y-intercept form. Slope intercept form is the y=mx+b from the standard form Ax+By=C of a line. While we can just find the y-intercept by looking at the equation that is, b from the slope-intercept form. I think the teacher can use this opportunity to correct the student's misconception and recall about the slope-intercept and the y intercept.
After that, the students continue answering the assessment.
S4: (S4 is the S4 awhile ago who asked question, raises her hand) Ma'am unsa imong gi-substitute? T: Diba naa tay equation.
S4: Ay okay ma'am. Kasabot na diay ko.
The students continue answering. Some students are answering while observing their teacher's solution on the board.
T: Don't forget to have checking, verification. Sayon ra man.
S: Unsaon siya ma'am?
T: Example kini:
On the board:

$2x+y=4$
$2(1)+2=4$
$4=4$
(1,2) is a solution.

T: In-anion pag verify para macheck ninyo kung sakto inyong na-solve na solutions. You verify the two equations to see if (1,2) are solutions.
After awhile, S4 raises her hand again.
S4: Ma'am, asa ka gikan sa y=2?
(S4 refers to the solution on the board given by their teacher about substitution.) S4: (* looks on the board. She observes the teacher's solution on the board again. S4: (realizes something) Aw, ayaw na diay ma'am, karon pa ko ka-gets.
After few minutes, there are 5-8 students who approached the practice teacher to confirm if their solutions are correct.
The PT responds to them. After that, the teacher writes a title "SUBSTITUTION" as label in her guide solution or her example on how to do substitution.
PT or T: Class, if magsubstitute, sa other equation na. Dili sa itself.
(After a while, many students still approach the teacher.)

S7: Lisud man pod ning no.3
S8: Nalimot ko sa elimination.
Reflection: The students have many questions about the two methods: substitution and elimination. The students are obviously don't know or still in the learning process about the two methods. They were not able to practice well the two strategies in solving systems of linear equations.
Insights: In my observation, it would be best if the teacher will try to re-discuss the two methods substitution and elimination. Also, I realized that it is necessary to aask questions or use probing questions when discussing so that the students can enhance their critical thinking skills upon understanding the process of solving. Using the questions can help students analyze the meaning behind each process. And so that the students can be able to reinforce the lessons they had. In this way, the students will be able to recall the lesson (and not totally forget the lesson). The teacher can also provide practice problems to students at home. I think that it is crucial to be intact and consistent when you try to use strategies to see the effectiveness of certain strategies. For example, in the beginning, the teacher was able to ask questions and even a probe question-so she could also use this one as she go on on her class.
T: Okay, class. Time's up. Exchange your papers. Put corrected by. Who will answer for no.2? (PT selects student to answer for no. 2 and no. 3) Okay. How about number 3?
The two students presented and wrote their answers on the board.
On the board:
Student's Answer: (No. 2)

x+y=14 y=x+2 x+x+2=14 2x+2=14 2x=14-2 2x=12 2x/2=12/2 x=6 y=6+2 y=8 Checking: 8=6+2 8=8 Teacher assigns point for this item with 6 points/6 points.

Student's Explanation: To solve for x, using substitution method, plug in y, so x+x+2=14…(continues) Adding those, so 2x+2=14
We have now, 2x=12
Dividing both sides by 2, x=6
Solving for y, plug in x:
y=6+2=8
For checking, plug in values of x and y
y=6+2
8=8
The solution is (6,8).
3.) Student's Answer

x-2y= -6 5x-3y= -30 5(x-2y)= (-6)5 5x-10y= -30 5x-10y= -30

-(5x-3y= -30) —-------------- -7y=0 y=0 For x: x-2y= -6 x-2(0)= -6 x= -6 Checking: x-2y= -6 -6-2(0)= -6 -6 = -6 5x-3y= -30 5(-6)-3(0)= -30 -30 = -30

Student's Explanation: Using elimination method, we multiply both sides of this (reffering to x-2y= - 6) by 5 and subtract results to other problem. We get y=0. Solving for x, kay amo lang gi-substitute si y na value na among nakuha. Ang result is x= -6.
To verify, gi-substititute namo ang value ni x and y.
x-2y = -6
-6-2(0) = -6
Ang mabilin kay -6, sakto ang solution.
(2) FORMATIVE ASSESSMENT 4: FEEDBACK or Explaining and Clarifying the Answer of the Student.
This FA occurs after the student presents his answer or solution, it might be on the board or a group activity or just a student explaining his/her answer on their seats when asked by the teacher to answer her question.
After each student's explanation, the teacher then explains and clarifies the process of solving in the item that uses elimination method.
T: Unsa iyang gibuhat diri (refers to the no.3) para mawala si x?
T: Nagmultiply siya then iyang gi-subtract para ma-eliminate si x. Nagmultiply siya og 5 sa equation. T: Pwede pod si y and i-eliminate una. For example, mag multiply ta og pila para mawala si y? since - 2y man ang naa sa first equation and ang sa second is -3y. Unsay imultiply para mawala si y? T: 3(x-2y)= (-6)3
-2(5x-3y) = (-30)-2
Imultiply na dayun nato sila:
3x-6y = -18
-10x+6y= 60
Pag i-add na nato sila, naa na dayun tay
-7x = 42
x= -6
So see, parehas ra japun ang nakuha na x-value and so ganiha, y=0.
T: Naggamit tag factors na 3 and -2 para ma-eliminate si y. Diba parehas japon ang results.
Reflection: The students are not answering the teacher's question upon discussion the elimination method used by the student in answering no. 3 as required. They are not actively listening to their teacher. I realized that it is still better if we try to roam our eyes around when we think that our students are not responding. The FA #4: FEEDBACK or Explaining and Clarifying the Answer of the Student
was okay but the probing question and the other questions are almost opportunities to help students understand the lesson fully and recall their lesson in the previous. It is a waste of time and effort because we know that if the students can't recall or understand the elimination method, then, we must reteach the concept and the process. But if you are already there, I think it is necessary to capture the student's attention so that the students can grasp already the idea of elimination method (or any other topic if it happens). I hope I can look at this are in the future as I teach already.
Insights: Probing question (Formative Assessment 2) was being used as being red-highlighted. However, it loses the chance to stimulate the critical thinking of the students since they were not attentive to their teacher. I think that scene is crucial if only the students were able to interact with their teacher so that the teacher can aso use proper questions to cultivate the student's critical thinking.

- Also, the teacher only explains the no. 3 solution of the student since it was the method that wasn't recalled earlier. The teacher also presents on how the student can eliminate the other variable (instead of x). This just showcases the teacher's willingness to help students understand the elimination method.

Critical thinking:

(1) As can be observed, the process of the students in solving on the board and explaining it is a part of their problem-solving skills. However, this also demonstrates the students' critical thinking. For example, the teacher presents two systems of linear equations and assigns different methods, helping students to analyze how to use the assigned strategy in each item. Then, the students demonstrate how they analyze and approach the given equations as solved by the two students on the board. (2) In the evaluation process, the teacher evaluates students' solution methods and reasoning through providing feedback and explanation to

the answer in elimination method. Students critically evaluate their own solutions and reasoning, ensuring that their arguments are logical and valid. For example, when the students provide verification in their answers.

(Continuation)
T: Let’s record your scores.
Scores (I wasn’t able to record properly all the scores): 14, 11, 14, 6, 8, 10, 6, 11, 13, 10, 5, 14, 7, 6, 13, 12, 6, 6,..
T: Lisud diay?
Reflection: I agree to the teacher’s tone. I can say that the students didn’t perform well on the given assessment. No further questions to be asked. It is clear that the students must practice well on these methods.
Insight: The teacher must provide ways to reinforce the lesson to the students. As I have suggested from my previous reflections, the students can have take home problem sets or exercises, collaborative or group activity, and much better to discuss the two strategies again.
T: Okay, I will introduce another method basin sayunan mo ani.
S (whispers to himself): Mas sayun gamiton if Matrix Method.
Insight: Maybe this student has studied in advance about this. Matrix method is another level or way of solving systems of linear equations. I just learned Matrix Method when I was in 3rd year college. But I was amazed by thatstudent since he knew about the Matrix Method. The student also got the perfect score in the assessment.
I can say at that time that the students maybe have varied learning styles and have varied learning needs. There were students who got perfect scores and students who pass the assessment but there are also students who fail. I think a collaborative activity or other strategies can solve this varied learning needs of the students in this lesson.
T: This is Comparison Method.
(This is how teacher presents the solution)

$$\begin{cases} x+y=6 \\ 2x-y=3 \end{cases} \Rightarrow \begin{array}{ll} y=-x+6 & y_1 \\ y=2x-3 & y_2 \end{array}$$

$$-x+6 = 2x-3$$

$$y_1 = y_2$$

T: Kuhaon sa nato ilang mga y-intercepts. Unsa gani ang y-intercepts ani (referring to the first equation? S: -x+6
T: Kani (referring to the 2nd equation)
S: 2x-3
T: Gamiton nato ang ilang mga y-intercepts and we will compare them. So this is our y1 and we will equate it to y2.

$$\begin{array}{rcl} -x+6 & = & 2x-3 \\ -2x & & -2x \\ \hline -3x+6 & = & -3 \\ +3 & = & +3 \\ \hline -3x+9 & \Rightarrow & x=3 \end{array}$$

T: Kabalo mo unsay additive inverse? Unsay additive inverse ani (referrig to 2x)? S:
uhmmm basta
S2: -2x
T: Okay. Walaon nato ang naa sa pikas equation. Maggamit tag additive inverse. Sa 3, unsay additive inverse?
S3: -3
T: So naa na dayun tay -3x+9. And that, we have x=3. To get the y, substitute lang japun nato ang value ni x.
On the board:
Instead of using the 2x-y +3, the teacher mistakenly uses the equation 3x+y =6. So she corrects her answer in y.
2(3)-y = 3
6-y = 3
y=3
T: Gets?
S: Mas nalibug ko ma’am.
S: Wa ko kasabot.
The teacher introduces another method.
T: Okay, naa pay another method, basin sayunan mo ani.
S: Naa pay Cramer’s Rule (the sae student who said “Mas sayun gamiton if Matrix Method”)
T: Unsa gali nang coefficient?
S: the number….
T: (On the board):
The teacher writes “Double X-Method”
On the board (I copied exactly what is written on the board since I have no time to capture the writings on the board):
<u>Double X Method</u>

T: Gamiton nato ilang coefficients. First, is a-b so -7 - 27. Then c-d. -14-3. So if evaluate nato (solving the value of x), x=3. Para ma-solve ang y, substitute si x (solves it directly), so y= -3. (The teacher only points out the coefficients without actually letting the coefficients which is which, like where did the a, b, c, d came from?)

T: Gets class?

S: Nalibog nako.

S: Wala nako kasabot.

S: Daghana uy.

Then, the teacher conducts **(3) Formative Assessment 3: Quick Quiz through Problem-Solving Activity** through letting the students use any method they want to use - substitution, elimination, comparison, and double X method.

After few minutes:

T: Pass your papers. Class dismissed.

Reflections: Some students did not listen to the teacher anymore. Some listened but they are confused after the teacher introduced the Comparison Method and the Double X Method. I can say that the teacher prepares a lesson plan for this. However, there is no perfect lesson plan. As what I can remember, we were told that all the things you have prepared before your class starts are not absolute. They can change. And to this case, I can see that the teacher prepares well but it turns out different to the plan. The students got bored or even more confused about the two latest methods being taught to them.

Insights: The two methods of solving systems of linear equations were enough to teach the students on how to solve systems of linear equations. Since this lesson was already discussed in the class and it happens that some students were having hard time recalling the lesson as well as in listening to their teacher, I highly suggest that the teacher may reinforce the previously discussed methods-substitution and elimination. I studied the two latest strategies (double x and comparison) as I got home at that time. The student can use them especially the comparison method. They can discover the methods on their own even without the teacher's presentation of that two methods if only the students got to practice well and enhance their skills on the last two strategies. Their critical thinking skills can be used especially the comparison method if only the students get to understand fully the last two strategies.

Critical Thinking: In this last part of the class, it was difficult to grasp the critical thinking skills since there were no interactions involved, only the teacher discussed the two methods then the teacher conducted the formative assessment.

To sum it all up: From the formative assessment done by the teacher which was recalling and asking questions about their previous lesson (Systems of Linear Equations), the students weren't able to answer the question asked by the practice teacher, "What are the strategies used to solve systems of linear equations?". The students forgot the concept but they recognized one strategy which is the use of Slope intercept form. They only realized it when the teacher presented another formative assessment which was to let the students answer the given problem of the system of linear equations. The teacher gave a clue: "What will be the 0 if we have x-intercept? " This part is important. That's why some students have already recalled the process.

I reflected that the students had to be asked properly about the topic of Solving Systems of Linear Equations so that they can be able to recall and dig deeper into their understanding. Some students approached the practice teacher to confirm if their answers were correct.I realized that some students were not paying attention and they just waited for some clues or hints to be given to them. Some students forgot the process and they tried to recall it.

The teacher used these formative assessment types:

Formative Assessment 1: Recalling of the Past Meeting's Discussions through Asking Questions Formative Assessment 2: Probing Questions

Formative Assessment 3: Quick Quiz through Problem-Solving Activity - QUICK QUIZ FORMATIVE

ASSESSMENT 4: FEEDBACK or Explaining and Clarifying the Answer of the Student - FEEDBACK
I can say that these FAs are crucial in the classroom. The teacher can use all of them in a part of the class session. But a teacher cal also use one, two or three of them at a time. The point is that, we can use each of them according to the academic situation or any peak of the discussion and according to the learning needs of the students. In this way, we can cater at most of the learning needs of our students. We just have to be consistent and adaptable to change.
My insights and suggestions:
Maybe the teacher can let students have self-assessment in their notebooks if they have time. (2) Provide a brief review of the key concepts related to solving systems of linear equations, emphasizing different methods and strategies. Ask questions that trigger students to recall and discuss these strategies. I can say that I highly suggest having the “recalling of the topic” session at that time. This can give time for students to master concepts before introducing more advanced strategies. Building a strong understanding of the basics will better prepare them for tackling more complex problem-solving activities. It's clear that the teacher is already reflecting on the effectiveness of the teaching methods and is willing to revisit and discuss concepts just like what she did when conducting assessments for substitution and elimination method. This continuous reflection and adaptability are key elements in creating an effective learning environment. However, the teacher introduces two “complex” methods which confused the students on that said methods since they were not able to practice more the past methods. I say that the teacher can have students to work collaboratively in pairs or small groups. This
is a chance for them where they can learn from each other and share different perspectives on problem solving. Consider conducting group discussions where students explain concepts to their peers. This not only reinforces their understanding but also enhances collaborative skills to develop their style both in dependent and independent learning as well. The teacher provided explanations and feedback. Feedback was attended to some student responses, emphasizing the concepts rather than focusing on correct answers. The teacher was not able to collectively respond to the queries and doubts of the students upon answering the problem.

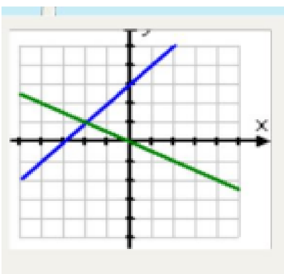
- The teacher is adaptable. It was shown when the teacher was trying to adjust instruction based on formative assessment data. This was evident when introducing new strategies (Comparison Method and Double X Method) after realizing the need for additional support following a quiz. However, it made the students confused about what strategy to use. I realized that they need to enhance their skill with the previous strategies introduced to them before engaging them in new strategies. Thus, I realize that we need to be adaptable to change when something is happening in the class that we are not expecting to happen including when some of your students can’t recall past lessons. That’s why formative assessments are there to be used in obtaining data if your students understand the topic. With the given results from the assessment of using substitution and elimination methods in solving the given linear systems, I must talk to myself or contemplate, what’s the best strategy I need to have so that students can understand the lesson.

Critical Thinking: In my observations, I discovered that students’ critical thinking skills are being triggered or showcased when there are interactions with their teachers especially when they have discussions. The teacher can stimulate their critical thinking when they use different types of oral questions like probing questions. It can be seen or observed clearly.

Total no. of hours working-rewriting, revisiting the concepts and lesson, encoding, analyzing: 3 days = 12 hours

OBSERVED CLASS ASSIGNMENT: GRADE 8-KAPPA
TEACHER: MA’AM RUSHEL MAY DIOLA (Practice Teacher) as **P.T.**
TEACHER: MA’AM MARY JOY LUGA as **I.T.**
DAY NO: 2 NO. OF HOURS: 2 HOURS DATE: FEBRUARY 27, 2024 (WEDNESDAY)

Topic: Systems of Linear Equations
The P.T. presents the quiz bee as a group activity. The five groups of students position themselves at each corner where their bulletin boards are assigned. The quiz bee consisted of 3 stages. After each stage, I will input my mini-reflection.
Stage 1:
Question 1: What type of system of lines portrayed in the illustration? (2 points)



Each group writes each answer on the respective bulletin board.
Group 1: Consistent and Independent
Group 2: Consistent and Independent
Group 3: Consistent and Independent
Group 4: Consistent and Independent
Group 5: Consistent and Independent
Correct Answer: Consistent and Independent
PT: Everybody got correct answers.
Ma’am Luga: Why is it consistent and independent, group 3?
S from G3: Because the lines intersect, ma’am.
Ma’am Luga: Yes, and they intersect at one point.

The teacher called the Group 3. And all other groups became alert. The question asked by the teacher is helpful to recall the concept of consistent and independent lines. (Formative Assessment 1: Recalling of the Past Meeting's Discussions through Asking Questions

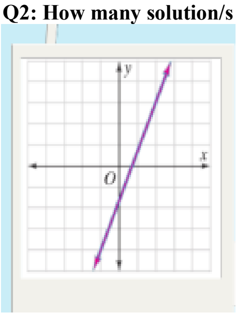
- Here, this F.A. presents that the teacher asks students questions to assess their understanding and retention of past discussions or topics**)**

Reflection: This serves also to strengthen the knowledge of the student about the said concept and a strategy of the teacher in making the students understand the concept.

Insight: The question of the teacher helps students to think again what is consistent and independent. In this way, the students can reinforce their knowledge through recalling. This also stimulates the critical thinking skills of the students. Hence, I can say that the formative assessment used by the teacher can aslo be a **Probing Question (Formative Assessment 2). - In this case, a probing question is a formative assessment type that lets students recall concepts discussed.**

Critical Thinking: The teacher triggers critical thinking by presenting a visual representation of lines and **asking students to identify the type of the system.** The question, "Why is it consistent and independent, group 3?" triggers students to provide reasoning for their answers that encourages them to analyze the characteristics of the lines and when they give answer to teacher - justifies their classification. It requires students to formulate arguments based on their observations and understanding of the concept. "Because the lines intersect, ma'am," shows critical thinking since they relate the observed intersection of lines with the concept of consistent and independent systems. The students have shown an understanding of the concept and the ability to provide reason in their answer.

Q2: How many solution/s does this system of equations have? (2 points)



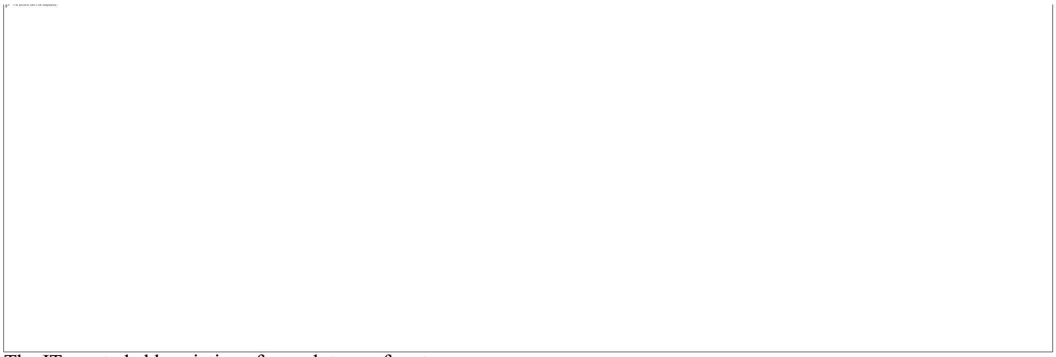
In each bulletin board:
Group 1: Infinite since the lines are coincidental lines
Group 2: Infinite
Group 3: Infinitely many solutions
Group 4: Infinite
Group 5: Infinite Solutions
Correct Answer: Infinitely many solutions
PT: Everybody got correct answers.

