# INVESTIGATING MATHEMATICAL REASONING BY TEACHING THROUGH PROBLEM SOLVING WITH CLAIM-EVIDENCE-REASONING

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# CHAPTER 1

# THE PROBLEM AND ITS SCOPE

## Background of the Study

Mathematical reasoning is a fundamental process in learning mathematics, as identified by the National Council of Teachers of Mathematics (NCTM). This process is where students think analytically and systematically as they investigate mathematical phenomena highlighting the role of conjecturing and justifying (Günhan, 2014; McCashin et al., 2022). In the Philippines, students often face difficulties in mathematical reasoning, primarily due to an overemphasis on rote memorization rather than the development of conceptual understanding. A research conducted by Jonsson et al. (2020) highlighted that this traditional approach, which heavily leans toward rote learning, fails to engage students in meaningful math struggles that are necessary for developing deeper understanding. These studies suggest the need for innovative teaching approaches that promote reasoning and problem-solving skills (Almerino et al., 2020).

One promising approach to address these challenges is Teaching through Problem-Solving (TTPS) – a teaching approach that encourages students to explore, conjecture, and justify their solutions, promoting their deep conceptual understanding. By presenting real-world problems, TTPS engages students in active knowledge construction and collaborative learning (Cai et al., 2014). Meanwhile, as TTPS encourages students to explore various paths to a solution, articulate their reasoning, and reflect on their learning experiences, the traditional assessments do not adequately

capture the complexity of problem-solving approaches like TTPS as it primarily focus on rote memorization (Smieee, 2023; Author, 2013).

Moreover, the Claim-Evidence-Reasoning (CER) framework, primarily used in science education, is repurposed in this study, which serves as an assessment tool to assess students' mathematical reasoning. CER provides a structured way for students to articulate their thought processes by presenting a claim, supporting it with evidence, and justifying it through reasoning (Caballero, 2023). This framework aligns with the goals of TTPS, as both emphasize justification, critical thinking, and clear communication of ideas (McNeill & Krajcik, 2014). By requiring students to construct and explain their solutions, CER directly assesses their ability to analyze, connect, and justify mathematical concepts, which are central to reasoning (ModelTeaching & Anderson, 2023).

The integration of TTPS and CER offers an innovative approach to address students' reasoning challenges. While TTPS builds reasoning through exploration and application, CER serves as an assessment tool to enhance these skills by requiring systematic articulation and justification of mathematical concepts. Despite their potential, limited research has explored the combined use of these approaches in mathematics education. Therefore, this study seeks to fill this gap by investigating students' mathematical reasoning through the use of TTPS and CER, offering insights into how these approaches can contribute to the student's mathematical reasoning.

**Research Objectives**

This study aims to address the following:

1. How are the lesson plans developed?

2. What is the mathematical reasoning of the students through CER writing in terms of Claim, Evidence, and Reasoning?
3. What are the perceptions of the teacher and students in learning mathematics through problem-solving with CER assessment?

**Significance of the Study**

The success of this study will provide further information on the investigation of using TTPS approach with CER assessment in mathematics classrooms.

For teachers, the study provides insights on the importance of incorporating open-ended problem-solving techniques that encourage collaboration and exploration. Additionally, the findings in this study will guide teachers in designing lessons that not only cover curricular objectives but also address students' gaps in reasoning and conceptual understanding.

For students, the study offers a structured approach to problem-solving that encourages them to articulate their reasoning and justify their solutions systematically. The use of CER helps students structure their mathematical thinking, developing their ability to justify and explain their solutions logically.

Furthermore, the study lays a foundation for future research, encouraging further exploration of the combined use of TTPS and CER in mathematics education. It highlights the potential for longitudinal studies to evaluate the long-term impact of these methods on students' performance, attitudes, and conceptual understanding. Overall, this research contributes to bridging the gap between procedural fluency and conceptual understanding, offering an innovative approach to teaching mathematics that enriches both the learning and teaching experiences.

**Scope and Limitations**

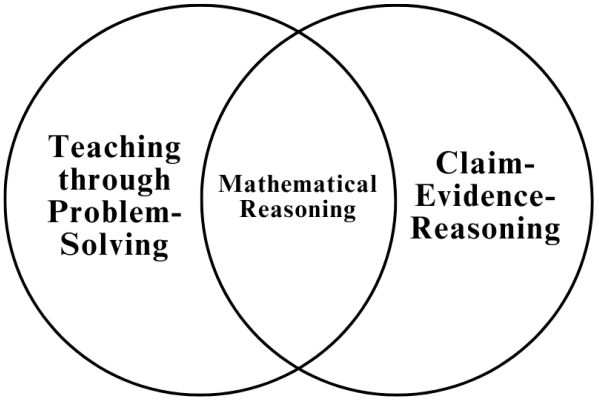
The study focuses on investigating Grade 7 students' mathematical reasoning through the implementation of Teaching through Problem-Solving with Claim-Evidence-Reasoning. Conducted over five regular class days at La Salle Academy, Iligan City. The research involved one section of Grade 7 students and their mathematics teacher. The study explored lesson delivery using TTPS approach, students performance in CER assessment, and thematic insights from classroom interactions and teacher feedback.

Moreover, the study had several limitations, such as the short observation period of five days, which restricted the documentation of students' reasoning progression over time. The limited existing literature on CER in mathematics education highlights the need for further research to develop a more comprehensive evaluation of CER. While the modified CER scoring rubric was not formally validated prior to implementation, its reliability was ensured through a percent agreement method conducted among three (3) mathematics teachers. Additionally, external factors such as time constraints, varying levels of student motivation, and classroom dynamics, which were not controlled, may have influenced the findings. Nonetheless, the study provides valuable evidence supporting the potential of TTPS and CER in fostering mathematical reasoning.

**Conceptual Framework of the Study**

**Figure 1.**

*The conceptual framework of the study*




The figure above illustrates the integration of two approaches - Teaching through Problem-Solving (TTPS) and Claim-Evidence-Reasoning (CER) to investigate mathematical reasoning of the students. The two circles in the diagram represent the distinct contribution of TTPS and CER, while their intersection highlights their shared goal of fostering mathematical reasoning.

The TTPS approach focuses on engaging students with open-ended problems that require exploration, collaboration, and critical thinking. This approach encourages students to construct their understanding of mathematical concepts through active participation and real-world problem contexts. On the other hand, CER provides a structured method for articulating and supporting mathematical ideas. Students are guided to make claims based on the problem, present evidence to support the claim, and provide reasoning to connect the evidence to the claim.

The intersection in the diagram shows and represents how these two - TTPS and CER complement each other to foster math reasoning, promoting a holistic

development of mathematical understanding, problem-solving skills, and the ability to communicate reasoning effectively. This integrated approach is particularly valuable in fostering higher-order thinking skills essential for success in mathematics (Caballero, 2023; Brookhart, 2010).

## Theoretical Framework of TTPS

Teaching through Problem-Solving is grounded in the ideas of the following; (1) Constructivism, (2) Social Constructivism, and (3) Vygotsky's Zone of Proximal Development.

### Constructivism

In the context of education, constructivism is a theory that emphasizes the active role of students in constructing their knowledge. Teachers assist and help students reach the information and develop it rather than directly impacting their knowledge (Ayaz, 2015). It points out that the student must construct knowledge and should not be supplied by the teacher (Albay, 2020). Accordingly, they learn best when they engage with the content through exploration, reflection, and interaction, which leads them to a deeper understanding of the material. As a result, this aligns with TTPS as it encourages students to participate in hands-on activities that address real-world problems. Doing this, students construct meaningful understandings based on their prior knowledge and experiences. This aims to encourage a constructivist type of learning that allows students to explore real-life problems on their own (Kurt, 2021)

### Social Constructivism

Developed by Lev Vygotsky, social constructivism is a prominent educational theory that emphasizes the importance of social interactions in the learning process.