Q3: Determine the type of the system: (2 points)

$$\begin{cases} -4x + 2y = 8 \\ 6x - 3y = -9 \end{cases}$$

Group 1: no answer
Group 2: no answer but discusses:
S1: pwede ra man ma-observe
S2: wait, i-solve daw nato
Group 3: no answer but tries to solve the plotted points of intersection
Group 4: same slope
Group 5: Infinite Solutions
PT: No one got the correct answers.
Correct Answer: Inconsistent and Independent

The students are confused about what "type of system" is the question referring to. The type of systems are the consistent (Consistent dependent and inconsistent independent and inconsistent systems) .The students knew these but weren't able to recognize that that was it. **Then I.T., Ma'am Luga, proceeds to discuss the Consistent dependent and inconsistent independent and inconsistent systems**. On the board (It's written like this):



The IT created abbreviations for each type of system.
IT: If the same slope, different y-intercept, unsa gani to?
Students: ININ ma'am (means Inconsistent Independent)
IT: same slope, same y-intercept?
Students: CODE (means Consistent Dependent)
IT: so if different slopes?
Students: COIN (means Consistent Independent)
Insight: Having these kinds of abbreviations in assigning the name of each type of linear system can help the students recall the concepts. This can also apply to any lesson where a teacher can use abbreviations in certain concepts so that students can easily recall those.
One Student: Ahh okay. Mao ra man diay japon, type of system jud lage to..
After that, the teacher proceeds to recall the concept of slope-intercept form that can be written as standard form: from y=mx+b to Ax+By=C.
IT: (writes on the board : Ax+By=C) What is the slope-intercept form of this? S1:

y = mx+b

IT: Very good. This is the standard form of a linear equation (Ax+By=C) while this is the slope-intercept form (writes on the board y = mx+b)
IT: Unsay slope ani (y = mx+b)?
S2: y, ma'am.
(The student is wrong but the IT did not explicitly said he's wrong, IT explains the slope)
IT: Okay, class. Notice that ang slope is it is the change of y over the change of x. That's why it is called slope.
IT: How about the y-intercept?
S3: b, ma'am. If i-zero ang m, ang mabilin is b which is the y-intercept (answers in chorus) I.T.: (IT

writes on the board -4x+2y=8) Diba nakastandard form ni, unsay A ani? S from G3: -4

IT: (calls another student- The IT roams her eyes around and calls student who is not looking on the board) Unsay A og B ani na equation?
S4: …. (no answer)
IT: Okay. Listen, class. Nganong gitawag ni (y = mx+b) og slope-intercept form? S5:
Ang slope garise over run sa y-intercept.
(The IT proceeds in discussing the concept. Take note that she already discussed this before the day 1 observation.)
IT: (Ax+By=C) Unsa ang slope? ang y-intercept?
S: m is the rise over run, and y-intercept is…
(IT calls a student)
IT: Why is this (y=mx+b) called a slope-intercept form?

- **It can be a form of probing question. (Formative Assessment 2)** A probing Question is a formative assessment type also that in this case would be a question that prompts students to recall concepts discussed. In this case, the student will use his/her critical thinking skill as to why is it called a slope-intercept form.

S6: kay from the equation, naa ang slope og y-intercept
IT: Good. (calls another student) Nganong gitawag slope-intercept form?
S7: ……. (no answer)
IT: Kung ang registration form kay gamiton para magregister.. so naay form para mag register..registration form. Nganong gitawag og slope-intercept form?
Class: Kay naa ang slope og ang y-intercept
IT: Okay. Transform this into slope-intercept form: x+y=1. (calls another student who is not looking or listening)
S8: (writes on the board as required by the IT): y=-x+1
IT: What is the slope?
S8: -1
IT: Very good. Kabalo man diay. Now, what is the slope of -4x+2y=8? Class: 2
I.T." How about b? "
Class: 4
I.T.: Why S9?
S9: Because from the equation standard form ma'am, our m is -A/B, so m is 4. I.T:

Very Good.

IT: (writes on the board: 6x-3y= -9) What is the slope and the y-intercept? (calls another student) S10: m is 2 and b=3

IT: Okay. So comparing this two equations (6x-3y= -9 and -4x+2y=8), ININ siya (Inconsistent Independent) kay same slope, different y-intercepts.
Reflection: In that portion, the teacher used:
- **(Formative Assessment 1: Recalling of the Past Meeting's Discussions through Asking Questions**
- **FORMATIVE ASSESSMENT 4: FEEDBACK or Explaining and Clarifying the Answer of the Student.** This FA occurs after the student presents his answer or solution, it might be on the board or a group activity or just a student explaining his/her answer on their seats when asked by the teacher to answer her question.

I honestly say that the teacher's strategy is effective since the class was able to participate and got correct answers when their teacher asked them.
Insight: IT used again the **Recalling Question and Active Feedback** so that students can recall the concept of slope-intercept form. This strengthens their math concept and this is a strategy for the teacher to enhance the mathematical knowledge of students on this topic as well as reasoning since after that she lets the class solve the slope and y-intercept of a given equation and then calls a student to explain his/her answer. This is crucial to build a strong foundation for students about the students. These two formative assessments are fit for that discussion.
Critical Thinking: The focus is on understanding and applying mathematical procedures rather than deducing new information or making assumptions based on existing knowledge. In this case, analysis is highlighted. The teacher's way of creating abbreviations like "ININ" for Inconsistent Independent systems, "CODE" for Consistent Dependent systems, and "COIN" for Consistent Independent systems, triggers critical thinking since students were able to analyze and identify each type of the system and followed the abbreviations.
In here, "If the same slope, different y-intercept, unsa gani to?" prompt students to think about the relationships between slopes and intercepts in linear equations and they were able to recognize that it is ININ. The teacher's use of probing questions "Why is this called a slope-intercept form?" enables students to construct arguments or explanations based on their understanding of the slope-intercept.
Insight: The teacher tried to simplify the concepts using abbreviations and used questions or a probing question. The class had interactive discussions. These are helpful ways that stimulated the critical thinking skills of the students especially on the indicator of Analysis. Evaluation and Inference is not that emphasized in this discussion since there were no proofs shown that there are actions for deducing new information or making assumptions based on existing knowledge - maybe for the difficult round of the quiz bee will enable the two indicators to be showcased by the students.
P.T. proceeds to present the Q4 of the quiz bee.
Q4: Create a system of equations and identify and identify if it is COIN, CODE, or ININ. (3 points)
Group 5: CODE
x+y=7
x+y=7
Group 4: COIN
2x+5y=10
2x+5=12
Group 3: CODE
x+y=2
x+y=2
Group 2: COIN
7x+2y=6
14x+4y=3
Group 1: CODE
2x+4y=8
4x+8y=16
Group 1 solves their equation to verify if they have the same slope then erased their solution. PT:

Everybody got correct answer.

I.T. Class, you can use the formula to find the slope easily.
Other groups: Yes, ma'am.
I.T. Sayun kayo ang gigamit sa ubang groups oh, parehas ra nga equation para CODE diretso. Ang ubang groups kay nagdifferent jud.
Critical Thinking: Analysis, Evaluation, and Inference can be seen. Analysis: Students were able to create system of equations (some portrayed simple system and some tried to have different two equations to form the linear system). By that, students also engage in analyzing the relationships between their equations and the given classifications (COIN, CODE, ININ). In that part where students classify their equations, evaluation and inference are present. Classifying it is also a form of evaluation - students assess the accuracy and validity of their solutions to the given task by reviewing their equations and classifying them based on the proper type of what equation they had created. For inference, when the students classify their equations, they are also making logical deductions based on their analysis of the equations and the given definitions or classification of their equation. That also tells that students are drawing conclusions according to the patterns of their equations.
Insight: I can say that the critical thinking indicators can actually be summed up into the indicator: analysis.
Take note that the abbreviations CODE, COIN, and ININ signifies **Consistent dependent and inconsistent independent and inconsistent systems. This was assigned to them by the IT and PT so that the students can quickly write their answers. This also helps the students recall what these systems are. IT or the teacher requests each group to discuss their answers and she inserts each after the representative's explanation. The teacher emphasized: IT: Basta CODE, unsa?**
Students: same slope, same y-intercept

IT: ININ?
Students: same slope, different y-intercepts
IT: COIN?
Students: different slopes
Then the teacher emphasized in solving the slopes and intercepts.
Stage 2
Q1: What is the slope of the line with points (-3,2) and (5,-3)?

G1: $m = \frac{-3-2}{5-(-3)} = -\frac{5}{8}$

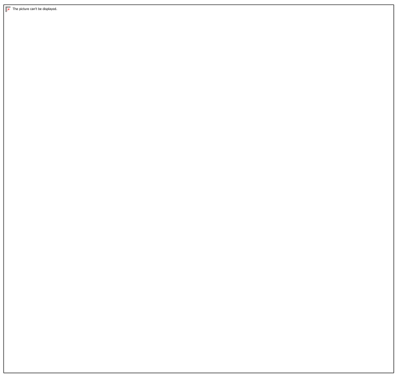
G2: $-\frac{5}{8}$
G3: No answer
G4: $-\frac{5}{8}$
G5: $-\frac{5}{8}$
PT: Group 2 has no answer and the rest of the groups are correct.
IT: Who will volunteer to explain the answer, group 2?
S from G2: para masayun lang namo ma'am kay gibale namo

$$\frac{5-(-3)}{-3-2} = -\frac{8}{5}$$

Maong pagbali, $-\frac{5}{8}$ lang japon amo answer.
IT: Gi run over rise. Class follow, okay. Rise over run.
After further explaining the concept of slope-intercept. IT concluded, that is why ssa Physics pa if rise over run, Vertical displacement over Horizontal displacement.
Insight: I realized that the teacher's strategy of calling certain student from a random group can help students boost their confidence- they must be confident in their answers since they knew already that the teacher calls a random student to explain the answer so that once they are called, they can be able to justify their answers. Hence, I think, this promotes the student's willingness to participate and be responsible when they solve their answers.
Critical Thinking: The practice teacher was able to use a question that can make students analyze the given points to determine the slope of a line. For example, Group 1 applies the slope formula (y2-y1/x2- x1) and manipulate the given coordinates to calculate the slope accurately. It demonstrates their analysis of the data to solve the problem. For the evaluation, the teacher reviews each answer and made judgments about the accuracy of their answer. But for the students, indicator:evaluation is not that evident.
Q2: What is the slope of the line with points (5, -3) and (7, -2)?
On their bulleting boards:
G1: y = - ½ x + -½
G2: No answer
G3: m= -½
y = - ½ x + -9/2
G4: y=½ x -½
G5: No answer.
PT: The correct answer is y = - ½ x + -½
IT: Good job, Group 1. Can you explain how did you get your equation?
S from G1: Among gikuha una ma'am is ang slope katung formula nga (y2-y1/x2-x1). Among m is -½ and then sa pagkuha ni b kay naggamit ra mi sa slope-intercept form and then gigamit namo ang isa ka point like ang (5, -3). Gisubstitute namo since pag i-subsitute kay ang mabilin ra man kay ang b. Giverify pod namo siya sa other point sakto ra man sab. So like y=mx+b, -3= -½ (5) + b, ang result is b= -1/2 . Mao dayun among equation y = - ½ x + -½ .
Insight:

- At first, G1 used the slope formula to get the slope. Then, the students was able to discover that they can get the b through substitution of the x value and y value of either of the given points. - Critical Thinking: The students from Group 1 showcased **critical thinking - analysis** in solving the problem. They correlate information gained from solving the slope using slope formula. Students applied the slope formula to calculate the slope between two given points (5, -3) and (7, -2)/
  - The students able to use the definition (that is making a definition form). Group 1 articulated their equation in slope-intercept form (y = mx + b) and explained their reasoning behind selecting the slope and determining the y-intercept. It is their ability to construct an argument (or logical reasoning) in problem-solving. "Gisubstitute namo since pag i-subsitute kay ang mabilin ra man kay ang b. ", is the explanation of the students when they get the value of b.
  - For evaluation, the teacher stimulated critical thinking by prompting Group 1 to explain their solution process, asking, "Can you explain how did you get your equation?" This prompted the students to evaluate their approach and justify how they got the equation. Group 1 provided an explanation of their solution which includes how they derived the equation, verified it using another point, and ensured its accuracy. G1 had shown their ability to evaluate their own work.

Q3: Write the equation for the line given below in slope-intercept form. (3 points)



G1: ½ x + (-2)
G2: ½ x + (-2)
G3: ½ x -2
G4: 1x+ (-2)
G5: No answer
PT: Group 1, 2, and 3 got the correct answer.
IT: Group 3, i-explain inyong answer.
S from G3: Among gilantaw lang ang graph ma'am. Diretso na siya makakuha sa m since rie over run and sa graph, nag rise og 1, nag run og 2. Tapos ang y-intercept is exactly -2. Amo lang dayun gibutang na sa equation sa y=mx+b.
Critical Thinking: The graph or the visual representation itself and the question of Q3 let students analyze how they can create equation based on the given line (It is obvious as to how the student representative from group 3 explains his answer.)
Insight: An oral question can help students stimulate critical thinking. But also, the questions being flashed in the screen or the type of questions and add-ons like visual representations in any type of assessment (quiz bee or summative exam) can help students trigger their critical thinking. In this case, when the students explain how they got their group's answer showcased collaboration and critical thinking skill. I realized that group activity is helpful for students to navigate their skills in analysis since they can share their ideas and come up with an answer.
(Continuation)
Q4: If the solution (x,y) satisfies given system of equations, what is the value of x? (3 points) 2y-x=0

x=y+7
Each group solves their answer and deletes it after writing their final answer:
G3: x=14
G2: x=14
G1: x=14
G4: x=14
G5: x=14
IT: Explain, Group 4.
S from G4: We used elimination method, ma'am.
From 2y-x =0
-y-x=7. Multiply both sides from this second equation with negative ma'am. Then: 2y-

x=0

y+x=-7
y=-7, so gi-substitute na dayun namo ang value ni y, so x=14.
Teacher: Very Good. Class, you can use any methods okay. Substitution, elimination, slope intercept, and anything, maarrive ra japon mo sa correct answers.
PT: Everyone got correct answers.
Insight: Each group solves the problem in their respective bulletin boards. I wasn't able to record all of their answers. However, the explanation from the representative of Group 4 helps me to confirm that they are able to analyze by their own the process on how to solve the given system of equations. This shozases the students' critical thinking skills in analyzing the problem. The teacher's way of leeting the student or any random student to explain their answer ensures validity and evaluation of the answers of the students. The teacher can evaluate if the students really understand their solution process. At the same time, I was able to confirm my analysis that the students have the skills in answering the problem.
Critical Thinking: Group 4 showed critical thinking by applying the elimination method and through that method, they were able to arrive at the correct value of x. It shows that they have ability to analyze and solve complex mathematical problems through the help of the practice teacher's (presentation of the Q4 problem and the help of IT (Ma'am Luga) to let students explain their answer even if in one group only).
Q5: What is the solution to the given system of equations? (3 points)

$$\begin{cases} x + y = 3 \\ 2x - 3y = -9 \end{cases}$$

G1: (0,3)
G2: x=0
G3: x=0, y=3
G4: (0,3)
G5: x=0, y=3
PT: Everyone got correct answer except group 2.
IT: Naunsa inyoha group 2? Nahutdan mo sa oras?
S from G2: Wala mi nakaconclude ma'am na y=3. We know ma'am that solution will meet the system of equation but we lack of time.
(same insight from Q4)
Q6:
Find the solution and identify the type of system (COIN, CODE, ININ):

$$\begin{cases} x + 6y = 10 \\ x + 5y = 9 \end{cases}$$

G1: (94/11, 1/11)
G2: y=1, x=4 COIN
G3:x=4, y=1 COIN
G4: x=4, y=1 COIN
G5: y=1, x=4 (G5 used elimination method)
PT: Everyone got correct answers.
Insight: This does not guarantee the critical thinking process since the IT did not ask students to explain one's answer but I observed that all groups at that time were able to have solutions before they arrive at their answers. I observed also that the teacher was aiming for enough time they can have since they will proceed already to Stage 3 which is the complex part.
Stage 3:
Q1: A farmer has a total of 10 chickens and pigs on his farm. The total number of legs among all the animals is 28. If chickens have 2 legs and pigs have 4 legs, how many chickens and pigs does the farmer have? (5 points)
IT: Okay, since the group 1 has no answer. I will guide you group 1. Okay, you write and let: Let

c=number of chickens and p=number of pigs.

Group 1 writes on their bulletin board
IT: How will you make an equation if the total number of all animals is 10 given that pigs and chickens are the only animals on the farmer's farm using those variables?
Group 1 representative writes: c+p=10
IT: So how about the total number of legs and given that chickens have 2 legs and pigs have 4 legs? The group

seems to get the idea already that is why, they continue to answer and solve: Group 1 representative quickly

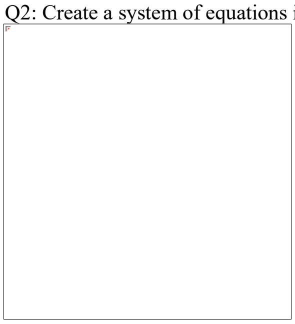
writes: 2c+4p=28

IT: Then solve the system.
Group 1 explanation and solution: Using elimination, multiply both sides of the first equation by -2, and:
-2c-2p= -20
2c+4p=28
Adding them, we'll have 2p=8
So, p = 4, and substitute value of p,
c+4=10, then c=6.
The farmer has 4 pigs and 6 chickens.
IT: Yes, very good. Class, don't panic when you first read the problem. Understand first. So what group got correct answer? PT: Group 5, Group 4, Group 3 and Group 2 got correct answers.
IT: I see that other groups got correct answers and their solutions were deleted. But I saw that one group tried to use random numbers and verify using the total numbers given in the problem. That's good. We can practice using systems of linear equations.
Inisghts: The IT (Ma'am Luga) was able to encourage her students through recognizing each answer. This is a good action because it lets students to take ownership on what they solve. Also, when the teacher lets the representative from group 1 to solve again the problem by guiding them is a good strategy to let students understand the process of solving the word problem. This is actually a part of **FORMATIVE ASSESSMENT 4: FEEDBACK or Explaining and Clarifying the Answer of the Student in another context. This FA occurs after the student presents his answer or solution, it might be on the board or a group activity or just a student explaining his/her answer on their seats when asked by the teacher to answer her question. But in this case, it does not only let students explain his answer but also, the teacher guided first the student in solving the problem so that they can understand on how to arrive the correct answer before IT lets thestudent explain the solution. This is a good**

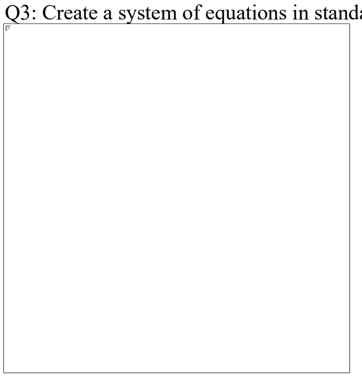
tactic since it lets student to revisiti what he has solved and to be able to reinforce his understanding.