Accordingly, in the educational context, it highlights that cognitive development is fundamentally rooted in social interactions and that students construct knowledge through collaborative experiences (Albay, 2020, p.81). Accordingly, it is also called collaborative learning because it is based on interaction, discussion, and sharing among students. This allows for a range of groupings and interactive methods—total class discussions, small group discussions, or students working in pairs on given projects, activities, or assignments. Hence, it shifts the responsibility of knowledge acquisition from the teacher to the student, as well as, transforms the student from a passive learner to an active participant and a co-constructor of knowledge among co-students (Akpan et al., 2020).

**Zone of Proximal Development (ZPD)**

ZPD represents the difference between what students can do independently and what they can achieve with guidance from a skilled partner. In educational settings, activities should be tailored to challenge students just beyond their current capabilities while providing appropriate support, known as scaffolding, ensuring that learning remains both engaging and achievable, thereby optimizing the learning process. Additionally, engaging students in problem-solving tasks within their ZPD encourages the development of higher-order thinking skills. By navigating complex problems with appropriate support, students are prompted to analyze, evaluate, and create solutions (Guseva & Solomonovich, 2017; Gauvain, 2020).

**Operational Definition of Terms**

The following terms are defined operationally to provide a better understanding to the students.

**Claim-Evidence-Reasoning (CER).** CER framework is a structured approach for evidence-based writing that encourages students to engage in deeper thinking and demonstrate higher-order thinking skills. In this study, the CER framework is utilized as an assessment tool following the implementation of a 4-day TTPS (Teaching Through Problem Solving) lesson. It serves to evaluate students' mathematical reasoning.

- **Claim.** It is a statement that responds to an original question. This is the argument or main idea presented by the student, typically expressed in a single, clear sentence.
- **Evidence**. It is the data that supports the claim which could be in the form of calculations, diagrams, charts, etc.
- **Reasoning**. It connects the evidence to the claim, explaining why the evidence is relevant and how it substantiates the claim.

**Mathematical Reasoning.** This term refers to a fundamental process in learning mathematics where students think analytically and systematically as they investigate mathematical phenomena highlighting the role of conjecturing and justifying. In this study, mathematical reasoning was investigated among the grade 7 students during the TTPS-CER implementation.

**Teaching through Problem-Solving (TTPS).** This term refers to a teaching approach that encourages students to explore, conjecture, and justify their solutions, promoting their deep conceptual understanding. In this study, the TTPS approach was implemented in a Grade 7 math classroom to deliver lessons.

# CHAPTER 2

# REVIEW OF RELATED LITERATURE

This chapter reviews literature relevant to the study, focusing on mathematical reasoning, the Teaching through Problem-Solving (TTPS) approach, and the Claim-Evidence-Reasoning (CER). It is organized by themes, addressing highlighting student's challenges in reasoning, the shift from traditional teaching to TTPS, and the use of CER for assessment, along with the perceived benefits and challenges students encounter with these methods and strategies.

## Mathematical Reasoning

Mathematical reasoning is a fundamental process in learning mathematics; as identified by NCTM, where students think analytically and systematically as they investigate mathematical phenomena highlighting the role of conjecturing and justifying (Günhan, 2014; McCashin et al., 2022). De Walle et al. (2014) also implies that reasoning helps students construct and validate mathematical ideas, deepening their understanding of the subject. While, Stylianides and Stylianides (2014) further emphasize that mathematical reasoning should extend beyond solving problems to include justifying and explaining solutions. In addition, Rittle-Johnson and Schneider (2015) argue that mathematical reasoning is not merely a reflection of procedural knowledge, but also a key component of conceptual understanding. They stress the importance of connecting different mathematical concepts, enabling students to move beyond rote memorization and engage with the "why" behind their solutions. However, despite its importance, students often struggle with reasoning, even when proficient in procedural fluency, because they do not fully understand the concepts they are applying (Schoenfeld, 2016; Muzaini et al., 2019) as their ability in

problem-solving and their reasoning skills is closely related to the depth of their conceptual understanding (Gunhan, 2014).