- The teacher initiated an analysis by prompting Group 1 to formulate equations about the total number of animals and legs on the farm.
  IT: "How will you make an equation if the total number of all animals is 10 given that pigs and chickens are the only animals on the farmer's farm using those variables?" This prompt encouraged students to analyze the problem and construct equations. The teacher facilitated critical thinking by guiding the students through the problem-solving steps:
- IT: "So how about the total number of legs and given that chickens have 2 legs and pigs have 4 legs?" This specific question prompted students to correlate the information provided and construct equations that represented the problem.
- Then, the teacher encouraged evaluation by acknowledging different problem-solving approaches: IT: "I saw that one group tried to use random numbers and verify using the total numbers given in the problem. That's good." This recognition highlighted the importance of evaluating various problem-solving strategies. The students showcased critical thinking skills by analyzing the problem- some students use random numbers, and some use strategies such as elimination. Group 1 explanation and solution: "Using elimination, multiply both sides of the first equation by -2, and: -2c-2p= -20. 2c+4p=28. Adding them, we'll have 2p=8. So, p = 4, and substitute value of p, c+4=10, then c=6." These lines demonstrate how the students applied critical thinking skills to solve the problem. The teacher's guidance nurtured and triggered critical thinking skills among the students.

(Continuation)
Q2: Create a system of equations in standard form illustrated in the graph. (5 pts)



G1: y= x+5
G2: 2x+y = -4x
G3: m=2, b=4
G4: x+y=5, -2x+y= -4
G5: x+y = 2
PT: Group 4 only got the correct answer.
IT: Class, pwede ra man ninyo lantawon ang graph. Unsay rise over run?
Class: 2/1 ma'am.
IT: Oh. Dayun substitute lang dayun ang values sa isa ka point kanang intersection nila, unsa man, (3,2), use y=mx+b. Parehas sa gibuhat kaganiha sa isa ka group diba. Same ra man ang question, istandard form lang. Proceed.
Q3: Create a system of equations in standard form illustrated in the graph.



G1: y= -4x
G2: -2x+y=6, -2x+y= -4
G3: -2x+y=6, -2x+y = -4
G4: -2x+y = -4, -2x+y=6
G5: -2x+y=6, -2x+y= -4
PT: Everyone got correct answer except group 1. Let us tally all your scores.
G1:48 points
G2: 46 points
G3: 49 points
G4: 50 points
G5: 47points
PT: Congratulations, class! Group 4 got 50 points, Group 5 got 47 points, Group 1 got 48 points, Group 2 got 46 points and Group 3 got 49 points. Class, always remember the Mr. Slope I introduced to you last week so that you will not

forget CODE, ININ, and COIN. Prepare for your long quiz, tomorrow. Congratulations to everyone! Class, dismissed. The teacher encourages group 1 to understand the problem. It turns out that Group 1 understood the problem but they just lack focus and time to fully comprehend the problem. The teacher recognized each group's weaknesses and strengths. I think that is the teacher's strategy to humanize Mathematics. Going back from the Math education strategy of the teacher, the teacher really emphasized the use of proper asking of questions and giving feedback so that students can fully understand the concepts and the process and to apply reasoning in their understanding of the systems of linear equations. The teacher recalls all the necessary concepts every after each presentation of answer and questions of the students from the quiz bee. The practice teacher also prepares a set of good questions that can build up the knowledge of the students from remembering, understanding to supplying and application. See questions from the quiz bee,

Stage 1

Q1: What type of system of lines portrayed in the illustration?

Q2: How many solution/s does this system of equation have?

Q3: Determine the type of the system shown.

Q4: Create a system of equations and identify and identify if it is COIN, CODE, or ININ. Stage 2

Q1: What is the slope of the line with points (-3,2) and (5,-3)?

Q2: If the solution (x,y) satisfies given system of equations, what is the value of x?

Stage 3:

A farmer has a total of 10 chickens and pigs on his farm. The total number of legs among all the animals is 28. If chickens have 2 legs and pigs have 4 legs, how many chickens and pigs does the farmer have?

The learning competencies from no. 7 to 15 are used. The performance standards as well are met. This is only a curriculum from the Matatag Curriculum and I see that the practice teacher used bases when trying to assess her students.

Reflections:

Formative Assessment

The teacher uses these types:

Formative Assessment 1: Recalling of the Past Meeting's Discussions through Asking Questions Formative Assessment 2: Probing Questions

Formative Assessment 3: Quick Quiz through Problem-Solving Activity - QUICK QUIZ FORMATIVE ASSESSMENT 4: FEEDBACK or Explaining and Clarifying the Answer of the Student - FEEDBACK

I think, the teacher also added strategies like the collaborative quiz bee as a whole. It is a COLLABORATIVE ACTIVITY (FORMATIVE ASSESSMENT) where students can share their knowledge to finish an activity or answer a certain item. In this case, students share ideas to answer each item in their quiz bee session. Also, the teacher promotes and spice up the FA #4 which is **FEEDBACK or Explaining and Clarifying the Answer of the Student - FEEDBACK** . In this case, the teacher will also ask questions that can be in a form of probing or a close-ended questions to trigger the analysis of the students in answering the problem. The teacher also incorporates in this formative assessment the method of guiding the student when they got wrong answer/solution in solving the particular problem (as shown in the stage 3 no. 1 question).

- I think this sums up as to how INTERACTIVE DISCUSSION looks like. Ma'am Luga played the big role in this. The practice teacher effectively used formative assessment to gauge student understanding and address emerging misunderstandings in using quick quiz assessments. This is important as well because it serves as a data to help ma'am Rushel know what will be her next step. **Recalling of the Past Meeting's Discussions through Asking Questions** plays a role in strengthening the retention of the students about the lesson. This will also increase their capability in analyzing situations which leads to the use of the **Formative Assessment 2: Probing Questions.** It helps the students to analyze and think of ways how to answer a problem which enhances their agency of learning a lesson. Lastly, **FORMATIVE**

ASSESSMENT 4:

FEEDBACK or Explaining and Clarifying the Answer of the Student is a crucial tool when the teacher wants students to build a strong foundation for students about the concepts. This also helps clarify the misconceptions of the students or recall the concepts that has been discussed but forgotten just like what Ma'am Luga did. By incorporating active feedback, questioning, and discussions, the teacher ensured that the quiz bee served not only as an assessment tool but also as a valuable learning experience.

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Insights: I hope I can use all of these strategies because these are effective means to reinforce the knowledge and the learnings of my students. This also stimulates the critical thinking skills of my future students. I saw the effects when the students are trying to answer each item of the quiz bee and collaborates with their group. The teacher also identified misconceptions and provided clarifications that can reinforce the learnings of the students.

Those are effective means to impact student's learning. The teacher's strategic use of questioning, varied problem-solving scenarios, and active engagement techniques cultivated critical thinking of the students. The emphasis on diverse solution methods and the teacher's guidance in addressing misconceptions contributed to the development of the students' knowledge.

CRITICAL THINKING SKILLS

- As I observed, analysis is dominant among all other indicators. I can say that evaluation and inference can be an umbrella connected to the analysis. Or these two indicators can be the subskills for the indicator of Analysis in Critical Thinking. (I think we will focus on the analysis served as the only indicator for our critical thinking kindicator, making inference and evaluation as the subdomains of analysis).
- Analysis is portrayed when the teacher uses the probe questions during the interactive discussion, as well as the other formative assessment types of: **Formative Assessment 1: Recalling of the Past Meeting's Discussions through Asking Questions , Probing Questions, Formative Assessment 3: Quick Quiz through Problem-Solving Activity - QUICK QUIZ, FORMATIVE ASSESSMENT 4: FEEDBACK or Explaining and Clarifying the Answer of the Student - FEEDBACK.** Letting the students answer and/or give explanations to their answer while the teacher uses a guide question can make it clearly seen that the critical thinking skills of the students are being triggered. Analysis plays a role in this area.

The Mathematics

The teacher employed a quiz bee format to assess students on the topic of Systems of Linear Equations. The questions covered various aspects, such as identifying types of systems, determining the number of solutions, and creating systems of equations. The teacher designed questions to align with the learning competencies and performance standards. The practice teacher used a variety of question types to engage students in recalling, understanding, applying, and analyzing the concepts related to systems of linear equations.

Cognitive Demand

Students engaged in individual and collaborative problem-solving activities, including determining the slope of a line, solving systems of equations, and analyzing a real-world problem involving chickens and pigs. The activities provided opportunities for students to grapple with challenging ideas. The teacher encouraged the use of various solution methods that foster cognitive demand and stimulating critical thinking by adapting tasks to challenge students at a level conducive to productive struggle. Students actively sought solutions and explained their reasoning.

Equitable Access to Mathematics

The teacher actively involved all groups in the quiz bee, creating an environment where students participated meaningfully. The teacher also provided support to a group that initially struggled, ensuring equitable opportunities for engagement. The teacher's support for diverse needs aligned with the goal of providing equitable access to mathematical content. The teacher's intervention with each group, as an example, intervention for Group 1 in the last stage (Q1) demonstrated a commitment to ensuring every student had the opportunity to contribute to the learning process.

Agency, Ownership, and Identity

: Students took ownership of the learning process by choosing solution methods during the quiz bee. The teacher encouraged individual and collective work where there is a sense of agency among students. The teacher's approach empowered students to make decisions about problem-solving strategies, reinforcing agency and ownership over their learning. Students actively participated in discussions, building on each other's knowledge.

No. of Hours working including the encoding, analyzing, and working for insights: 8 hrs for 2 days.

Observer: Tagalogon, Mariaje Fhey B. (EDM133-EDM132)

OBSERVED CLASS ASSIGNMENT: GRADE 8-KAPPA

TEACHER: MA'AM RUSHEL MAY DIOLA (Practice Teacher)

TEACHER: MA'AM MARY JOY LUGA

DAY NO: 3 NO. OF HOUR/S: 1 HOUR DATE: FEBRUARY 28, 2024 (THURSDAY)

Topic: Systems of Linear Equations

On the third day of observation, the practice teacher administered a summative assessment in the form of a long quiz to evaluate the Grade 8 Kappa class' understanding of Systems of Linear Equations.

Reflections:

The choice of a long quiz as a summative assessment indicates the practice teacher's commitment to evaluating the students' comprehensive understanding of the topic. This assessment allows for examination of their knowledge and application of concepts related to Systems of Linear Equations.

Insights:

I realized that the incorporation of both formative and summative assessments throughout in my observation showcases an approach of the teacher to evaluate. While formative assessments provide ongoing feedback and opportunities for improvement, the summative assessment serves as a culmination, assessing the overall learning outcomes. This is helpful because by evaluating student performance, the practice teacher can gain insights into the progress and retention of knowledge of her students. The long quiz serves as an opportunity for students to showcase their understanding. The student's engagement and preparation for the assessment can reflect the effectiveness of the instructions including the previous formative assessments, discussions, and activities employed by the practice teacher assisted by Ma'am Luga.

I think that summative assessment in the form of a long quiz is a crucial component of the teaching and learning process just like what we have learned in our previous CPE courses. It allows for an evaluation of student understanding and informs instructional decisions.

OBSERVED CLASS ASSIGNMENT: GRADE 8-KAPPA
TEACHER: MA'AM RUSHEL MAY DIOLA (Practice Teacher) as PT
TEACHER: MA'AM MARY JOY LUGA (Not Around)
DAY NO: 4 NO. OF HOUR/S: 2 HOURS DATE: MARCH 06, 2024 (Wednesday)
Topic: Graphing of Linear Inequalities Involving Two Variables

The Practice Teacher manages the class for the whole duration of time. Ma'am Diola was assisted by one of the other practice teachers.

The PT **presents a well-crafted problem connected to their past lesson (linear equalities)**. But before that, PT tells her students that each of them must have their papers, 1 half crosswise to answer the problem. She advises them to read the problem first and understand what the problem requires. She **requires them to answer the problem individually.** The PT then asks to **graph their solutions by group**.

The problem is provided below:

"Imagine you and your friends are in a big Math Quiz. Easy questions get you 3 points, and the harder ones are worth 5 points each. Your team needs 45 points to advance to the next round. Can you figure out three ways to mix easy and hard questions to get **exactly** 45 points?"
PT: Let us all read the problem. (altogether reads the problem). Take note class the word "exactly"
Then, the students answer the given problem.

The PT uses a PowerPoint Presentation to present the problem. She highlights (red) the word "**exactly".** Highlighting these words helps lead the students to have clues about what this problem is trying to tell them. The problem, centered around a Math Quiz scenario, required students to not only devise algebraic representations but also sketch graphs. The students are done solving systems of linear equations and they have dealt with equalities. Today, the PT presents a problem that deals with equality. This serves as a formative assessment **-Quick Quiz Formative Assessment.** A quick quiz about what they have learned last week. The students quickly answer the problem. The problem is easy for them since they have encountered a problem regarding linear equations from their last topic of Solving Systems of Linear Equations. They have done a series of formative assessments including **Formative Assessment 1: Recalling of the Past Meeting's Discussions through Asking Questions , Probing Questions, Formative Assessment 3: Quick Quiz through Problem-Solving Activity - QUICK QUIZ, FORMATIVE ASSESSMENT 4: FEEDBACK or Explaining and Clarifying the Answer of the Student - FEEDBACK** or it can be teacher's other alternative methods (rediscussing some concepts that are forgotten or providing alternative ways to solve or answer a problem) based from the data of previous formative assessment, and collaborative activity. They are also done by taking summative assessments. With all of these things, the students tried to answer problems related to the linear equation (learned from the system of linear equations). They can answer the problem being presented to them today. To figure this all out, the PT lets the student answer the problem. The PT gives students 15 minutes to answer, on their own, the problem being presented on their papers.

Reflections:

- This is a **strategy of the practice teacher to transition the students t**o their next lesson. For assurance, the students can answer the given problem applying the knowledge and skill they gained from the past meetings. This ensures that the Mathematics behind the problem encapsulates the knowledge and skills of the students based on their answers.
- **This also serves as a quick formative assessment to check** whether the students have learned well their lessons and have inculcated in them the lesson. The problem was intentionally designed to gauge the retention of knowledge and skills acquired from the previous lesson on solving systems of linear equations.

The students' prompt and accurate responses demonstrated a strong foundation in the application of mathematical concepts. Ma'am Diola's approach, incorporating various formative assessment techniques, ensured that the transition was smooth, and the new lesson was built upon the previously acquired knowledge. Overall, the class effectively exemplified a strategic shift to a new topic, providing students with the opportunity to apply their skills and reinforcing their understanding with their next lesson: linear inequalities involving two variables.

Let us discover what happened as to how the PT transitioned the problem to proceed to their main topic of the day.

After 15 minutes, the **PT divides the students into 11.** Then, the teacher requires each group to **share their answers, graph solutions, and solve the presented problem collaboratively (Group Activity- another formative assessment strategy)**. Also, the teacher gives a cartesian plane in a manila paper for each group.

PT: Are you done? Now, share your answers with your groupmates and make a graph. Post your answers at your respective corners.
Group 1's Answer: 3x+5y=45
Group 1 gives only one answer.
They have: x=5, y=6. That is why they have a graph that looks like this:

The group only pointed out the point they had which is (5,6).

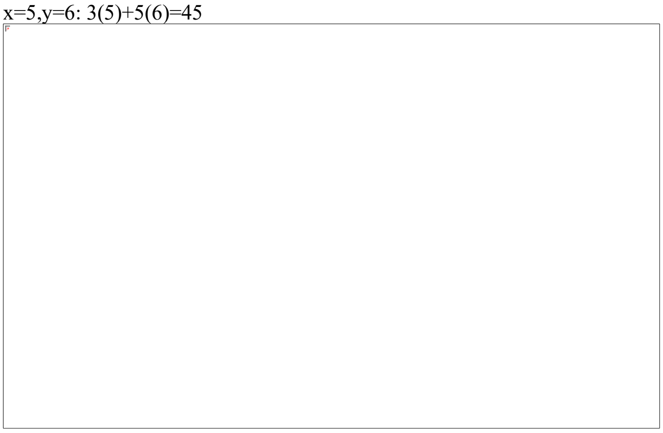
G2: Group 2 forms 3 squares where they can add the points together to make it 45 points. They graph these points.

9—-5 pts
0—-3 pts

6—-5 pts
5—-3 pts

10—-3 pts
3—--5 pts

Graph:
They put the points according to what the group has.
Group 3: 3x+5y=45
No graph yet.
Group 4: 3x+5y=45
No graph yet.
Group 5: 3x+5y=45
x=3,y=6: 3(3)+5(6)= 39
x=5,y=6: 3(5)+5(6)=45



They put the points according to what the group has.

Group 6: They created a series of combinations of numbers to add to 45 just like in Group 2.
Illustration:

E	H	
20	25	45
10	35	45

They come up with points using the equation they had::
5x+3y=45;
x=9, y=0
x=6, y=5
x=3, y=10
x=0, y=15

Group 7: 6x+5y=45
x=5,y=3

Their graph looks like this and uses only one point in labeling one of the points.
Group 8: Unfinish.
Group 9: 3x+5y=45
No graph shown.
Group 10: 10x+3y=45
x=3, y=5

Their graph looks like this and uses only one point in labeling one of the points.

Group 11: No answer.

After 15-20 minutes:
PT: Okay, class. Post all your cartesian planes at each corner where your group is assigned.

Each group follows.

- Some groups were not able to sketch their graphs but were able to make an equation. Some groups were not able to utilize their time well.

The PT proceeds and asks a question.

(**Probing Question-Formative Assessment** but this is a leading question that may not be explicitly answered by the students; they must realize this after their new lesson)
PT: **What can you observe in your cartesian planes?**

S: Line
S: Points
S: Linear System
PT: Okay. So nakapaerform mo og lines. Now, I will call Group 6 since they were able to plot their points and they have a total of 4 points labeled in their graph.
Representative from Group 6: Among gibuhat ma'am kay naghunahuna sa mig mga values, combination of values, para mahimong 45.

x=9, y=0
x=6, y=5
x=3, y=10
x=0, y=15
Dili jud ni siya in-ani tanan, naa mi gipangwala na uban kay tungod gusto mi magfocus sa amoang nabuo na equation which is ang: 5x+3y=45

So for easy questions and hard questions, using these values, masatisfy ang amoang equation. Mao dayun ni among pagplot sa among points, ma'am.

Correct Answer: The students can use any coefficients for two variables so that it equates to 45. Groups 1,3,4,5,6,7,9,10 have correct answers. The graph may also vary as to what their equations are, as long as, it represents the whole equation of the problem and the expression equates to 45.

PT: Very good. Okay, class, everyone, settle down, I have another question for you. In this problem, **what if your team needs AT LEAST 45 points to advance to the next round? (Transitioning Strategy- FA #5 In this case, I define this type of formative assessment as a strategy that helps students further or transition their learning to the new lesson that the teacher wants to have for them on a certain day. Their previous lesson on systems of linear equations will equip the students to grasp the new lesson which is about linear inequalities. The teacher starts the transitioning through a Probing Question -F.A.)?**
Insights: I realized that this is one of the good methods that can be used when employing the TTP strategy. The lessons are also perfectly fit to be in sequence- starting from linear equations and systems of linear equations to the new topic which is linear inequalities.

- Critical Thinking Skills -The teacher stimulated critical thinking among the students by structuring the problem-solving process and facilitating collaborative group activities. The teacher prompts individual reflection In here - PT: "Let us all read the problem. Take note class the word 'exactly'." This instruction encouraged students to **analyze the problem**, highlighting the word 'exactly' in formulating their responses. The teacher fostered critical thinking by organizing collaborative group activities which helped students share and discuss their solutions:
- PT: "Are you done? Now, share your answers with your groupmates and make a graph. Post your answers at your respective corners." This group activity promoted interaction and collective problem-solving. This enables students **to evaluate and refine their solutions collaboratively.** Moreover, the teacher encouraged **inference by prompting students to observe and interpret their graphical representations**: While here, PT: "What can you observe in your cartesian planes?" This question encouraged students to **infer patterns and relationships from their graphs**. The teacher also facilitated evaluation and we can see it through the different problem-solving solutions of the students. And this: PT: "So nakapaerform mo og lines. Now, I will call Group 6 since they were able to plot their points and they have a total of 4 points labeled in their graph.", highlights the validity of solutions which tells about evaluation.

(PT presents the second problem-which is the next lesson)
Here is the problem.

"Imagine you and your friends are in a big Math Quiz. Easy questions get you 3 points, and the harder ones are worth 5 points each. Your team needs **at least** 45 points to advance to the next level round. Can you come up with different combos of easy and hard questions to ensure your team hits or exceeds the 45-point target?"