Many students also face challenges in developing mathematical reasoning due to an overreliance on rote memorization, which limits their ability to analyze and solve unfamiliar problems. On the other hand, teachers face difficulties in addressing diverse student needs, bridging foundational gaps in knowledge, and navigating the constraints of traditional teaching methods (Herbert, 2021; Oliveira & Henriques, 2021). These challenges highlight the need for teaching approaches that integrate reasoning with problem-solving, promoting not only procedural fluency but also conceptual understanding.

**Teaching through Problem-Solving (TTPS)**

In response, Teaching through Problem-Solving (TTPS) has emerged as an effective approach for fostering mathematical reasoning. By engaging students in conjecturing, justifying, and explaining, TTPS encourages the development of deeper conceptual understanding (Schoenfeld, 2016; Stylianides & Stylianides, 2014) unlike traditional methods. Moreover, TTPS has been notably successful in Japanese mathematics education and is recognized for its potential to enhance mathematics learning. It positions problem-solving as the central medium for learning, encouraging students to discover new mathematical concepts through exploration, collaboration, and reflective thinking (Bataluna et al., 2021; McDougal & Takahashi, 2014). This approach provides a structured yet flexible framework that engages students in activities such as conjecturing, justifying, and explaining, all of which are essential for developing mathematical reasoning (Takahashi, 2014).

The TTPS framework generally follows a multi-stage process to structure lessons effectively. The original framework includes five key stages—1) lesson overview, 2) problem presentation, 3) individual or collaborative problem solving, 4) student sharing of solutions, and 5) lesson summary—localized adaptations like the DOST-SEI Project Science Teachers Academy for the Regions framework simplify this to four stages: 1) problem presentation, 2) student collaboration in problem exploration and resolution, 3) lesson processing, and 4) summarization (Buan et al., 2021). These adaptations highlight TTPS's flexibility in addressing diverse educational contexts while maintaining its core focus on reasoning and problem-solving.

In practice, TTPS begins with the teacher presenting a thoroughly planned problem and setting the context. Students work in pairs or small groups to explore the problem, with the teacher observing their approaches and providing guidance as needed. Afterward, a whole-class discussion allows students to share their strategies, compare their solutions, and reflect on the reasoning behind their answers. This collaborative process exposes students to diverse methods of problem-solving, helping them construct a deeper understanding of mathematical concepts (Sionicio & Barbacena, 2021). By making problem-solving the primary vehicle for learning, TTPS inherently fosters logical thinking, analysis, and justification—key elements of mathematical reasoning. This approach encourages students to critically analyze problems, identify relevant mathematical concepts, and conjecture potential solutions. In doing so, it not only enhances procedural fluency but also strengthens the conceptual foundation necessary for more advanced reasoning. TTPS effectively addresses the challenges of developing mathematical reasoning by offering students

meaningful opportunities to justify and explain their solutions, thereby supporting the development of more proficient mathematical thinkers (Stylianides & Stylianides, 2014).

**Perceived Challenges Experienced by Students in Implementing TTPS**

While TTPS offers significant benefits in promoting math reasoning and problem-solving, it also presents certain challenges. One of the difficulties is that TTPS places considerable cognitive demands on students, requiring them to actively engage in complex thinking. Many students struggle with understanding the context of problems, particularly when these involve real-world applications that require them to connect abstract mathematical concepts to practical situations. Since TTPS encourages students to build on prior knowledge to address challenging problems, those with gaps in foundational understanding or weaker problem-solving skills may find it difficult to fully engage in the exploratory nature of this approach. The cognitive load required to analyze, recall, and apply mathematical concepts simultaneously can overwhelm some students, making the learning process more difficult (Schoenfeld, 2016; Sweller & Sweller, 2019).