PT: (reads the problem in front of the class) Okay, class. **What do you mean by the word at least"?**
Class: Maximum, ma'am
PT: **What do you mean by maximum?**
Some students: **Greater than or equal, ma'am.**
PT: So? What will you do, class? **Unsa dayun ang mga 3 combinations para ma-obtain ang atleast 45 points?** Answer it. Then, use the cartesian plane in each of your manila papers to plot your answer.

The teacher now is using the **Teaching through problem-solving strategy**. She uses first the **previous topic to transition to another topic (using the second problem)** which is the Graphing of Linear Inequalities involving two variables. Take note that the PT did not introduce to the class their main topic. I call this a strategy of the teacher which is "**Creating a Well-crafted**

Integrated Problem" and can be generalized or much better to use **TRANSITION STRATEGY- presenting a problem from the past lesson to the next lesson**. The PT crafted a problem that can be solved by the students using their knowledge of their past topic, and now, there's this **stage** on what we call the students would think, "**What if**?". The students know **equalities, how about inequalities** - so this is how the PT thought of her strategy to **implement the TTP strategy.** Also, the PT conducts the activity by individual and by group which can make students work, learn, and think both independently and dependently. **Additionally, the PT thought of a problem that can upskill the students' critical thinking like if they are given an "equality" problem, how will they do in equality? How will the students graph their equations?** The teacher targeted the Mathematics content and the cognitive demand of the students as to how students can develop their critical thinking and problem-solving skills well. The teacher uses a type of formative assessment-**Probing Questions and Quick quizzes and Group Activities about past lessons** to help students build up their thinking and analysis. As we can observe, the PT emphasized the word "AT LEAST". **Now, let's discover how students answer the problem.**

Insights and Coverage: The focus was on graphing linear inequalities involving two variables. The class began with a transition problem that effectively bridged the previous lesson on solving systems of linear equations to the current topic. Each group was tasked with solving a problem that required mixing easy and hard questions to reach a target of exactly 45 points. The problem was designed to serve as a quick formative assessment, evaluating the retention of knowledge from the previous lesson. The strategic use of individual papers and the emphasis on "exactly" guided students in analyzing the problem, fostering independent problem-solving. After the allotted time, each group presented its solution, showcasing various approaches. Some groups utilized equations to express combinations of easy and hard questions, while others graphed their solutions. The effectiveness of the transition problem was evident as students adeptly applied their knowledge and skills to arrive at solutions. As the students presented their work, the teacher **facilitated a class-wide observation** of Cartesian planes. This collaborative sharing of solutions encouraged an exchange of ideas and strategies among groups. Ma'am Diola then utilized **probing questions** to elicit critical thinking and engage students in analyzing their solutions. I think this is actually how Ma'am Rushel wanted to occur.

- The class proceeded to a second problem, in the lesson, where students were tasked with finding different combinations of easy and hard questions to ensure the team reached or exceeded 45 points. The use of the term "AT LEAST" prompted students to think about inequalities. In critical thinking indicator, the students established the elements of (1) The students **analyze** questions from their teacher for recording known information including the total number of questions a total for easy and hard ones, and they have taken observations about the word "at least". They ask questions to plan concepts when there is problem-solving in the presented problem. (3) Then they arrive to the clarification- they identify and logically present facts when asked by the teacher about a concept which will be shown when they start answering the problem.

- In summary, this observation shows me a learning environment where students actively participated in problem-solving and critical thinking procedures, transitioning smoothly between related mathematical concepts. And what I have shared earlier are just manifestations of the TTP strategy used by the practice teacher. The formative assessments like probing questions as well as the well-crafted problem contributed to the effectiveness of the TTP strategy in the learning process of the students.
    - However, we must still measure this and confirm if students did learn. Ma'am Diola's strategy addressed the cognitive demands of the students, ensuring the approach to the development of critical thinking skills. The use of formative assessment techniques, collaborative activities, and probing questions contributed to the success of the Teaching Through Problem Solving strategy.

After a while, the students answer the given problem. Then, one student just explicitly says,
S: Ma'am, mag inequality ko sa akoang equation.
PT: Why inequality?
S: Kay atleast ma'am , greater than or equal.
The student continues to answer.

After 15 minutes, PT: Are you done? Now, All groups from Group 1 to Group 5 will now be Group 1 and the rest, Group 6-11 will be Group 2. Present and post now your graphs and your equations.
(**Compounded Group Activity**-Formative Assessment Strategy- In this case, the PT combines 11 groups, forming and dividing it into 2 groups. This is a strategy of the teacher so that an accurate idea can be distinguished between the two groups since this is a new topic. The collaboration of a group promotes the sharing of ideas.) I basically think that this is a strategy for group activity of the teacher so that students can have their sharing of ideas about the new lessons. The effectiveness of this type of formative assessment is present when students come up with an answers from their sharing.

Group 1:
From G1's discussion with their groupmates: Ingon atleast, so beyond the line. Or apil ang line kay equal and greater than man.
Group 1's answer: $3x+5y \geq 45$

Group 1's Graph exactly looks like this, and they use the points on the previous group 6's answers but they also added points that are beyond 45.
x=9, y=0
x=3, y=10
x=9, y=10
x=100, y=50
(10,10), (10,5), (0,10)

G1's Explanation: Among theory ma'am is para masatisfy ang equation is we need values for x and y na mahimong it's either equal sila sa 45 or beyond sa value sa 45, maong amoang gi-shade ang the rest of the parts beyond sa line and apil ang line. Parehas sa x=9, y=0, kay moequal sila sa 45, and ang point na (10,10) kay moexceed siya which satisfies as well the equation. Mura bitawg boundary ang line ma'am pero apil siya sa shade kay greater than or equal man ang symbol ma'am.
PT: Okay, let's sum up all of your answers after group 2's explanation. Explain now your answer Group 2.
Group 2: $3x+5y \geq 45$

G2's Explanation: Nagtry mi og plot sa point namo ma'am which is ang (0,9), mo satisfy amoang equation pero naa mi nalibog ma'am. Unsay naa sa greater than or equal na symbol ma'am?

PT: So if greater than or equal ang symbol, moequal ba japon imohang $3x+5y$ sa 45?
G2 Representative: Yes, ma'am.
PT: How about if mogreater than sa 45?
G2: Ahh so pwede lage siya molapas ma'am. Naa lang ang boundary diari sa line. So if we try to have other random point say (7,14)
$3(7)+5(14)=91$ na greater than sa 45. What if we try on the left side of the graph ma'am? We use point (2,2), so we will have $3(2)+5(2)=16$ which is less than 45 na dili siya mosatisfy sa equation. Our theory is that para ma-satisfy ang $3x+5y \geq 45$, dapat ang points must be equal or greater than the original point.

(Group 1's answer and graph are correct while Group 2's answer is correct but the graph is incorrect)
Then, the PT explains and clarifies the understanding of the students.

PT: Settle down, class. Very good. You have done great observations. For group 2, ang graphing kay since we have a symbol that is greater than or equal, the side that is greater than on the line is still part of the equation. Right, class? So sa upper right side sa line (referring to G2's graph), ma true japon ang inequality but if naa sa left side sa line or down side kay ma-false ang inequality, right? You get to have the correct points para mameet ang inequality, like for example, katung sa (7,14) na point diba mosatisfy siya sa inequality, greater than to 45 ang result is if isubstitue nato ang values sa $3x+5y \geq 45$. Mo-meet pod siya basta equal sa 45.

The practice teacher provides FEEDBACK (Formative Assessment) for clarification and discussion of the topic.

PT: Nasabtan?
…..
Insights:
The practice teacher provides Compounded Group Activity-Formative Assessment Strategy-combining 11 groups, forming and dividing it into 2 groups. This helps the students to work and learn collaboratively. This showcases and boosts the confidence of the students to answer the math problem presented by the teacher. Anyone can contribute to the output by answering the given problem-sharing ideas, concepts, confusions, assumptions, and past knowledge.
The practice teacher provides FEEDBACK (Formative Assessment) for clarification and discussion of the topic. This helps in making the students understand well about the new topic. This will make the students reflect and realize about the

difference of "exactly" and "at least" when applied to mathematics. This also serves as a reflection about the difference between equality and inequality. Let us figure out how the teacher assesses the students.

- **The PT was able to integrate the lesson of inequality. The students were able to comprehend the problem yet there are still parts of the topic that have not been recalled by the students like the concept of inequality (ex. When the student asks for what the "greater than or equal" symbol means.) I suggest that the PT must have established the different symbols of inequality as she already discussed the answers of two groups. But the teacher did well on this probing question she used for formative assessment when G2 students honestly said about "greater than or symbol" really meant.**

In here: *"PT: So if greater than or equal ang symbol, moequal ba japon imohang 3x+5y sa 45? (Probing Question)*
G2 Representative: Yes, ma'am.
PT: How about if mogreater than sa 45?
G2: Ahh so pwede lage siya molapas ma'am. Naa lang ang boundary diari sa line."

The students analyzed the given data or questions from the teacher which is the 2nd skill regarded to critical thinking. The students did Hypothesis Testing: Applying the studied methods accurately. Analyzing and evaluating the values or the points to the given inequality (problems/statements) carefully. Further, if we base on Group 1's answer and explanations, they establish the 3 key indicators of critical thinking. The third indicator which is the evaluation, has 4 subskills including reviewing information, verification, decision-making, reasoning presentation, and application. They disclosed data/definitions/theorems for solving problems appropriately. They were able to recognize what "greater than or equal to 45" would look like in a graph.

"*Among theory ma'am is para ma-satisfy ang equation is we need values for x and y na mahimong it's either equal sila sa 45 or beyond sa value sa 45, maong amoang gi-shade ang the rest of the parts beyond sa line and apil ang line.*"

Insights (Critical Thinking): To dissect more of the critical thinking indicators:
The teacher triggered critical thinking among the students by presenting a problem that required an understanding of inequalities. The teacher prompts students to consider the meaning of the term "at least" in the context of the problem: *PT: "What do you mean by the word 'at least'?"* This question encouraged students to analyze the problem and recognize that "at least" implies greater than or equal to, prompting them to consider the use of inequalities in their equations.
In here: *PT: "Now, All groups from Group 1 to Group 5 will now be Group 1 and the rest, Group 6-11 will be Group 2. Present and post now your graphs and your equations."* is a group activity that promotes interaction and collective problem-solving, allowing students to evaluate and compare different approaches to solving the problem. Moreover, the teacher encouraged inference by prompting students to interpret the implications of their inequalities: *PT: "How about if it's greater than 45? What if we try on the left side of the graph?"* This question encouraged students to infer the behavior of inequalities on different sides of the graph which showcases critical interpretation of their solutions.

The formative assessment: the teacher provided feedback and clarification to ensure students understood the concepts: *PT: "So sa upper right side sa line, ma true japon ang inequality but if naa sa left side sa line or down side kay ma-false ang inequality, right?"* This clarification reinforced the understanding of how inequalities behave in relation to the graph, helping students refine their problem-solving strategies.

Correct Answer: The students can use any coefficients for two variables and use the symbol "≥ " for greater than or equal symbol . Groups 1 and 2 have correct answers. The graph may also vary as to what their equations are, as long as it represents the whole equation of the problem and the expression must be greater than or equal to 45. Hence, Group 1 is correct for shading the upper right parts along the line of their graph. Group 2 only provides a line that equates only to 45 and is not greater than or equal to 45.

Reflections: They presented reasoning within valid and convincing arguments during mathematics discourse and problem-solving as they examined the problem given. They distinguished between conclusions based on logic and reasoning during mathematics discourse from their past knowledge of equality and applied their knowledge to what they have now-inequality. The students also establish the 3rd skill of critical thinking skill which is the "Inference". They use both deductive and inductive reasoning to test if their knowledge is true when they apply their skills in answering the given problem using their knowledge from the past. They hypothesized that if their values of x and y are such then they must be greater than or equal to 45, and then they arrive at correct answers and correct conclusions.

Insights: I think the Mathematics content of this class meeting was established well which is important for a teacher to deliver in a class. The teacher did well in sequencing the parts of the lesson so that the students could apply their past knowledge about equality to the new topic which is the Graphing of Linear Inequalities. This is a strategy of the teacher that can strengthen the student's understanding and application of their understanding to the different aspects/areas of Mathematics.

However, as per my observation, although the class is active and the discussion is engaging, some students have their worlds or they don't listen to the teacher. There are parts at the moment of the discussion where some students are not listening to their teacher.

- **I suggest that the PT may try to lighten up the mood of the students-they need to be energized. At the very least, a short icebreaker will do.**

After the discussion, the PT assesses the students through a short quiz. (Quick Quiz Formative Assessment)
PT: Let's have a quiz. Get 1 whole sheet of paper, class. With the problems presented earlier, answer this problem.

“Imagine you and your friends are in a big Math Quiz. Easy questions get you 3 points, and the harder ones are worth 5 points each.

1. **Your team needs more than 45 points to advance to the next round. Write the algebraic representation of this scenario. Sketch the graph.**
2. **What if your team, for some reason, only wants to get less than 45 points? Write the algebraic representation of this scenario. Sketch the graph.”**

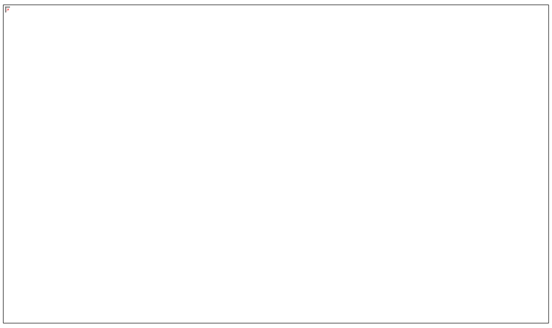
The PT uses a PowerPoint Presentation to present the problem. She highlights the words more than and less than. Highlighting these words helps lead the students to have clues about what this problem is trying to tell them. The PT gives students 15 minutes to answer, on their own, the problem being presented.

PT: Class, take note of the highlighted words, “more than” and for no. 2, “less than 45 points”. How will you do that? Solve on your own and graph your answers. (Probing Question)

This short quiz as a quick quiz formative assessment will let the PT assess if the students learn and understand the lesson. She uses the probing question to guide the student on answering the problem on the short quiz.

- **While the students are answering on their own, I roam around the classroom just like what I did earlier. I see different answers and hear different murmurs.**

1. **One student from the first line of sitting arrangement answers: $3x+5y\geq45$.**



$3x+5y<45$

(Take note that the greater than or equal symbol just uses solid line while the less than symbol uses broken line)

One student asks the PT: Ma’am, what will we do if dili apil ang line kay since less than man and dili less than or equal?
PT: Very good question. Class, we will make a deal. If it has an equal sign, greater than or equal and less than or equal, use solid line then decide if shaded or not, then for those symbols with less than and more than, use broken lines since what?.... Apil or dili apil ang line?
Class: Dili apil, ma’am.
PT: Good.

Insights: The PT was able to use the probing questions (formative assessment) to make students analyze what they are going to do with the “less than” and “more than” symbols. Through the questioning and the feedback of the teacher (another form of formative students), the students were able to analyze what is the difference between less than and less than or equal. The cognitive demand in this situation is cultivated through the problem given by the PT and was satisfied by the agency of the students to unlock their knowledge about inequalities. This is also an indicator that the students were able to map information based from their past knowledge and present analysis. The teacher’s strategy to have a deal about the illustration for less than/more than (broken lines) and greater than or equal/less than or equal (solid line) made it easier for students to understand what this is trying to tell them about the whole lesson.
Critical Thinking: *PT: "Take note of the highlighted words, 'more than' and for no. 2, 'less than 45 points'. How will you do that?"* This instruction encouraged students to analyze the problem and apply their understanding of inequalities to formulate algebraic representations.The teacher fostered critical thinking by addressing student inquiries and providing clarification: *Student: "Ma’am, what will we do if dili apil ang line kay since less than man and dili less than or equal?"*

PT: "If it has an equal sign, greater than or equal and less than or equal, use solid line then decide if shaded or not, then for those symbols with less than and more than, use broken lines since what?.... Apil or dili apil ang line?"

This interaction prompted students to consider the significance of the line type in graphing inequalities that encourage analysis.

2. Student from the second line: 3x+5y>45

(Unfinish, no answer for no. 2)

Students at the middle line sitting arrangement:
S1: Wala ko kasabot, sakto man ata to akong gibuhat.
S2: Gatanga ra ko
S1: Wala koy idea.

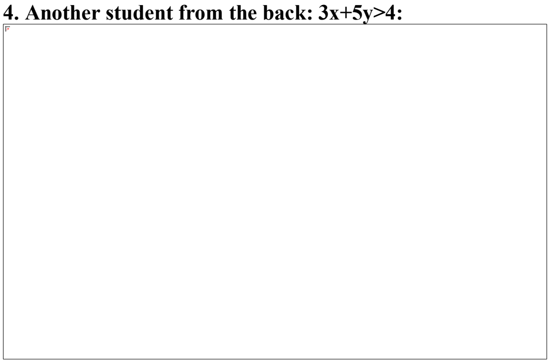
Insights: The PT was not able to observe the students and the other parts of the class. Some students got bored and were not actively learning and listening to the discussions made by the PT as well as to their classmates. I suggest that the teacher must click that "go" signal so that her students will listen every time she has an important detail to discuss or give feedback based on other students' opinions and queries. I could see in my visual imagination that if Ma'am Luga was there, she would make the class be attentive and she would ask questions to the students at each corner of the room just to make sure that everyone is engaged and everyone gets to understand the lesson. She would randomly say, "Okaty pa ta, class?". Ma'am Luga's feedback method (formative assessment) is that she will listen to the students' explanations and queries then she will provide feedback through asking probing questions, recalling the concepts (discussion of important details), and calling any students to answer her other questions so that students can think independently. *Ma'am Rushel's feedback method* is that she will listen to her student's explanations and queries then give explanations and she will try to ask questions to the students. I realized that a teacher must really be attentive to what the students are doing. Are they active in listening or does everyone understand the problem? In this way, we can be able to cater to every learning needs of the students not perfectly, rather we are able to address the needs of the students collectively.

3. One student from the last line's answer:

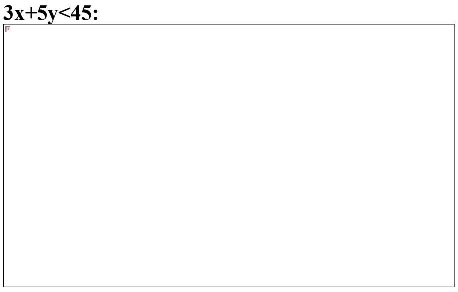
3x+5y>4:

3x+5y>4:

4. Another student from the back: 3x+5y>4:



3x+5y<45:

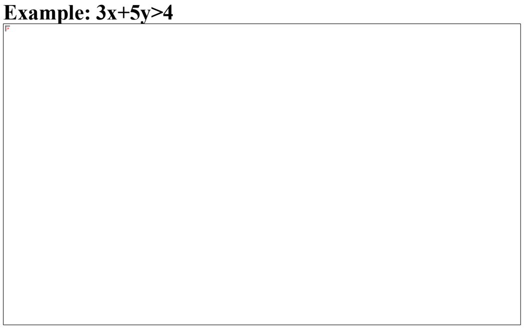


This student got the wrong graph but he has an idea on how to graph inequalities, he needs guidance for this. Since this is still the first day of them learning about inequalities, they still have lots of opportunities to grasp everything they need to know about inequalities.

Correct Answer:

1. **The students can use any coefficients for two variables and use the symbol "> " for more than symbol . Red highlighted 1-3 students have correct answers and graphs. The graph may also vary as to what their equations are, as long as it represents the whole equation of the problem and the expression must be more than 45 when substituted with values. Hence, they are correct for shading the upper right parts in which the line is NOT part of their graph, they used broken lines to signify that it is not included.**

   Example: 3x+5y>4

   2. The students can use any coefficients for two variables and use the symbol "< " for less than symbol . Red highlighted 1-3 students have correct answers and graphs. The graph may also vary as to what their equations are, as long as it represents the whole equation of the problem and the expression must be less than 45 when substituted with values. Hence, they are correct for shading the lower left parts in which the line is NOT part of their graph, they used broken lines to signify that it is not included.

   Example: 3x+5y<4

After 15 minutes or more, the teacher asks for 2 volunteers to answer the no. 1 and no. 2 problems individually. After solving on the board, the students explain their answers respectively. This strategy of the teacher can help students boost their confidence in solving the problem independently. They can ask questions if there are any.
SA:
"More than" so walay equal, mas molabaw siya ma'am ang result dapat. So among equations kay gigamit lang japon to nako katung nabuo kaganiha: 3x+5y>4. x for easy questions and y for the hard ones.
For example guys, if I have x=8 and y=8:
3(8)+5(8)>45
24+40>45
64>45
So it satisfies the equation. And sa amoang graph ma'am kay gi-shadean nako ang upper right part ani na line tapos gihinimo nako nga broken line since dili siya included:

(1) (the graph shows like this)

It is evident that this student is actively listening to the PT. There is an essence of "ownership" and agency of learning to the student since he was able to explain all the necessary solutions and answers required by the PT. The student presents reasoning within valid and convincing arguments during his explanation and when he was still solving the problem. He distinguishes between logic and reasoning when he is trying to figure out the problem (Evaluation in Critical Thinking Indicator). The content in this problem cultivated the student's skill in mathematical investigation.

PT then explains why the student's graph appears to be like that. The teacher provides FEEDBACK (FORMATIVE ASSESSMENT)

PT: Naa diri ang mga points class (pointing out on the shaded part of the graph).
* The PT emphasized the shaded part of the graph.
PT: Daghan kaayog points. For example sa kaganiha na gihatag na equation and a point of (8,8), diba ang result is 64 which has value more than 45. It is indeed greater than 45. So solution jud siya.

This Feedback and discussion from the teacher can help the student analyze and understand the lesson as well as the given solutions to the problem.

The PT establishes again the cognitive process of the students. With that brief explanation, all the students understood as to why the graph is like that and how the values satisfy the inequality. It showcases an equitable access to the content.

PT: Thank you. You can take your seat. Number 2?

(2) SB: I used the "less than" symbol in my equation.
* The student writes: 3x+5h<4
x=6, h=2

3(6)+5(2)<45

$18+10<45$

$28<45$

x is for the easy questions and h is for the hard questions.

Then I had a graph of:

(the graph shows like this)

The student: Ako na dayun ning gishade diri nga portion (referring to the lower left parts of the graph).

- The student did not use broken lines but he clearly shaded the part that is only included for his graphing.

PT: Very good. But, next time, class, since we have agreed already, we can use broken lines, okay? But if less than or equal, we can use a solid line. (Agreement for case to case basis)

- This agreement helps the students become attentive and responsible to use the rules. This is similar to the abbreviations of types of systems of linear equations such as COIN, ININ, and CODE. But in this case, an agreement about the broken lines and solid lines which can be almost similar to the agreement of abbreviation in the systems of linear equations. This way, tt will make students realize as to why they use broken lines and solid lines for respective symbols.

PT: From this graph, the shaded part has many points. Actually, you can choose any point as long as ang result is less than 45. True na dayun ang inequality nimo.

The feedback and giving clarity to the students is both a strategy and a method of formative assessment provided by the PT. The PT clarified the concept about the reason why they have a representation of broken lines for the "less than" symbol and how it matters to the content.

PT: You may take your seat. Thank you. I will give plus points to those who participate.

Next Part: Part of Discussion

PT; Going back to class, what can you say from this graph about the points of (0,6) and (2,0). Solution siya kay satisfy man ang given inequality. Daghan kaayog points, sa intercepts nga (0,9) og (15,0), diba they are the intercepts, so sa number 2 na graph, tanan points less than or before sa kani na points (0,9) og (15,0) kay mosatisfy siya sa inequality. Unsay tawag ani nila na mga points na mosatisfy sa inequality? Diba gitawag sila og solutions, unya kay daghan man sila, unsay tawag? So naay set diba.

One student from the class: Solution set?

PT: Very good. They are called solution set kay naa nay solution, set pa jud sila diba. Daghan kayo siya na mga solutions na mosatisfy sa given inequality.

This is still part of the TTP implementation of the PT. The PT explains about the "solution set". Solution set is the set of values that satisfy a given set of equations or inequalities. The teacher explains the concept in a manner that can be understood and easily remembered by the students.

PT: Submit all your papers, class.

- The teacher conducts formative assessment in the form of a quick quiz to check if the students understand the topic. We will discover how the teacher will enrich the learning of the students for the next session.

Critical Thinking: The teacher encouraged critical analysis by prompting students to analyze and explain their solutions and graphing choices: *PT: "Naa diri ang mga points class... Daghan kaayog points. For example sa kaganiha na gihatag na equation and a point of (8,8), diba ang result is 64 which has value more than 45. It is indeed greater than 45. So solution jud siya."* This feedback emphasized the interpretation of the solutions and graphical representations, encouraging students to critically assess their work and understand the implications of their choices.

"PT: So if greater than or equal ang symbol, moequal ba japon imohang 3x+5y sa 45? G2 Representative: Yes, ma'am." The evaluation indicator is evident. The teacher evaluates the student's understanding of inequality symbols by asking probing questions and receiving a response that confirms comprehension.

"SB: I used the 'less than' symbol in my equation."

Also, the student makes an inference about the appropriate inequality symbol to use based on their understanding of the problem requirements and mathematical conventions.

PT: Class, you have an assignment (The PT wrote already the assignment on the board). Pass it tomorrow for our class time.

Next Part: Assignment

Assignment:(Graphing Paper)

Graph the solution set of the following inequality:

1.) $6x+y>6$
2.) $5x+2y\leq 10$

The assignment provided by the teacher is a practical application of the lesson on Graphing of Linear Inequalities in 2 Variables. It serves as a formative assessment tool to gauge individual comprehension and application of the newly acquired knowledge. It serves as a Reinforcement of Learned Concepts. By requiring students to apply their understanding and graph solution sets independently, it (1) solidifies their knowledge and skills related to inequalities. (2) Practice and Application: Students are allowed to practice what they learned during the lesson. They can apply the graphing techniques and rules discussed in class to solve and represent the solution sets of the given inequalities. (3) Assessment of Individual Understanding: The assignment acts as an informal form of assessment. When students submit their graphed solution sets, the teacher can gauge each student's comprehension of the graphing process, accuracy in representing inequalities, and application of the concepts taught during the class. This encourages independent learning as students are required to apply their knowledge without direct guidance.

Last Part: Announcement of the Lesson
PT: Everybody, please be seated. From the activity and discussion, what can you observe? What do you think is our lesson today?
Students from the front: Inequalities, ma'am.
PT: Very good. We dealt with two variables, right? Can you tell me the complete topic we had, _____(calls a student)?
S: Inequalities in 2 variables?
PT: Okay, our lesson was about Graphing of Linear Inequalities in 2 Variables. That would be all, class. I will give the test results you took last week by tomorrow. Goodbye, class is dismissed.
S: Goodbye, ma'am Rushel. Goodbye, Sir. Good bye, visitors. We love you, kapamilya!

- The engagement began with a well-crafted problem presented via a PowerPoint Presentation. The PT uses Teaching Through Problem-Solving Strategy. The problem, centered around a Math Quiz scenario, required students to not only devise algebraic representations but also sketch corresponding graphs. What went particularly well was Ma'am Diola's strategic use of instructions and materials. She encouraged students to thoroughly read and comprehend the problem. The choice of words like "more than" and "less than" was purposefully highlighted, providing subtle clues for problem interpretation. This approach effectively aligns with the Teaching Through Problem Solving strategy, it cultivates for independent thinking and active participation. Ma'am Diola allowed students 15 minutes to solve the problem autonomously, promoting individual reflection and problem-solving skills. The integration of real-world scenarios into mathematical concepts challenged students to apply their knowledge enriching their understanding of Systems of Linear Equations. Overall, the the class demonstrated an integration of problem-solving techniques, promoting both independent thinking, mathematical investigation, equitable access to content, indicators of critical thinking, and practical application of mathematical concepts which TTP is trying to help.

Insights:
Critical thinking: The formative assessments including the probing questions or any type of questions, discussion/feedback, quick quiz, well-crafted problem,group activity and compounded group activity, and quick quiz encapsulates thetransitioning strategy of the teacher to impact her TTP strategy.

- The probing questions or any type of questions, discussion/feedback, quick quiz, well-crafted problem, and quick quiz played the building of the concepts for the students reinforcing their critical thinking skills and understanding of the lesson. While the group activity processes is a way to navigate the process of the whole discussion and reinforcing of the students' ideas.
- The indicators: inference and evaluation may indeed be a subskill to the indicator: analysis since analysis plays a head role among the other critical thinking indicators. The application of studied methods lets students carefully analyze and evaluate the given inequality problem. The probing questions posed by the teacher prompted students to think about the meaning of symbols such as "greater than or equal". The students engaged in hypothesis testing by applying their knowledge to solve the presented inequality problem. They formulated hypotheses based on their understanding of equality and tested them through deductive and inductive reasoning, arriving at correct answers and conclusions.

Formative Assessment: The teacher used a well-crafted problem as a formative assessment to check the students' retention of past lessons. This approach not only gauged their understanding but also served as a strategic bridge to the new topic to have a smooth transition. The interactive nature of the class, with students actively participating in problem-solving and group discussions, indicates a positive and engaging learning environment. The use of individual papers and group collaboration encouraged individual thinking and collective sharing of ideas.

- Sequencing of Lesson Parts: The teacher's sequencing of lesson parts was effective in building a logical progression of concepts. By first addressing a problem related to the previous topic, students were naturally led to consider the implications of inequalities, setting the stage for the new lesson. The teacher successfully employed a strategy of transitioning from the previous topic (solving systems of linear equations) to the current one (graphing linear inequalities involving two variables). This method, known as "Creating a Well-crafted Integrated Problem," effectively engaged students and demonstrated the interconnectedness of mathematical concepts.
    - The teacher's clarification and explanation of concepts, especially regarding the interpretation of symbols in inequalities, demonstrated effective communication. The class discussion, particularly with

Group 2, illustrated the teacher's ability to guide students in understanding mathematical representations. The teacher's encouragement of observations and insights from the students ex: asking them to observe their Cartesian planes, facilitated a collaborative learning environment. This approach not only reinforced learning but also allowed the teacher to address any misconceptions promptly.

Reflections on the Method of Teaching through Problem-solving

Transitioning from Previous Knowledge, Real-life Context: problem, Formative Assessment Types, Student Participation, Clarity in Instructions, Feedback, Opportunities for Differentiation

The teacher integrated the new topic of Graphing Linear Inequalities with the students' previous knowledge of solving systems of linear equations. This connection helps students see the relevance and continuity in their mathematical learning. The problem presented to the students about scoring points in a Math Quiz adds a real-life context to the lesson. This not only makes the content more relatable but also encourages students to think critically and apply their mathematical skills to practical situations. The teacher used formative assessment techniques throughout the class, such as asking questions, listening to student explanations, and providing feedback. The short quiz at the end further assesses individual understanding and allows for immediate feedback. The strategy encourages active student participation through individual problem-solving, group collaboration, and sharing of solutions. This approach fosters a sense of ownership and agency in their learning. The teacher provided clear instructions for the assignment, specifying the use of graphing paper and the inequalities to be solved. This clarity ensures that students understand what is expected of them, promoting independent work. The assignment allows for differentiation as students can choose coefficients for the inequalities. This provides opportunities for both challenging and advanced students to engage with the lesson.

In conclusion, the overall Teaching through Problem-solving strategy effectively incorporates various instructional techniques, promotes student engagement, and facilitates a positive learning environment.

The observed lesson demonstrated effective teaching strategies, emphasizing content integration, cognitive engagement, equitable access, student agency, and critical thinking development. Addressing areas for improvement can enhance the learning experience. The teacher's approach to formative assessment and feedback contributes to a positive learning environment.

More Observations/Reflections/Analysis:

Content: The lesson integrated the transition from solving systems of linear equations to graphing linear inequalities involving two variables. The problems presented provided application of knowledge and skills learned in previous lessons. The focus on inequalities was well-sequenced, building on the foundation of equality concepts.

Cognitive Demand: Students demonstrated reasoning, logical analysis, and application of deductive and inductive reasoning in solving inequality problems. The teacher's strategy of probing questions and formative assessments effectively engaged students in critical thinking. The cognitive demand was appropriately aligned with the students' level of understanding, introducing them to the concept of inequalities.

Equitable Access to Content: The teacher's strategy of using a variety of problems and engaging activities ensured equitable access to content for all students. The inclusion of probing questions and formative assessments allowed the teacher to address misconceptions and guide students toward a better understanding.

Agency/Ownership/Identity: Some students actively participated, demonstrated ownership of their learning, and confidently presented their solutions. The teacher's encouragement of questions and explanations empowered students to take ownership of their learning process.

Formative Assessment: The teacher used effective formative assessment strategies, including probing questions, discussions, and quizzes, to gauge student understanding. Immediate feedback and clarification provided by the teacher during and after student presentations contributed to an understanding of concepts.

Critical Thinking Indicators: Students displayed critical thinking skills such as hypothesis testing, inference, logical analysis, and evaluation during problem-solving. The teacher's use of probing questions and feedback contributed to the development of critical thinking skills in mathematical problem-solving.

Areas for Improvement: Some students appeared disengaged during parts of the lesson, indicating a need for varied teaching methods to maintain attention. Implementing interactive strategies or short icebreakers may help energize students and enhance overall class engagement.

Teacher Strategies: The teacher effectively used sequencing of lesson parts, integrated problems, and clarification to strengthen students' understanding. Further attention to class engagement and mood could enhance the learning experience.

No of hours working and analyzing: 12 hrs (3 days)

OBSERVED CLASS ASSIGNMENT: GRADE 8-KAPPA

TEACHER: MA’AM RUSHEL MAY DIOLA (Practice Teacher) as PT

TEACHER: MA’AM MARY JOY LUGA (Not Around)

DAY NO: 5 NO. OF HOUR/S: 1 HOUR

DATE: MARCH 07, 2024 (Thursday)

Topic: Graphing of Linear Inequalities Involving Two Variables

(Continuation of the Lesson)

The teacher conducts a formative assessment in a form of an outside-the-classroom and collaborative activity. This assesses the student’s understanding about what they have learned yesterday.

PT: Good morning, class. We will play a game today. But this is not just a typical game, you will use what you have learned yesterday. You will play it outside this classroom. Ofcourse, naay points ang makacorrect. Do you still remember our lesson yesterday? Before that, submit your assignments first.

The students submit their assignments at the table. Then, the teacher divides the class into 7 and uses the groupings they had yesterday.

PT: Magpakita ko og Linear Inequalities and then naay graph sa yuta. Mao na inyong gamiton para maggraph mo sa linear inequality na akong ihatag. Ang unang makaraise na group sa ilang hands kay maoy makaperform sa linear inequality. If broken lines, mag form lang mo og line na dili dikit-dikit and if solid line, magdikit jud mo sa pagform ninyo og line. Clear?

Students: Okay, ma'am. Asa pod ta ma'am?

PT: Let's proceed and form your lines na.

They gather at the school ground at the front of the waiting tables. Ma'am Diola draws a graph at the ground and she has the bond papers with linear inequalities in it on her hands. The PT gives a short instruction.

PT: Okay, I will raise the paper para makabalo mo sa inequality and then pag mo go-signal nako para mopataas mo sa inyong kamot as a group sa kung kinsa ang ganahan mo answer sa linear inequality. Each must only have 15 seconds to form the graph.

No. 1: The PT raises a paper that shows a linear inequality of: $y \geq 4x+1$.

PT: Ready? Raise your hands in one, two, three, go!

The PT selects Group 1. In the graph, the group forms a solid line. They glue themselves with one another and they show a graph of:

PT: Unsa ni, broken line or solid line?

G1: Solid Line, ma'am.

PT: What is your x-intercept?

R of G1: -¼ ma'am

PT: Your graph is… correct.

PT: I repeat class. If broken line, maglagyo mo pero maggunitay lang mo. If solid line, magdikit jud mo.

PT: Next,

The PT shows another linear inequality:

2) $y \leq 4/3\ x-4$

PT: Raise your hands, 1,2,3, go.

The PT selects Group 3:

Group 3 performs a solid line at the human graph:

One member from Group 3: Solid line jud diay basta naay equality kay included man siya pero ang broken line kay dili included ang line, ahh.

He realized about the symbols and how to graph it as they perform the line. I realized that there are some students who have different ways to understand math. Similar to this student, not generalizing him as a person, but he spoke that he actually realized the purpose of broken lines and solid lines when graphing inequalities.

PT: Your graph is….correct. 1 point. Let's proceed.

The PT raises a paper for another linear inequality.

PT: Raise your hands, 1,2,3, go.

3.) $x<-5$

We will expect that a selected group will form a broken line.
PT: Raise your hands, 1,2,3, go.
The PT selects G2.
Group 2 performs a broken line at the human graph:

This is wrong since they perform $x<5$ and not $x<-5$.
PT: The graph is incorrect. Another group. Who wants to graph this? Raise your hands, 1,2,3, go.
The PT selects Group 3.
3.) $x<-5$
Group 3 performs a broken line at the human graph:

PT: Correct. 1 point. Next.
Comments from other group: Dali kayo sila makapataa sa ilang kamot

- Taas man gud sila

The PT notices this, which is why she roams her eyes again to her students.
The PT raises a paper for another linear inequality.
4,) $3x-2y<10$
PT: Raise your hands, 1,2,3, go.
The PT selects G4.
Group 4 performs at the human graph a broken line:

PT: What is your y-intercept?
G4: -5, ma'am.
PT: Correct. 1 point.

The PT raises a paper for another linear inequality.

5,) $y \geq -3x+4$

PT: Raise your hands, 1,2,3, go.
The PT selects G5.
Group 5 performs at the human graph with a solid line:

The G5 graphs it incorrectly since the x-intercept: 4/3 or 1.333 is positive and not negative.
PT: The graph is incorrect. Another group. Who wants to graph this? Raise your hands, 1,2,3, go.
The PT selects Group 6.

5,) $y \geq -3x+4$

Group 6 performs at the human graph a solid line:

PT: Your graph is correct. 1 point. Next,

The PT shows another linear inequality:

6) $y \geq 7/4\ x+2$

PT: Raise your hands, 1,2,3, go.
The PT selects Group 7:
Group 7 performs a solid line at the human graph:

Group 7 graphs the inequality incorrectly. The y-intercept must be +2.
PT: What is your y-intercept?
Group 7: -2, ma'am.

PT: The graph is incorrect. Who wants to graph this? Raise your hands, 1,2,3, go.
The PT selects Group 6.
6) $y \geq 7/4\ x+2$

Group 6 performs a solid line at the human graph:

PT: What is your x-intercept?
Group 6: -8/7, ma'am.
(-1.143 in decimal)
PT: Very good. Your graph is correct. Let us all clap our hands for a job well done. Form two lines and proceed na dayun ta sa atung classroom.

(in the classroom)
The PT announces the scores of the collaborative outdoor activity. She writes the scores on the board
PT: The groups got, for :
Group 1: I
Group 2:
Group 3: II
Group 4: I
Group 5:
Group 6: II
Group 7:

This is a collaborative outdoor activity. This is a formative assessment type of group activity that differs from the group activities they had previously- compounded and the other one. Unlike the previous collaborative activity that students used the collaborative works for sharing of ideas to analyze and get results since it's their first encounter with the new lesson that caters as well the past knowledge as well of the students. But now, this is a collaborative activity in which the lesson has been introduced to them already. This helps the teacher to know whether the students understand the lesson they had yesterday. This is a strategy of the teacher so that she can know what steps she is going to take for their next meeting. Some students were able to graph the linear inequalities correctly but there are some who weren't. They had mistakes when they got to their intercepts since most of their mistakes were having to use the positive signs and negative signs correctly. They might just need a little bit more of focus since they are being time pressured. They understood the difference between the equalities and inequalities especially when using broken lines and solid lines.