Moreover, students who have been accustomed to traditional teaching methods may become reluctant to engage with open-ended problems as they find the TTPS approach unfamiliar (Boaler, 2016). Additionally, traditional assessments tend to emphasize procedural fluency over reasoning and problem-solving skills that TTPS promotes. This misalignment between traditional assessments and TTPS's goals can create challenges, as students may feel unprepared or unsupported when faced with

assessments that do not align with the deeper, conceptual learning promoted by TTPS (William, 2018).

**Perceived Benefits Experienced by Students in Implementing TTPS**

Amidst the challenges students face in adapting to a new teaching approach, TTPS also presents advantages that can help student's learning experience. One key benefit of problem-solving approaches such as TTPS is their natural promotion of student-centered learning. This approach acknowledges and adapts to the unique needs of each student, enabling them to progress at their own pace, engage deeply with the material, and actively shape their learning experience. As a result, students enjoy a more tailored educational journey, where they can draw on their individual strengths and interests, cultivating a sense of ownership and responsibility for their learning environment (Guido, 2016; Marshall, 2022).

Moreover, according to Buan et al. (2021), students exhibited enhanced collaboration with both teachers and peers during group activities when utilizing the TTPS approach. Engaging in a range of mathematical learning activities helped reduce their anxiety about solving problems. Additionally, students demonstrated a more positive attitude toward mathematics and greater confidence in their mathematical reasoning, while the use of TTPS also fostered higher-order thinking, which enabled them to make meaningful connections and bridge gaps in their knowledge (Carrazza, 2021).

**Teachers Reservation in Implementing TTPS**

Despite the recognized benefits of Teaching through Problem-Solving (TTPS) in promoting deeper student engagement and higher-order thinking, many educators remain hesitant to implement it due to several challenges, including, limited

knowledge of both mathematical content and effective pedagogical strategies, insufficient access to resources, and a lack of time to design or adapt appropriate materials for TTPS. In addition, some teachers express concerns that TTPS may lead to student engagement, particularly among those struggling academically (Hourigan & Leavy, 2022). A study by Groves et al. (2016) revealed that some teachers were skeptical about dedicating an entire lesson to a single problem, as well as to adapt to structural shifts inherent in TTPS, such as allowing students to discover the learning goals independently through problem-solving instead of presenting them at the start of the lesson.

Another significant challenge in the lack of adequate training for teachers in developing mathematical reasoning. According to Mukuka & Alex (2024), many teachers have not received extensive training in developing students' reasoning skills, limiting their ability to effectively implement instructional strategies that promote critical thinking and problem-solving. However, despite these challenges, research by Ali et al. (2010), King (2019), and DiVriK (2023) supports the National Council of Teachers of Mathematics (NCTM, 2003) in advocating for teaching mathematics through problem-solving. This approach is shown to help students understand mathematics as a sense-making process, deepening their comprehension of the mathematical concepts and methods (Bataluna et al., 2021).

**Claim-Evidence-Reasoning (CER)**

Assessing students in problem-solving contexts requires innovative strategies that effectively evaluate their reasoning, strategy, and ability to communicate their mathematical thinking (Ukobizaba et al., 2021). One such strategy is the Claim-Evidence-Reasoning (CER) framework, a structured approach that supports

evidence-based writing. The CER framework consists of three key components: Claim, Evidence, and Reasoning. The **claim** is a statement that responds to an original question. This is the argument or main idea presented by the student, typically expressed in a single, clear sentence. The **evidence** is the data that supports the claim which could be in the form of calculations, diagrams, charts, etc. By requiring evidence, students strengthen understanding of the mathematical concepts and establish connections between their solutions and underlying principles. Finally, **reasoning** connects the evidence to the claim. It explains *why* the evidence is relevant and *how* it substantiates the claim. This component compels students to apply mathematical concepts to demonstrate the logical relationship of the evidence and claim. Reasoning is particularly valuable for addressing open-ended problems with multiple possible solutions, as it encourages students to articulate their thought process and assess the validity of their arguments (VanTassel, 2022; Samosa, 2021; Caballero, 2023).