Reflections from the Activity:
Reflections:

Content: It reinforces the concept of graphing linear inequalities involving two variables. It extends the learning from the classroom to a real-world setting.
Cognitive Demand: The outdoor activity demands cognitive engagement as students need to apply their understanding of linear inequalities quickly. The time pressure adds a layer of difficulty that requires students to think quickly about inequalities.
Equitable Access to Content: The group format of the activity ensures that each student has an opportunity to participate and contribute to the graphing process. However, the teacher might consider providing additional support to groups that struggled during the activity to have equitable understanding like a smooth flow discussion as to what they have learned-this may provide clarity and focus to the students.
Agency/Ownership/Identity: The collaborative activity promotes a sense of ownership among students as they work together to graph linear inequalities. It encourages them to take responsibility for their learning and engage in the process.
Formative Assessment: The outdoor activity serves as an effective formative assessment tool. It allows the teacher to observe students' application of the learned concepts and identify specific areas of misunderstanding, especially related to signs and intercepts.
Critical Thinking Indicators

Analysis: Students are prompted to analyze the given linear inequalities and translate them into graphical representations. The things observed in some groups' graphs indicate areas where students need to refine their analytical skills including how they form the line of a given inequality.
Inference: Students are required to make inferences about the correctness of their graphs based on feedback from the teacher including the groups who were asked by their teacher about their graphs. This process encourages them to reflect on their understanding and make adjustments.

The PT distributes the long quiz results they had last week about Systems of Linear Equations. She announces those students who got 40 above their scores. Then, the teacher gives students an exercise quiz. This serves as a quick quiz formative assessment since the teacher wants to know if the students really understand the lesson based on the outdoor activity and if the TTP strategy being used for the said lesson yesterday was effective.
PT: Let's have a quiz.
Students: Ma'am 7 minutes nalang ang nabilin
PT: 8 minutes
On the board:
Instructions: Find the solution set and provide test points.

The PT instructs again the class to use the broken lines if the symbol stated id less than or more than. But if there is less than or equal and greater than or equal- use a solid line. She highlights the meaning behind it.
PT: We use the broken line since we don't include the values or the points from that line, only beyond or below it. While, solid line, we use the solid line since we include the points formed from that line and the rest of the parts of the linear inequality.

The PT also provides an example as to how the students answer the given exercise. As can be seen in the example, there are also procedures provided by the teacher:
6x+y >6 —Change this to equation 6x+y=6

- Find the x and y intercepts of 6x+y=6
- Test pt (0,0)
- x=1, y=6

Then the PT illustrates the sample linear inequality through a graph with the test points used.
From this, the students will be able to answer the given exercise. However, there are still some students who raise their hands and approach their teacher about the procedure on answering.

This exercise or quick quiz assessment serves as a formative assessment for the students. This will also strengthen the students' knowledge about the content and delve into their cognitive processes.

The students answer the exercises and submit their papers, finished or unfinished.

PT: Submit your papers. Class dismissed.
While waiting for other students to submit their papers,
PT: Btw, class. We will have a quiz next meeting.

I don't know what will happen for their next session but as we walk to the faculty room, the PT shares to us that she will discuss the lesson next meeting so that students can have clarity, focus, and full understanding about the said topic.

Reflections:
By announcing the students who scored 40 or above in the previous long quiz, the teacher fosters a positive and motivating atmosphere.

Formative Assessment: The quick quiz assessment serves as a formative assessment tool. The teacher can gauge students' understanding following the outdoor activity. This timely assessment allows for quick adjustments in teaching strategies based on observed gaps in comprehension.
Clarity in Instructions: The teacher's emphasis on using broken lines for "less than" or "more than" symbols and solid lines for "less than or equal to" or "greater than or equal to" symbols indicates a clear communication of mathematical conventions. This clarity promotes a standardized approach to graphing linear inequalities.
The teacher provides a step-by-step procedure for answering the exercise. This offers clarity on how to find intercepts, and use test points. This procedural guidance is essential for students who may need additional support in the solution process.
Feedback: The teacher's willingness to address student queries about the procedures demonstrates an open and supportive learning environment. Encouraging students to seek clarification where questions are welcomed, promoting a deeper understanding of the material.
The mention of an upcoming quiz signals the teacher's proactive approach to assessment planning. By informing students in advance, the teacher provides an opportunity for focused review, learning, and preparing for the next evaluation.
Intention of the PT: The teacher's plan to discuss the lesson further in the next meeting showcases a commitment to ensuring clarity and understanding. This approach helps prevent misconceptions from reinforcing the importance of ongoing discussion for enhanced comprehension.
This contributes to an effective learning experience, continuous assessment, clarity in instruction, and responsiveness to student needs.

Suggestions:
Peer Feedback Session: After discussing the scores on the board, encourage groups to provide constructive feedback to one another. This can be a collaborative learning environment and allows students to learn from each other's successes and mistakes.
Additional Practice: Assign supplementary practice problems for homework that is similar to the difficulties observed during the outdoor activity. This extra practice can reinforce the concepts and address specific areas of struggle. (The PT asks the students to study sothat they can answer the quiz at the next meeting. This reinforces the students to explore independently of their knowledge and understanding about the topic.)
Class-wide Discussion: Conclude the activity with a class-wide discussion where the teacher highlights common misconceptions, addresses questions, and emphasizes key points. This ensures that the entire class benefits from the insights gained during the activity.(as being said for the next meeting)
Explore the use of technology, such as graphing software or apps, to create a virtual graphing experience. This can provide an alternative perspective and cater to students who may be more comfortable with digital tools. Frame linear inequalities within real-life scenarios during class discussions. This helps students connect the abstract mathematical concept to practical situations, enhancing their understanding and engagement.
Continuous Formative Feedback or Providing Clarity- Throughout the lesson, provide continuous formative feedback. This can be done through circulating among groups during the outdoor activity, addressing misconceptions promptly, and offering guidance to enhance accuracy. (The PT and Ma'am Luga have done this, and we can see results if there is the consistent application for this formative feedback).

APPENDIX R
TABLE 8: OVERALL REMARKS AND ANALYSIS (FREQUENCY)

Critical Thinking Indicator	Sub-indicator	Remarks and Analysis (Including Frequency & Types of Critical Thinking Observed)	
		Kappa	**Epsilon**
1.Asking Insightful Questions	Questions are directly related to the current mathematical concept or problem being discussed.	**Observed** on Days 1, 2, 4, and 5. On Days 1-2, students raised questions on the process of solving for intersections of lines (e.g., "How do you solve the intersection from two lines?"). This happened during the group work when students were unsure how to approach the system of equations. The PT consistently asked questions related to graphing inequalities, such as "What does 'at least' mean?" on Day 5, and similar queries on Day 4. This is a **probing question** about the meaning of symbols (e.g., . This prompted students to engage with the content more deeply.	On **Day 1**, students were actively involved in solving systems of equations using **graphing** and **substitution**. A student asked, "How do I solve the intersection from two lines using graphing?" which is directly related to the topic of graphing linear systems. On **Day 2**, students asked specific questions to clarify their understanding of the **elimination** method versus **substitution**, for instance, "Why do we use substitution here instead of elimination?" These questions were clearly tied to the lesson on solving systems of equations. On **Day 4**, when the teacher shifted the problem from "exactly 45 points" to "at least 45 points", students began asking, "Can we have multiple solutions for this

			inequality?" This was another insight-driven question, as it prompted students to consider how inequalities can have multiple solutions above or below a given line.
	Questions seek to resolve misunderstandings or errors in reasoning.	**Observed on Day 2:** When students didn't understand the steps of elimination, they asked for clarifications, such as "Why do we eliminate variables?" The teacher provided a response that helped clear confusion and allowed students to proceed with the correct method. **Observed** on **Day 5** when the PT asked probing questions like "What if your team needs at least 45 points?" to clarify misunderstandings about inequalities. The teacher asks why the inequality symbol is important in graphing. This is observed in the group discussions of Day 1-Day 5.	On **Day 1**, a student raised their hand and asked, "How do I plot this point correctly?" This indicated a gap in their understanding of graphing, and the teacher used the question to resolve the misunderstanding by providing clarification on how to plot points on the Cartesian plane. On **Day 2**, when confusion arose between the **substitution** and **elimination** methods, another student asked, "Why do we use substitution here instead of elimination?" This question was crucial in resolving the students' misunderstanding about which method to use for solving the system of equations. On **Day 3**, students questioned why their calculated

			values did not fit into the solution set and asked for clarification when checking the validity of their points in inequalities. On **Day 4**, when the teacher posed the new problem of finding combinations for "at least 45 points," students again asked for clarification: "Can we have multiple solutions for this inequality?" The teacher used this question to help students understand that inequalities can have a range of solutions, not just one fixed answer.
	Questions challenge the assumptions underlying a problem or a solution.	**Observed** on **Day 4** when students were solving inequalities: Students raised the question, "How do we know which side of the line to shade?" This question challenges the basic understanding of inequality graphs and leads to a deeper reflection about the method of shading the solution region. **Not observed on the other days since** there were no instances of students being directly prompted to challenge underlying assumptions about the method or beyond surface-level questions.	**Not Observed.** No student was observed asking questions that challenged the assumptions behind the given problems.

	Questions consider alternative methods for solving a problem	**Observed on Day 1 and Day 2**: When solving for intersection points, students discussed various ways to approach the problem, including whether to use substitution or elimination. This indicates students consider multiple strategies to solve the same problem. **Observed** during **Day 5** when students were discussing alternatives for representing inequalities (solid vs. broken lines). The PT asked students to compare the outcomes of different graphing methods. This was also particularly evident when comparing answers between groups during Day 4's outdoor activity.	On **Day 2**, students considered alternative methods for solving systems of linear equations, like using substitution and elimination. On **Day 4**, when solving for the inequality $3x + 5y \geq 45$, groups explored multiple combinations of points to get at least 45 points, demonstrating an understanding of alternative solutions.
	Questions prompt further investigation.	**Observed** when PT asked, "What would happen if we used different values for x and y?" during **Day 5**, prompting students to explore beyond just the equations. Students were asked to consider multiple solutions (e.g., exploring various combinations of answers that satisfy the inequality).	On **Day 5**, a student asked, "How can we determine if a point is in the solution set of an inequality?" This prompted further investigation into testing points and determining whether they satisfy the inequality.
	Questions reflect on the learning process and personal understanding.	Observed in **peer interactions** during the group activities (e.g., discussions about the meaning of "greater than or equal to" and "less than" symbols) in Day 4.	On **Day 1**, a student asked, "Is this the right way to graph it?" showing reflection on their understanding of graphing. On **Day 5**, a student asked, "How do we know if our point is valid for the inequality?" This was a reflection on

			their learning process, confirming that the point chosen met the conditions of the inequality.
	Questions seek to understand the underlying principles or theories behind.	**Not observed**. The questions focused mainly on solving the problems rather than delving into the theory or reasoning behind the methods.	**Not Observed.**
2. Analyzing information from multiple perspectives	Recognizes that there are multiple ways to approach a mathematical problem.	**Observed Day 1, Day 3, and Day 4:** During the graphing activity on Day 1, students were able to identify that there are different ways to plot solutions to systems of linear equations (e.g., using substitution versus graphing). In Day 4, when solving for inequalities, students explored both graphical solutions and test point methods. **Observed** throughout **Days 4 and 5** when students discussed different ways to graph inequalities (solid vs broken lines). Groups compared how they applied the principles of inequalities.	On **Day 1**, during the lesson on systems of equations, students were able to recognize that they could use both **graphing** and **substitution** methods to solve the same problem. For example, a student mentioned, “We can graph the solution and then check it with substitution,” showing that they understood the two methods could be used to cross-check each other and lead to the same conclusion. On **Day 2**, when solving systems of equations, students discussed how different methods like **elimination** and **substitution** could be applied to the same problem. A few students noted that

			elimination was simpler for some equations, while substitution might be easier for others. This showed their ability to think about problems from different angles and select the method that suited them best. On **Day 4**, during the problem-solving activity for “at least 45 points,” students acknowledged that they could use both **graphing** and **algebraic substitution** to find solutions to the inequality. Some students used graphing to visualize the solutions, while others used algebra to solve for the exact values, showing flexibility in their problem-solving approaches.
	Compares the outcomes of using various strategies to solve the same problem.	**Day 2 and Day 5**: Students compared the outcomes of using the elimination and substitution methods for solving systems of equations. Similarly, on **Day 5**, when working with inequalities, students compared outcomes based on different test points that satisfied or did not satisfy the inequalities. **Observed** on **Day 4** when groups compared different	On **Day 4**, students compared the outcomes of their graphing solutions by discussing whether the points above the line satisfied the inequality. Some groups discussed how their answers (from **substitution**) matched the results from their graphs,

		methods (solid vs broken lines) and discussed their approaches to solving inequalities.	while others tested points above the line on their graph to check if they met the condition of "at least 45 points."
	Examines alternative solutions and explains why they work or do not work.	**Observed on Day 1 and Day 3**: When discussing different methods for solving systems (substitution vs elimination), students explained why one method worked better for certain types of equations, showcasing an understanding of the strengths and weaknesses of each approach. **Observed** during **Day 5** when students analyzed alternative graphing methods, such as the use of solid lines vs. broken lines, and provided explanations for their solutions.	On **Day 4**, students explained why some points (like (5, 9)) satisfied the inequality and others did not, demonstrating a critical examination of their solutions.
	Synthesizes information from various perspectives to form a comprehensive understanding.	**Observed** when groups synthesized different graphing strategies (e.g., solid line for $\geq$ and $<$, and broken lines for $<$ or $>$) to form a clearer understanding of how these affect their graphs on Day 4 and Day 5.	On **Day 4**, students used both graphical and algebraic methods to solve inequalities, synthesizing their understanding of both approaches.
	Reflects on how considering multiple perspectives enhances understanding	**Not observed**. Though perspectives were shared, students did not explicitly reflect on the value of considering **multiple approaches** in depth.	**Not Observed.** While students used multiple approaches, there was no direct reflection on how these different methods enhanced their understanding.

3. Evaluating Evidence	Selects evidence that directly supports a mathematical argument or solution.	**Day 2 and Day 4: On Day 2,** when solving systems of equations, students presented their solutions and then validated them by substituting values back into the original equations to check for consistency. In Day 4, students selected test points from the solution regions to validate that they satisfied the inequalities they were solving. **Observed** during **Day 5**, particularly when students validated their graphs and test points (e.g., verifying that x=9, y=0 was correct because it satisfied the inequality).	On **Day 3**, students used test points to validate their solutions, confirming that their answers met the criteria of the problem. On **Day 5**, students used test points to ensure their graphical solutions satisfied the inequality.
	Verifies the accuracy of calculations and provides enough evidence.	Observed **Day 1, Day 2, and Day 3**: Students verified their results when solving equations and systems. For example, in **Day 1**, after solving graphically, students checked their points by substituting them back into the original equations. This was a consistent practice across multiple days of observation. **Observed** on **Day 5** when students checked their intercepts and test points to ensure their graph represented the correct solutions for the inequality. This included comparing their results with others'.	On **Day 1**, after students solved systems of equations, they used both the **graphing** and **substitution** methods to verify their answers. For example, a student graphed their solution and then checked it by substituting the coordinates into the original equations. On **Day 2**, students verified their work after using **elimination** and **substitution**. They compared the results of both methods to ensure they arrived at the same solution.

			On **Day 5**, when students were asked to test points for linear inequalities, they correctly used **test points** to check whether the points they selected on their graph satisfies the inequality. This verification process demonstrated their ability to double-check their work.
	Providing enough evidence to support reasoning	**Observed** during **Days 4 and 5** when students explained their graphing process, citing test points, intercepts, and rules of graphing inequalities to support their work. This is also observed for day 1, 2, and 3 where students tried the intercepts to see the evidence if their graphs are correct.	On Day 1's activities, students demonstrated **providing enough evidence** to support their reasoning when they justified their graphing results. For example, one student explained how they substituted values into equations to find the point of intersection and then verified this point using their graph. On **Day 2**, when discussing the results of solving systems of equations, students provided evidence for their answers by **checking their calculations** and verifying the results with substitution. For instance, when substituting a value back into one of the original equations,

			the students showed how the values satisfied the equation. On **Day 3**, as students solved these problems, they **supported their reasoning** by providing **evidence** for their answers. For example, when finding the equation of a line, students showed step-by-step calculations, such as finding the slope, intercepts, and substituting values into the equation. On **Day 4**, when the students graphed the inequalities and presented their solutions, they provided evidence to justify their reasoning. **Test points** were used as evidence to verify whether the points on the graph satisfies the inequality. On **Day 5**, students **provided evidence** by selecting test points from the solution set and checking if they satisfied the inequality. For example, when solving for the inequality

			6x+y>66x + y > 66x+y>6, students provided test points like (4, 8) and (3, 7), and demonstrated that these points satisfied the inequality.
4. **Demonstrating logical reasoning**	Ensures each step of the reasoning process is clear and follows from the previous step.	Observed throughout **Day 1 to Day 5**: When solving linear equations, especially in **Day 2 and Day 4**, students followed a clear, step-by-step process. In **Day 2**, when using substitution, students logically deduced the value of one variable before substituting into the second equation. **Observed** on **Days 4 and 5** when students provided a logical sequence for their graphing steps, such as confirming intercepts, applying test points, and ensuring correct shading.	On **Day 1**, students demonstrated clear logical reasoning when solving systems of equations, especially when they explained each step of the **substitution** and **graphing** methods. For example, a student explained, “First, we substitute the value of y into the second equation, then solve for x,” showing that they understood how to logically move through the process. On **Day 2**, when students used **elimination** and **substitution** methods, they logically explained their steps. For example, in the **elimination method**, students would say, “We eliminate one variable by multiplying the equations and then

			solve for the other variable," clearly outlining their reasoning. On **Day 5**, during the test point exercise, students demonstrated step-by-step reasoning when testing their points. For example, one student showed their work by saying, "If x = 3 and y = 5, substitute these values into the inequality to check if the solution is valid." This step-by-step clarity in reasoning helped them verify their results.
	Supports claims with appropriate mathematical evidence, examples, theorems and principles.	**Day 3 and Day 5**: Students supported their solutions to equations with evidence. For example, on Day 3, students showed their step-by-step work to justify the values they obtained for the unknown variables. Similarly, on Day 5, students used graphical evidence and test points to validate their inequalities. **Observed** on **Days 4 and 5** when students used specific mathematical evidence (e.g., intercepts, test points) to validate their graphs and solutions. For day 1-3, in group discussions, students supported their choices with evidence by calculating **intercepts** and testing points	On **Day 2**, students supported their solutions with algebraic evidence, verifying their results through substitution and elimination. On **Day 5**, students used mathematical evidence by applying test points to verify that the solutions satisfied the inequalities.

		(e.g., "Does this point satisfy the equation?").	
	Avoids contradictions in reasoning and calculations.	**Observed on Days 1, 2, and 5:** When solving systems of equations, students consistently avoided contradictions in their reasoning. For example, on Day 1, when using substitution, students did not get contradictory solutions when they checked their answers by substituting them back into the original system. **Not observed in the other days**. Some errors in sign usage (positive/negative) were noticed, but not contradictions in reasoning.	**Not observed.**
	Applies general principles to specific cases accurately.	**Observed** during **Days 4 and 5** when students applied the general rules for graphing inequalities (solid vs broken lines) accurately to specific cases. Students applied principles of graphing inequalities to specific equations. They correctly differentiated "greater than or equal to" with "less than or equal to" inequalities.	On **Day 5**, students applied general principles of inequalities and the Cartesian plane to solve specific cases, such as graphing inequalities and choosing test points.
	Uses patterns and examples to form generalizations.	**Observed** in **Day 5** when students generalized the use of solid lines for inequalities like y≥ and broken lines for <, based on previous examples from class.	**Not Observed.** Students did not explicitly use patterns to form generalizations. Their approach was more focused on applying given methods to solve specific problems.

5. Applying Knowledge to Real-World Applications	Demonstrates how mathematical theories and principles can be used to solve practical problems.	**Day 4**: The teacher presented a real-world problem involving a quiz game where easy and challenging questions earned points. Students applied their knowledge of linear equations to solve for different combinations of easy and challenging questions that would total 45 points. Day 5 Observed: In the **outdoor group activity**, students solved real-life problems (e.g., math quiz with easy and hard questions worth points), graphing inequalities to find solutions.	On **Day 3**, students applied the concept of **systems of equations** to a real-world situation about **pigs and chickens** on a farm. They used the total number of heads and legs to set up equations and solve for the number of pigs and chickens. This demonstrated their ability to connect algebraic concepts to practical scenarios. On **Day 4**, when solving the problem about **easy** and **challenging questions** in a quiz, students used inequalities to determine combinations that would achieve a total of **45 points** or more. This real-world application helped them understand how linear inequalities can be used to solve practical problems, such as scoring a certain number of points in a quiz.

	Justifies the selection of specific methods based on the problem context.	**Observed on Day 3 and Day 5**: Students justified their method of solving inequalities based on the problem context. On **Day 3**, students chose substitution over elimination for problems where one equation was already solved for a variable. On **Day 5**, students used test points to verify solutions, justifying the method based on the need to check the feasibility of solutions in real-world contexts (e.g., points on a graph satisfying inequalities). **Observed** on **Day 4** when students explained why they used solid vs. broken lines depending on the inequality symbols, demonstrating context-based decision-making.	On **Day 4**, students justified using the graphing method to find solutions to inequalities, explaining that it was easier to visualize the solutions in this format.
	Develops mathematical models to represent real-world situations.	**Day 4:** Students developed mathematical models when solving the quiz problem by creating equations based on the number of easy and hard questions. They translated this model into a solution that could be graphed on a Cartesian plane to find combinations that meet the given conditions (45 points). **Observed** on **Day 4**, where students created graphs representing real-world situations (quiz points) to solve practical problems using linear inequalities.	On **Day 5**, students developed mathematical models by graphing inequalities to represent real-world scenarios such as meeting a score threshold.

	Interprets the results of mathematical models in the context of the real-world problem.	**Observed** on **Days 4 and 5**, when students interpreted the results of their graphs, such as checking whether points like (8,8) satisfied the inequality.	On **Day 5**, students interpreted their graphical solutions by evaluating whether the plotted points met the inequality constraints, such as ensuring the score was at least 45.
	Explains the application of mathematical concepts and solutions clearly.	**Observed** on **Days 4 and 5**, when students clearly explained their graphs and reasoning to the class, demonstrating an understanding of how their solutions applied to real-world problems as well as their graphing models represented real scenarios. For example, on **Day 4**, students explained how the points above the line represented valid solutions to the quiz problem. On Day **5**, they explained the concept of test points to validate the inequality solutions.	On **Day 5**, students explained their process of graphing and verifying inequalities to the class, demonstrating a clear understanding of how the concepts applied to real-world problems.
	Reflects on the effectiveness of applying mathematical knowledge to real-world problems.	**Not observed during the observations**. Although students validated their answers using test points and by checking calculations, they did not explicitly reflect on the effectiveness of their methods or solutions.	**Not Observed.**

APPENDIX S
TABLE 10: SCENARIOS OF SUB-INDICATORS

Critical Thinking Indicator A. Asking Relevant Questions to Open Critical Thinking Skills" to emphasize the role of questions in fostering deeper thinking.

- Discovery learning through questioning.

Sub-indicator A. Questions are directly related to the current mathematical concept or problem being discussed.

Description	Actual Interaction
In this classroom scenario, the teacher presented a quiz where students had to solve a system of linear equations using the graphing method. One student, after solving for the intercepts and graphing the equations, reached the solution (x=1, y=2). Afterward, another student asked an insightful question about how to determine the point of intersection of the two lines after obtaining the equations that shows curiosity and a deeper understanding of the graphing method. The teacher responded by explaining the process of finding the slopes and intercepts and how the point of intersection (x=1, y=2) satisfies both equations, confirming it as the solution to the system. The student's question arose from a desire to fully understand the process and clarify how the intersection of the lines represents the solution to the system of equations.	T: Okay, let's have a quiz. ● On the board: Solve the system by graphing method. Find the solution: $2x + y = 4$ $4x - y = 2 = 2$ S1's answer: $x = 1, y = 2$ S1: Nagkuha kog x −intercept and y −intercept. I let x as 0 to get y −intercept. Nag let $y = 0$ pod ko para makuha ang x −intercept on both equations. Mao dayun ni ang mga intercepts and the solution is $x = 1,\ y = 2$. The student does not include the explanation as to how he got the solution $x = 1\ and\ y = 2$. Then, the teacher explains the answer of S1. T: Unsay solution class? First, to get x, we will let $y = 0$. Same pod, to get y, we let $x = 0$. (The teacher explains the process on what is written on the board by the student's answer about getting the intercepts) Continuation* S: Pero ma'am hmm, unsaon or uhm mao ba ni pagkuha sa point of intersection sa two lines if naa na tay equations? (Asking Insightful Question Subindicator #1) T: We will answer that. But, listen first, we have to get the slopes and the y-intercepts to graph the equations. Naa tay $y = mx + b$. Sa first equation ang atung slope is $\frac{-2}{1}$, ang intercept is $(0{,}4)$. Iplot ang intercept then mag rise/run dayun. Sa kani (referring to the (0,4) point), mag rise/run ta og $\frac{-2}{1}$. Paubos ang -2 and pa-right and 1. Mao na dayun ni (referring to the (1,2) point. Sa 2nd equation, ang slope is $\frac{4}{1}$and ang intercept is $(0, -2)$. Iplot napod nato ni.. Ang rise over run is positive. From the point, magcount ta 4 pataas and 1 to the right. Niarrive ta ani na point. (Take note that the teacher refers to the graph of the student) So sa kani na graph (referring to S1's graph), kani na point diri nag satisfy ($x = 1, y = 2$) ang system of the equation since they (the lines) intersect. It is the solution to the system.

Sub-indicator B. Questions seek to resolve misunderstandings or errors in reasoning.

Description	Actual Interaction
During the discussion on graphing inequalities, Group 2	Nagtry mi og plot sa point namo ma'am which is ang $(0{,}9)$, mo satisfy amoang equation pero naa mi nalibog ma'am. Unsay naa sa greater than

encountered confusion about the meaning of the "greater than or equal to" (≥) symbol in their inequality, 3x + 5y ≥ 45. While their algebraic reasoning was correct, they misinterpreted how to represent the solution graphically. Through questioning and guided interaction with the teacher, they clarified their understanding by testing points and analyzing their placement relative to the boundary line.	or equal na symbol ma'am? PT: So if greater than or equal ang symbol, moequal ba japon imohang $3x + 5y$ sa 45? G2 Representative: Yes, ma'am. PT: How about if mogreater than sa 45? G2: Ahh, so pwede lage siya molapas ma'am. Naa lang ang boundary diari sa line. So if we try to have another random point, say $(7,14)$: $3(7) + 5(14) = 91$ which is greater than 45. What if we try on the left side of the graph ma'am? We use point $(2,2)$, so we will have: $3(2) + 5(2) = 16$ which is less than 45 na dili siya mosatisfy sa equation. Our theory is that para ma-satisfy ang $3x + 5y \geq 45$, dapat ang points must be equal or greater than the original point. (Group 1's answer and graph are correct, while Group 2's answer is correct but their graph is incorrect.) PT then explains and clarifies the correct way to represent the solution graphically.

Sub-indicator C. Questions challenge the assumptions underlying a problem or a solution.

Description	Actual Interaction
A student questioned the necessity of graphing when an algebraic solution was already available. This prompted a clarification on the value of visual methods and challenged the idea that one method is sufficient in problem-solving.	S: Ma'am, kung na-solve naman nato ang x ug y gamit ang equation, kinahanglan pa ba gyud nato i-graph? T: That's a good question. Even if you have the algebraic answer, graphing helps you see the solution and verify it visually. It gives more meaning to your answer.

Sub-indicator D. Questions consider alternative methods for solving a problem.

Description	Actual Interaction
During quiz bee, students asked whether they could use substitution or elimination instead of graphing. This showed their initiative in exploring other methods for solving systems of equations.	S from G1: Among gikuha una ma'am is ang slope katung formula nga $\frac{(y_2-y_1)}{x_2-x_1}$. Among m is $-½$ and then sa pagkuha ni b kay naggamit ra mi sa slope-intercept form and then gigamit namo ang isa ka point like ang $(5, -3)$. In this moment, students asked whether they could use substitution. This showed their initiative in exploring other methods for solving b. S: Pwede substitution method na lang amo gamiton ani, Ma'am? Mas sayon man gud namo. T: Yes, that's correct. Substitution is another valid way. What's important is you understand the process and choose the method that works best for the situation. S: Gisubstitute namo since pag i-subsitute kay ang mabilin ra man kay ang b. Giverify pod namo siya sa other point sakto ra man sab. So like $y = mx + b, -3 = -½\,(5) + b$, ang result is $b = -1/2$. Mao dayun among equation $y = -½\,x + -½$.

Sub-indicator E. Questions prompt further investigation.

Description	Actual Interaction
While analyzing graphs of inequalities, students raised follow-up questions that required testing different points and checking solution regions. This led to further inquiry and verification exercises. After the discussion, the PT assesses the students through a **short quiz**. **(Quick Quiz Formative Assessment)**	PT: Let's have a quiz. Get 1 whole sheet of paper, class. With the problems presented earlier, answer this problem. "Imagine you and your friends are in a big Math Quiz. Easy questions get you 3 points, and the harder ones are worth 5 points each. 1. Your team needs **more than** 45 points to advance to the next round. Write the algebraic representation of this scenario. Sketch the graph. 2. What if your team, for some reason, only wants to get **less than** 45 points? Write the algebraic representation of this scenario. Sketch the graph." One student asks the PT: Ma'am, what will we do if dili apil ang line kay since less than man and dili less than or equal? PT: Very good question. Class, we will make a deal. If it has an equal sign, greater than or equal and less than or equal, use solid line then decide if shaded or not, then for those symbols with less than and more than, use broken lines since what?.... Apil or dili apil ang line? Class: Dili apil, ma'am. PT: Good.

Sub-indicator F. Questions reflect on the learning process and personal understanding.

Description	Actual Interaction
The PT presents a well-crafted problem connected to their past lesson (linear equalities). She advises them to read the problem first and understand what the problem requires. She requires them to answer the problem individually. The PT then asks to graph their solutions by group. The problem is provided below: "Imagine you and your friends are in a big Math Quiz. Easy questions get you 3 points, and the harder ones are worth 5 points each. Your team needs 45	PT: Let us all read the problem. (altogether reads the problem). Take note class the word "exactly" Then, the students answer the given problem. After 15 minutes, the PT divides the students into 11. Then, the teacher requires each group to share their answers, graph solutions, and solve the presented problem collaboratively (Group Activity- another formative assessment strategy). Also, the teacher gives a cartesian plane in a manila paper for each group. PT: Okay. So nakapaerform mo og lines. Now, I will call Group 6 since they were able to plot their points and they have a total of 4 points labeled in their graph. Representative from Group 6: Among gibuhat ma'am kay naghunahuna sa mig mga values, combination of values, para mahimong 45. $x = 9, y = 0$ $x = 6, y = 5$ $x = 3, y = 10$ $x = 0, y = 15$ Dili jud ni siya in-ani tanan, naa mi gipangwala na uban kay tungod gusto mi magfocus sa amoang nabuo na equation which is ang: $5x + 3y = 45$ So for easy questions and hard questions, using these values, masatisfy

points to advance to the next round. Can you figure out three ways to mix easy and hard questions to get exactly 45 points?"	ang amoang equation. Mao dayun ni among pagplot sa among points, ma'am. Is this correct, ma'am? Or naa pay kulang sa amo I think? Correct Answer: The students can use any coefficients for two variables so that it equates to 45. Groups 1,3,4,5,6,7,9,10 have correct answers. The graph may also vary as to what their equations are, as long as, it represents the whole equation of the problem and the expression equates to 45. PT: That is correct. Very good.

Sub-indicator G. Questions seek to understand the underlying principles or theories behind.

Description	Actual Interaction
A student asked about the substitution method, prompting the teacher to review and re-teach the concept using a detailed example. The students actively engaged by asking follow-up questions and recognizing the use of slope-intercept form, showing their effort to understand the underlying principle of substitution.	S3: Nakalimot mi ma'am unsaon ang substitution. (The class gets noisy again). S4: Unsay i-substitute sa substitution method gani ma'am? The teacher now realizes that the students can't recall their previous discussion. T: Okay, class. Magreview sa daw ta. Unsaon gani ang substitution? S5: Naay isubstitute, ma'am.

Critical Thinking Indicator B. Analyzing information from multiple perspectives

- Examine a math problem or concept in different ways or using methods and representations.

Sub-indicator A. Recognizes that there are multiple ways to approach a mathematical problem.

Description	Actual Interaction
In the lesson, the teacher presented 3 problems, and the problem 2 where students needed to find combinations of easy (3 points) and hard (5 points) questions to earn at least 45 points to advance to the next round. Group 2 (G2) began by plotting the point (0, 9), which satisfied the equation 3x + 5y = 45. However, they became confused about the meaning of the "greater than or equal to" (≥) symbol in the equation. The teacher clarified that the total points could be equal to or greater than 45. G2 then tested other points: (7, 14) resulted in more than 45 points, and (2, 2) resulted in fewer than 45 points. Through this exploration, G2 understood that there are multiple ways to solve the problem, as long as	The PT presents a well-crafted problem connected to their past lesson (linear equalities).She requires them to answer the problem individually. The PT then asks to graph their solutions by group. Problem 1: "Imagine you and your friends are in a big Math Quiz. Easy questions get you 3 points, and the harder ones are worth 5 points each. Your team needs 45 points to advance to the next round. Can you figure out three ways to mix easy and hard questions to get **exactly** 45 points?" PT: Let us all read the problem. (altogether reads the problem). Take note class the word "exactly" Then, the students answer the given problem. —------------ (PT presents the second problem-which is the next lesson) Problem 2: "Imagine you and your friends are in a big Math Quiz. Easy questions get you 3 points, and the harder ones are worth 5 points each. Your team needs at least 45 points to advance to the next level round. Can you come up with different combos of easy and hard questions to ensure your team hits or exceeds the 45-point target?" G2's Explanation: Nagtry mi og plot sa point namo ma'am which

the points meet or exceed 45. This realization helped them recognize that there are different combinations of easy and hard questions that satisfy the equation.	is ang (0,9), mo satisfy amoang equation pero naa mi nalibog ma'am. Unsay naa sa greater than or equal na symbol ma'am? PT: So if greater than or equal ang symbol, moequal ba japon imohang $3x + 5y\ sa$ 45? G2 Representative: Yes, ma'am. PT: How about if mogreater than sa 45? G2: Ahh so pwede lage siya molapas ma'am. Naa lang ang boundary diari sa line. So if we try to have other random point say $(7,14)$ $3(7) + 5(14) = 91$ na greater than sa 45. What if we try on the left side of the graph ma'am? We use point $(2,2)$, so we will have $3(2) + 5(2) = 16$ which is less than 45 na dili siya mosatisfy sa equation. Our theory is that para ma-satisfy ang $3x + 5y \geq 45$, dapat ang points must be equal or greater than the original point. (2 Ways to solve the problem)

Sub-indicator B. Compares the outcomes of using various strategies to solve the same problem.

Description	Actual Interaction
In the observed lesson, the teacher posed a problem involving a total of 45 points from a combination of easy and challenging questions, allowing students to solve it using their own strategies. After working individually, students were grouped to discuss their solutions and plot them on a Cartesian plane. Each group formed equations, converted them to standard form, and identified points that satisfied the condition. The teacher then modified the problem to "at least or equal to 45 points," prompting students to find new combinations that met the updated condition. Through discussion and presentation, students demonstrated an understanding of linear equations and inequalities by identifying points above or on the line that satisfies the given conditions.	**Sub-indicator B. Compares the outcomes of using various strategies to solve the same problem.** Short Description of what happened: Actual Interaction: Teacher: "So, most of your answers are correct. So now, what if I'll change the question of the problem? From a total of 45 points to at least or equal to 45 points? Can you find a combination or targets (3) to get at least or equal to 45 points using your cartesian plane. I'll give you 5 mins" (After 5 mins) Teacher: "Post your cartesian plane on the board and explain to the class your answers." Group A: ("A" don't represent group 1 and so on) "Give me points that are above the line? (He asked his classmates and his classmates responses 9 and 9) Now, let's try, $3x + 5y \geq 45$ using $(9,9)$ $3(9) + 5(9) \geq 45$ $27 + 45 \geq 45$ $72 \geq 45$ Which is correct, so magpili ramog points nga lapas sa line since at least or equal to 45 man." Group B: "Among gipili nga points ma'am kay 5 and 9 so (5,9). Now, itry nato, $3x + 5y \geq 45$ $3(5) + 5(9) \geq 45$ $9 + 45 \geq 45$ $54 \geq 45$ So maskig unsa nga points ang kuhaon basta kay above the line ma satisfy ra ang inequality. Example, sa last group and amoa, we didn't have the same values but na satisfy ra namo respectively. Which is correct"

	Teacher: So why are there two lines in your cartesian plane? Please Group C explain this." Group C: "Kuan maam, ang amoa kay if mangita napod kag points babaw sa line nga $3x + 5y = 45$ kay ma satisfy ang $3x + 5y \geq 45$. Pwede pod maam to verify the inequalities kay mo pili kag points nga below sa line if dili ma satisfy ang inequalities meaning correct and representations. In other words, dili ka pwede magpili og values depend on what areas, example kani kay dapat sa above ragud sa line na mga points para ma satisfies ang inequality."

Sub-indicator C. Examines alternative solutions and explains why they work or don't work.

Description	Actual Interaction
In this scenario, the teacher asked students to post their Cartesian planes and explain their solutions to an inequality problem involving a total of at least or equal to 45 points. Group A and B explained that points above the line of the equation 3x+5y=45 satisfy the inequality. They each selected different points that met the condition, demonstrating that multiple valid answers exist. When the teacher inquired about the presence of two lines in the graph, Group C clarified that one line represents the boundary (the equation), while the other helps verify which side of the graph satisfies the inequality. They emphasized the importance of choosing appropriate regions—above or below the line—depending on the inequality's direction.	Teacher: "Post your cartesian plane on the board and explain to the class your answers." Group A: ("A" don't represent group 1 and so on) "Give me points that are above the line? (He asked his classmates and his classmates responses 9 and 9) Now, let's try, $3x + 5y \geq 45$ using (9,9) $3(9) + 5(9) \geq 45$ $27 + 45 \geq 45$ $72 \geq 45$ Which is correct, so magpili ramog points nga lapas sa line since at least or equal to 45 man." Group B: "Among gipili nga points ma'am kay 5 and 9 so (5,9). Now, itry nato, $3x + 5y \geq 45$ $3(5) + 5(9) \geq 45$ $9 + 45 \geq 45$ $54 \geq 45$ So maskig unsa nga points ang kuhaon basta kay above the line ma satisfy ra ang inequality. Example, sa last group and amoa, we didn't have the same values but na satisfy ra namo respectively. Which is correct" Teacher: So why are there two lines in your cartesian plane? Please Group C explain this." Group C: "Kuan maam, ang amoa kay if mangita napod kag points babaw sa line nga $3x + 5y = 45$ kay ma satisfy ang $3x + 5y \geq 45$. Pwede pod maam to verify the inequalities kay mo pili kag points nga below sa line if dili ma satisfy ang inequalities meaning correct and representations. In other words, dili ka pwede magpili og values depend on what areas, example kani kay dapat sa above ragud sa line na mga points para ma satisfies ang inequality."

Sub-indicator D. Synthesizes information from various perspectives to form a comprehensive understanding.