Moreover, CER emphasizes the importance of justification, urging students to not only arrive at answers but also explain why their solutions are valid. This process directly develops students' mathematical reasoning by promoting the construction of valid arguments, identifying mathematical patterns, and drawing logical conclusions (Mata-Pereira & Da Ponte, 2017). Open-ended assessments like CER have shown to encourage deeper learning compared to multiple-choice tests, as they evaluate complex tasks and higher-order thinking skills (Polat, 2020). As a result, these assessments help students become more proficient in mathematical reasoning, especially when they receive constructive feedback. Furthermore, CER assessments provide valuable insights for teachers, enabling them to adjust their instructional

strategies to better meet students' needs and create a more engaging and meaningful learning environment (Karaman & Büyükkidik, 2023; Widiartana, 2018).

However, despite these benefits, challenges remain. Research by Traut (2017) and Erin (2022) suggests that while students may successfully connect claims with evidence, they often struggle to articulate their reasoning. This difficulty can hinder their ability to fully engage with the reasoning component of CER, limiting their development of comprehensive mathematical reasoning.

**Claim-Evidence-Reasoning as a Writing Strategy**

Across different areas, Claim-Evidence-Reasoning (CER) is used as a writing strategy designed to enhance students' analytical thinking and argumentative writing skills especially in English and Science. This framework guides students in formulating a claim, supporting it with evidence, and justifying the connection between the two through reasoning. CER is particularly effective in teaching students how to construct persuasive arguments in their writing (Samosa, 2021).

As the CER consists of three core components: claim, evidence, and reasoning. The claim presents the argument or main idea of the student, typically expressed in a single, clear sentence. The clarity and strength of the claim directly influence the effectiveness of the argument being presented (Mastro, 2017). Evidence refers to the factual information, data or example that supports the claim which must be directly linked to the claim. This component lends credibility to the argument and helps persuade the audience by providing concrete data that supports the students' position. Reasoning connects the evidence to the claim, justifying why the evidence is relevant and substantiates the claim. Accordingly, students often find this part

challenging, but it is essential for creating a robust argument. Strong reasoning not only reinforces the claim but also addresses potential counterarguments, making the overall argument more robust (Afrin et.al, 2020).

CER extends beyond English writing to become a valuable tool in scientific inquiry. In science classes, students can apply the CER framework to analyze lab results and draw conclusions from gathered data. This approach helps students articulate their hypotheses and reflect on their experimental outcomes (Carrie, 2024; Guhlin et al., 2024). The use of CER in science education not only supports the development of argumentative writing skills but also enhances students' engagement and reasoning with scientific inquiry. Repeated practice with CER enables students to refine their ability to construct well-reasoned arguments, offering long-term benefits in various academic and professional contexts (Samosa, 2021).

**Implementing CER Assessment in the Classroom**

Implementing an assessment such as the Claim-Evidence-Reasoning (CER) strategy in the classroom is only effective when teachers have a sufficient level of pedagogical content knowledge to support the interpretation of the results. This reiterates the need for teachers to have clear direction or goals when implementing assessments and, hence, use the assessment data in support of the improvement of the student’s learning (Brunsell, 2012).

Moreover, using CER assessment in math classes enables students to clearly explain their mathematical understanding and assess their classmates’ arguments and supporting data. It also helped students develop logical and critical thinking abilities, giving them a chance to connect various mathematical ideas and articulate their

reasoning in a clear and orderly manner. Over the course of practicing CER, students become reflective problem solvers (Edquilag et al., 2023).

**Perceived Challenges Experienced by Students in Implementing CER**

The study by Edquilag et al. (2023) indicates that students faced challenges when adapting to the Claim-Evidence-Reasoning (CER) framework as an assessment tool. The unfamiliarity with this method led to difficulties in effectively formulating claims based on mathematical evidence. Students struggled to apply mathematical reasoning to support their claims and provide sufficient evidence, often lacking the practice and familiarity needed to connect reasoning with mathematical concepts. This challenge resulted in poorly constructed arguments and diminished effectiveness across various mathematics courses. Despite being able to establish a claim, students had difficulty justifying their answers and often skipped the reasoning portion. Some students engaged with CER merely out of compliance rather than genuine effort. Additionally, the implementation of CER can also be hindered by insufficient integration into classroom practices. Educators may not adequately emphasize or model the CER framework, leading to confusion and inconsistency in its application by students. Hence, a lack of structured guidance in constructing arguments can exacerbate students' challenges in adopting the framework successfully.

**Perceived Benefits Experienced by Students in Implementing CER**

Despite the unfavorable feedback and criticism that CER receives from students, there are positive aspects that underscore its benefits. According to Edquilag et al. (2023), although students initially faced difficulties with CER, many eventually showed progress. Their outputs reflected notable improvements in both results and the quality of their work. CER proved beneficial in the mathematics classroom as it

provided students with an opportunity to articulate their understanding and evaluate the arguments and information presented by their peers. This process contributed to the development of critical and logical thinking skills, which are essential in mathematics. Additionally, CER facilitated connections between different mathematical ideas and concepts, allowing students to express reasoning more clearly.

Notwithstanding that, CER faces concerns related to its concept and implementation process, partly due to a lack of published studies. Furthermore, there has been no formal research specifically focusing on the implementation of CER in mathematics classrooms from the students' perspective. In this study, the findings of Edquilag et al. (2023) are utilized to analyze the perceived challenges and benefits that teachers encounter when implementing CER.

# CHAPTER 3

# RESEARCH METHODOLOGY

This chapter discusses the methods and procedures used in the study. The following information provides details on the research design, setting, subjects, instruments used, data gathering procedure, and data analysis.

## Research Design

A descriptive qualitative research design was used to gain insights into the experiences and perspectives of students and the implementing teacher involved in this study. This design was chosen to provide a contextual understanding of the implementation of the TTPS approach and CER assessment in the classroom. Multiple data collection methods were employed, including CER assessment, classroom observation, and semi-structured interview with the participants, to ensure a comprehensive and corroborated analysis of the findings.

## Research Setting

The study took place at La Salle Academy - Iligan, a non-profit Catholic Basic Education Institution situated in Iligan City. Such selection is done with intention due to its implementation of the CER test in mathematics among other neighboring schools. The said institution served a valuable ground in the investigation of the experiences of the participants towards the implementation of the teaching approach and the assessment.

## Research Subject

The subject of the study was the Grade 7 math classroom of La Salle Academy - Iligan. A purposive non-probability sampling method was used in selecting respondents considering their availability, schedules, and the shared agreement

between the school and researchers. The section comprised one (1) mathematics teacher and forty (40) diverse grade 7 students representing the Grade 7 population.

**Instruments to be Used**

In documenting the experiences of participants and the mathematical reasoning of students, the study utilizes the following tools necessary to gather data.

- TTPS Lesson Plan
- CER Scoring Rubric
- TTPS-CER Semi-structured Interview

**TTPS Lesson Plan**

A 4-day lesson plan using Teaching through Problem-Solving (TTPS) was employed in the lesson implementation. The said lesson plan was created and planned collaboratively, with the researchers and the implementing teacher of the partnered institution.

The developed lesson plans were reviewed for 1) content and 2) pedagogy, undergoing two revisions that incorporated feedback, suggestions, and comments from the review process to ensure the mathematical content is accurate, relevant, and aligned with curriculum goals. This includes reviewing learning objectives, word problems that provide opportunity for student exploration, and use of questions centered on mathematical reasoning.