Description	Actual Interaction
In this scenario, the teacher posed a real-world problem involving a point system, encouraging students to	(After forming the equation) Teacher: "Post your cartesian plane on the board and explain to the class your answers." Group A: ("A" don't represent group 1 and so on)

explore various ways to represent and solve it. Initially, students worked individually, then collaboratively in groups to form equations, graph them, and interpret the results. Each group presented different strategies—some focusing on converting equations to standard form, while others tested multiple value combinations. When the condition changed from an exact total to "at least or equal to" 45 points, students identified and plotted new solutions, highlighting the region that satisfies the inequality. Group C further explained the use of multiple lines to test and verify which areas satisfy the condition. Through group discussion and explanation, students synthesized different perspectives and methods, leading to a clearer and shared understanding of linear equations and inequalities	"Give me points that are above the line? (He asked his classmates and his classmates responses 9 and 9) Now, let's try, $3x + 5y \geq 45$ using (9,9) $3(9) + 5(9) \geq 45$ $27 + 45 \geq 45$ $72 \geq 45$ Which is correct, so magpili ramog points nga lapas sa line since at least or equal to 45 man." Group B: "Among gipili nga points ma'am kay 5 and 9 so (5,9). Now, itry nato, $3x + 5y \geq 45$ $3(5) + 5(9) \geq 45$ $9 + 45 \geq 45$ $54 \geq 45$ So maskig unsa nga points ang kuhaon basta kay above the line ma satisfy ra ang inequality. Example, sa last group and amoa, we didn't have the same values but na satisfy ra namo respectively. Which is correct" Teacher: So why are there two lines in your cartesian plane? Please Group C explain this." Group C: "Kuan maam, ang amoa kay if mangita napod kag points babaw sa line nga $3x + 5y = 45$ kay ma satisfy ang $3x + 5y \geq 45$. Pwede pod maam to verify the inequalities kay mo pili kag points nga below sa line if dili ma satisfy ang inequalities meaning correct and representations.In other words, dili ka pwede magpili og values depend on what areas, example kani kay dapat sa above ragud sa line na mga points para ma satisfies ang inequality."

Sub-Indicator E. Reflects on how considering multiple perspectives enhances understanding.
(NOT OBSERVED)

Description	Actual Interaction
N/A	N/A

Critical Thinking Indicator C. Evaluating Multiple Perspectives with Evidence

- Judging the validity of the information/arguments used to solve a math problem

Sub-indicator A. Selects evidence that directly supports a mathematical argument or solution.

Description	Actual Interaction
During a problem-solving activity, students were tasked with solving a system of linear equations using the substitution and elimination method. One student selected a piece of evidence-substitution, specifically a calculated value for x, that directly supported their solution. When solving for y, the student validated the solution by substituting back into the original equations to	T: Okay, class. Time's up. Exchange your papers. Put corrected by. Who will answer for no.2? (PT selects student to answer for no. 2 and no. 3) Okay. How about number 3? The two students presented and wrote their answers on the board. On the board: Student's Answer: (No. 2) $x + y = 14$ $y = x + 2$ $x + x + 2 = 14$ $2x + 2 = 14$ $2x = 14 - 2$ $2x = 12$ $2x/2 = 12/2$ $x = 6$

check for consistency. This evidence confirmed that their solution was correct, and the student was able to present their argument clearly to the class. The student demonstrated how their calculations and substituted values directly supported their argument that the solution was correct.	$y = 6 + 2$ $y = 8$ Checking: $8 = 6 + 2$ $8 = 8$ Teacher assigns point for this item with 6 points/6 points. Student's Explanation: To solve for x, using substitution method, plug in y, so $x + x + 2 = 14$…(continues) Adding those, so $2x + 2 = 14$ We have now, $2x = 12$ Dividing both sides by $2, x = 6$ Solving for y, plug in x: $y = 6 + 2 = 8$ For checking, plug in values of x and y $y = 6 + 2$ $8 = 8$ The solution is $(6,8)$.

Sub-indicator B. Verifies the accuracy of calculations and provides enough evidence.

Description	Actual Interaction
During a problem-solving activity, students were tasked with solving a system of linear equations using the substitution and elimination method. One student selected a piece of evidence-elimination, specifically a calculated value for x, that directly supported their solution. When solving for y, the student validated the solution by substituting back into the original equations to check for consistency. This evidence confirmed that their solution was correct, and the student was able to present their argument clearly to the class. The student demonstrated how their calculations and substituted values directly supported their argument that the solution was correct.	T: Okay, class. Time's up. Exchange your papers. Put corrected by. Who will answer for no.2? (PT selects student to answer for no. 2 and no. 3) Okay. How about number 3? The two students presented and wrote their answers on the board. Student's Answer No. 3 $x - 2y = -6$ $5x - 3y = -30$ $5(x - 2y) = (-6)5$ $5x - 10y = -30$ $5x - 10y = -30$ $-(5x - 3y = -30)$ — — — — — — — — — — — — — — — — $-7y = 0$ $y = 0$ $For\ x$: $x - 2y = -6$ $x - 2(0) = -6$ $x = -6$ $Checking$: $x - 2y = -6$ $-6 - 2(0) = -6$ $-6 = -6$ $5x - 3y = -30$ $5(-6) - 3(0) = -30$ $-30 = -30$ Student's Explanation: Using elimination method, we multiply both sides of this (reffering to $x - 2y = -6$) by 5 and subtract results to other problem. We get $y = 0$. Solving for x, kay amo lang gi-substitute si y na value na among nakuha. Ang result

	is $x = -6$. To verify, gi-substititute namo ang value ni x and y. $x - 2y = -6$ $-6 - 2(0) = -6$ Ang mabilin kay -6, sakto ang solution.

Critical Thinking Indicator D. Demonstrating logical reasoning

- Showing a clear, step-by-step thought process in solving math problems connecting mathematical concepts.

Sub-indicator A. Ensures each step of the reasoning process is clear and follows from the previous step.

Description	Actual Interaction
Topic: Systems of Linear Equations The P.T. presents the quiz bee as a group activity. The five groups of students position themselves at each corner where their bulletin boards are assigned. The quiz bee consisted of 3 stages.	Q2: What is the slope of the line with points $(5, -3)\ and\ (7, -2)$? On their bulleting boards: G1: $y = -½x + -½$ G2: No answer G3: $m = -½$ $y = -½x + -9/2$ G4: $y = ½x - ½$ G5: No answer. PT: The correct answer is $y = -½x + -½$ IT: Good job, Group 1. Can you explain how did you get your equation? S from G1: Among gikuha una ma'am is ang slope katung formula nga $((y_2 - y_1)/(x_2 - x_1))$. Among m is $-½$ and then sa pagkuha ni b kay naggamit ra mi sa slope-intercept form and then gigamit namo ang isa ka point like ang $(5, -3)$. In this moment, students asked whether they could use substitution. This showed their initiative in exploring other methods for solving b. S: Pwede substitution method na lang amo gamiton ani, Ma'am? Mas sayon man gud namo. T: Yes, that's correct. Substitution is another valid way. What's important is you understand the process and choose the method that works best for the situation. S: Gisubstitute namo since pag i-subsitute kay ang mabilin ra man kay ang b. Giverify pod namo siya sa other point sakto ra man sab. So like $y = mx + b, -3 = -½(5) + b$, ang result is $b = -1/2$. Mao dayun among equation $y = -½x + -½$.

Sub-indicator B. Supports claims with appropriate mathematical evidence, examples, theorems and principles.

Description	Actual Interaction
In this scenario, Group 1 demonstrated their critical thinking skills by clearly explaining their process for solving the problem involving inequalities. They provided appropriate evidence to support their claim and validated their reasoning through graphical representations and algebraic manipulations.	Group 1: The representative from Group 1 shared their process for solving the inequality, explaining, "We used the equation $3x + 5y \geq 45$ and selected points like (9, 0) and (3, 10) because they satisfy the inequality, where the sum of the two expressions exceeds 45." The student highlighted how these points, plotted on the graph, fit the inequality's conditions by shading the appropriate area to represent the solution region. The student also referenced test points, such as (8, 8), which yielded a value greater than 45, to validate their claim that the inequality holds true in the shaded region. Teacher (PT): "Very good! As you correctly pointed out, the points $(9, 0)$ and $(3, 10)$ satisfy the inequality, and the graph correctly shows the solution set. This method of validating through test points is crucial in proving that your solution is valid."

Sub-indicator C. Avoids contradictions in reasoning and calculations.

Description	Actual Interaction
During a group discussion, the students encountered a slight issue when discussing how to graph inequalities. Despite initially plotting the inequalities and checking their work, some confusion arose regarding the interpretation of the inequality symbols, particularly with how the line should be represented. The teacher provided feedback on how inequalities should be treated (using solid vs. broken lines for different inequalities), ensuring that the students understood the logic behind the distinctions.	PT: Now, all groups from Group 1 to Group 5 will now be Group 1 and the rest, Group 6-11 will be Group 2. Present and post now your graphs and your equations. (Group activity promoting interaction and comparison of different approaches to solving the problem) Student from Group 1: We shaded the upper right part of the graph because the equation satisfies values greater than or equal to 45, using the '≥' symbol. PT: "Exactly! So, remember, when you have 'greater than or equal,' we use a solid line. If it's just 'greater than,' we use a broken line.

Sub-indicator D. Applies general principles to specific cases accurately.

Description	Actual Interaction
During the observation of the class on solving systems of linear equations, Group 1 demonstrated the application of general principles of algebra to solve a word problem involving the number of chickens and pigs on a farm through a quiz bee. The	In Stage 3 of the quiz, the teacher guided Group 1 through the creation of a system of equations based on a word problem: Problem: A farmer has a total of 10 chickens and pigs on his farm. The total number of legs among all the animals is 28. If chickens have 2 legs and pigs have 4 legs, how many chickens and pigs does the farmer have? Group 1 formulated the equations as:

students were able to translate the real-world scenario into algebraic equations and solve them accurately.	$c + p = 10$ (representing the total number of animals) $2c + 4p = 28$ (representing the total number of legs). The teacher then guided them to solve the system using the elimination method: They multiplied the first equation by -2 to facilitate elimination: $-2c - 2p = -20$ $2c + 4p = 28$ Adding the equations gave them: $2p = 8 \quad , p = 4$ Substituting p=4 into the first equation, they solved for c: $c + 4 = 10 \quad c = 6$ The solution was confirmed as c=6 (chickens) and p=4 (pigs). The teacher praised Group 1 for using general algebraic principles to solve the problem accurately and emphasized the importance of applying known mathematical concepts (such as the elimination method) to solve real-world problems.

Sub-indicator E. Uses patterns and examples to form generalizations.
(NOT OBSERVED)

Description	Actual Interaction
N/A	N/A

Critical Thinking Indicator E. Application of Concepts to Real-World Problems

- Using mathematical concepts and techniques to solve practical problems encountered in everyday life, demonstrating in addressing real-world situations.

Sub-indicator A. Demonstrates how mathematical theories and principles can be used to solve practical problems.

Description	Actual Interaction
The PT presents a well-crafted problem connected to their past lesson (linear equalities) leading to linear inequalities. The students were asked to devise algebraic representations and sketch corresponding graphs. This real-world scenario challenged students to apply their mathematical knowledge of linear equations and inequalities in a practical context, reinforcing their understanding of systems of equations and graphing.	(PT presents the second problem-which is the next lesson) Here is the problem. "Imagine you and your friends are in a big Math Quiz. Easy questions get you 3 points, and the harder ones are worth 5 points each. Your team needs **at least** 45 points to advance to the next level round. Can you come up with different combos of easy and hard questions to ensure your team hits or exceeds the 45-point target?" After a while, the students answer the given problem. Then, one student just explicitly says, S: Ma'am, mag inequality ko sa akoang equation. PT: Why inequality? S: Kay atleast ma'am , greater than or equal. The student continues to answer. After 15 minutes, PT: Are you done? Now, All groups from Group 1 to Group 5 will now be Group 1 and the rest, Group 6-11 will be Group 2. Present and post now your graphs and your equations.

	Group 1: From G1's discussion with their groupmates: Ingon atleast, so beyond the line. Or apil ang line kay equal and greater than man. Group 1's answer: $3x + 5y \geq 45$ Group 1 graphs it, and they use the points on the previous group 6's answers but they also added points that are beyond 45. $x = 9, y = 0$ $x = 3, y = 10$ $x = 9, y = 10$ $x = 100, y = 50$ $(10,10), (10,5), (0,10)$

Sub-indicator B. Justifies the selection of specific methods based on the problem context.

Description	Actual Interaction
The PT presents a well-crafted problem to review their past lesson-linear equations. The students were asked to devise algebraic representations . This real-world scenario challenged students to apply their mathematical knowledge of linear equations and in a practical context, reinforcing their understanding of systems of equations and graphing.	Problem: "Imagine you and your friends are in a big Math Quiz. Easy questions get you 3 points, and the harder ones are worth 5 points each. Your team needs 45 points to advance to the next round. Can you figure out three ways to mix easy and hard questions to get **exactly** 45 points?" Group 6: They created a series of combinations of numbers to add to 45 just like in Group 2. Illustration: (see table below) They come up with points using the equation they had:: $5x + 3y = 45;$ $x = 9, y = 0$ $x = 6, y = 5$ $x = 3, y = 10$ $x = 0, y = 15$ PT: Okay, class. Post all your cartesian planes at each corner where your group is assigned. Each group follows. ● Some groups were not able to sketch their graphs but were able to make an equation. Some groups were not able to utilize their time well. The PT proceeds and asks a question.

E	H	
20	25	45
10	35	45

	(Probing Question-Formative Assessment but this is a leading question that may not be explicitly answered by the students; they must realize this after their new lesson) PT: What can you observe in your cartesian planes? S: Line S: Points S: Linear System PT: Okay. So nakapaerform mo og lines. Now, I will call Group 6 since they were able to plot their points and they have a total of 4 points labeled in their graph. Representative from Group 6: Among gibuhat ma'am kay naghunahuna sa mig mga values, combination of values, para mahimong 45. $x = 9, y = 0$ $x = 6, y = 5$ $x = 3, y = 10$ $x = 0, y = 15$ Dili jud ni siya in-ani tanan, naa mi gipangwala na uban kay tungod gusto mi magfocus sa amoang nabuo na equation which is ang: $5x + 3y = 45$ So for easy questions and hard questions, using these values, masatisfy ang amoang equation. Mao dayun ni among pagplot sa among points, ma'am. Is this correct, ma'am? Or naa pay kulang sa amo I think? PT: That's correct. Very good.

Sub-indicator C. Develops mathematical models to represent real-world situations.

Description	Actual Interaction
In this scenario, Group 1 applied mathematical concepts to develop a model for a real-world problem involving the distribution of points in a quiz competition. They used a linear inequality to model the relationship between the number of easy and hard questions needed to reach a target score. By translating the real-world situation into a mathematical equation, the students demonstrated their ability to create a model and solve it using algebraic methods.	PT (Practice Teacher): "Let's imagine a math quiz where you earn 3 points for each easy question and 5 points for each hard question. Your team needs to score at least 45 points to advance to the next round. How would you represent this mathematically?" Group 1 (Student): "We used the inequality $3x + 5y \geq 45$, where x is the number of easy questions and y is the number of hard questions. This inequality models the total points our team needs to score to move to the next round." PT: "Great job! How did you proceed from here?" Group 1 (Student): "Next, we graphed the inequality and shaded the region that satisfies the equation, showing all the combinations of easy and hard questions that give us a total of 45 points or more.Give me points that are above the line? (He asked his classmates and his classmates responses 9 and 9) Now, let's try, $3x + 5y \geq 45 \; using \; (9,9)$ $3(9) + 5(9) \geq 45$ $27 + 45 \geq 45$ $72 \geq 45$ Which is correct, so magpili ramog points nga lapas sa line since at least or equal to 45 man."

	PT: "Excellent!"

Sub-indicator D. Interprets the results of mathematical models in the context of the real-world problem.

Description	Actual Interaction
In one of the observed sessions, the teacher engaged the students with a real-world problem through a Quiz Bee activity (3 stages) involving systems of linear equations. The problem scenario was based on the concept of chickens and pigs on a farm, where students had to create equations based on given conditions and solve for the unknowns. This exercise encouraged the students to apply their understanding of linear equations and inequalities to practical situations, reinforcing the link between mathematical concepts and real-life contexts. Group 1 demonstrated the application of general principles of algebra to solve a word problem involving the number of chickens and pigs on a farm through a quiz bee. The students were able to translate the real-world scenario into algebraic equations and solve them accurately.	In Stage 3 of the quiz, the teacher guided Group 1 through the creation of a system of equations based on a word problem: Problem: A farmer has a total of 10 chickens and pigs on his farm. The total number of legs among all the animals is 28. If chickens have 2 legs and pigs have 4 legs, how many chickens and pigs does the farmer have? Group 1 formulated the equations as: c+p=10 (representing the total number of animals) 2c+4p=28 (representing the total number of legs). The teacher then guided them to solve the system using the elimination method: They multiplied the first equation by -2 to facilitate elimination: Group 1 formulated the equations as: $c + p = 10$ (representing the total number of animals) $2c + 4p = 28$ (representing the total number of legs). The teacher then guided them to solve the system using the elimination method: They multiplied the first equation by -2 to facilitate elimination: $-2c - 2p = -20$ $2c + 4p = 28$ Adding the equations gave them: $2p = 8 \quad , p = 4$ Substituting p=4 into the first equation, they solved for c: $c + 4 = 10 \quad c = 6$ The solution was confirmed as c=6 (chickens) and p=4 (pigs). The teacher praised Group 1 for using general algebraic principles to solve the problem accurately and emphasized the importance of applying known mathematical concepts (such as the elimination method) to solve real-world problems.

Sub-indicator E. Explains the application of mathematical concepts and solutions clearly.

Description	Actual Interaction
In this scenario, Group 1 demonstrated their critical thinking skills by clearly explaining their process for solving a problem involving inequalities. They provided appropriate evidence to support their claim and validated their reasoning through graphical representations and algebraic manipulations. The teacher presented a problem about inequality. The teacher used TTP Strategy.	Problem: "Imagine you and your friends are in a big Math Quiz. Easy questions get you 3 points, and the harder ones are worth 5 points each. Your team needs **at least** 45 points to advance to the next level round. Can you come up with different combos of easy and hard questions to ensure your team hits or exceeds the 45-point target?" Group 1: The representative from Group 1 shared their process for solving the inequality, explaining, We used the equation 3x+5y≥45 and selected points like (9,0) and (3,10) because they satisfy the inequality, where the sum of the two expressions exceeds 45." The student highlighted how these points, plotted on the graph, fit the inequality's conditions by shading the appropriate area to represent the solution region. The student also referenced test points, such as (8,8), which yielded a value greater than 45, to validate their claim that the inequality

	holds true in the shaded region. Teacher (PT): "Very good! As you correctly pointed out, the points (9,0) and (3,10) satisfy the inequality, and the graph correctly shows the solution set. This method of validating through test points is crucial in proving that your solution is valid.

Sub-indicator F. Reflects on the effectiveness of applying mathematical knowledge to real-world problems.
(NOT OBSERVED)

Description	Actual Interaction
N/A	N/A

APPENDIX T
COMMENTS AND SUGGESTIONS AFTER DEFENSE

The picture can't be displayed.

APPENDIX U
COMMENTS AND SUGGESTIONS OF DRAFT CHAPTER 4 AFTER DEFENSE

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APPENDIX U (Cont'd)
COMMENTS AND SUGGESTIONS OF DRAFT CHAPTER 4 AFTER DEFENSE

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APPENDIX U (Cont’d)
COMMENTS AND SUGGESTIONS OF DRAFT CHAPTER 4 AFTER DEFENSE

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APPENDIX U (Cont'd)
COMMENTS AND SUGGESTIONS OF DRAFT CHAPTER 4 AFTER DEFENSE

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APPENDIX U (Cont'd)
COMMENTS AND SUGGESTIONS OF DRAFT CHAPTER 4 AFTER DEFENSE

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