**Claim-Evidence-Reasoning (CER) Scoring Rubric**

In evaluating the CER assessment, a scoring rubric was adapted from the National Science Teachers Association (2020) and of the partnered institution. The rubric is presented below.

**Table 1.**

*National Science Teachers Association's CER Scoring Rubric*

| Category | Not Evident (0) | Beginning (1) | Approaching (2) | Meeting (3) |
|---|---|---|---|---|
| **Claim** | Does not make a claim. | Makes an inaccurate claim. | Makes an accurate, but incomplete claim. | Make an accurate and complete claim. |
| **Evidence** | Does not provide evidence. | Evidence is inappropriate or it does not support the claim. | Provides appropriate, but insufficient evidence. May include some inappropriate evidence. | Provides appropriate and sufficient evidence to support the claim. |
| **Reasoning** | Does not include reasoning. | Reasoning is not appropriate or does not link the claim to the evidence. | Provides reasoning that links claims to evidence. Repeats evidence and/or includes some scientific principles, but not sufficient. | Provides accurate and complete reasoning that links evidence to the claim, includes appropriate and sufficient scientific principles. |

Adapted from: *McNeill, K.L. & Krajcik, J. (2008). Assessing middle school students' content knowledge and reasoning through written explanations. In assessing science learning: Perspectives from research and practice, eds. J. Coffey, R. Douglas, and C. Stearns, 101–116. Arlington, VA: NSTA Press*

**Table 2.**

*Partnered Institutions' CER Scoring Rubric*

| | **4** | **3** | **2** | **1** |
|---|---|---|---|---|
| **Claim (10%)** | The answer is correct and clearly stated. | The answer is correct. | The correction is partially correct. | The answer is incorrect. |
| **Evidence (60%)** | Solutions are correct and complete which supports the claim with detailed process, illustrations, and interpretations. | Solutions are correct and complete which supports the claim. | Solutions support the claim but are lacking and incomplete. | Solutions are incorrect and do not support the claim. |
| **Reasoning (30%)** | Provides clear, correct and substantial explanation on the connection between evidence and claim based on mathematical concepts. | Provides clear and correct explanation on the connection between evidence and claim based on mathematical concepts. | Explanation lacks clarity but is correct on the connection between evidence and claim based on mathematical concepts. | Explanation is unclear and incorrect on the connection between evidence and claim based on mathematical concepts. |

**Table 3.**

*Modified CER Scoring Rubric*

| ***Criteria*** | ***Meeting (3)*** | ***Approaching (2)*** | ***Beginning (1)*** | ***Not Evident (0)*** |
|---|---|---|---|---|
| **Claim** | States a mathematical claim that is clearly stated, complete, and correct. | States a mathematical claim that is partially correct or incomplete. | States a mathematical claim that is incorrect. | Does not make a claim. |
| **Evidence** | Provides mathematical evidence where the solution is correct, complete, and sufficient to support the claim. | Provides mathematical evidence where the solution is correct but incomplete and contains minimal error. | Provides mathematical evidence where the solution contains significant errors leading to incorrect answers which does not support the claim. | Does not provide evidence. |
| **Reasoning** | Provides a clear, complete, and correct explanation which shows the connection of the claim and evidence based on mathematical concepts. | Provides correct explanation but lacks clarity in showing the connection of the claim and evidence. | Provides unclear, insufficient, and incorrect explanations failing to connect the claim and evidence. | Does not include reasoning. |

The CER scoring rubric presented above was modified based on the two rubrics that were previously presented. The modification was prompted by the fact that the CER framework has been predominantly utilized in science education to help students construct scientific explanations (McNeill & Krajcik, 2011). Its application in math classrooms has been limited due to the inherent differences between the disciplines, necessitating revisions to suit

mathematical practices. The said modification was done with specificity accordingly.

- **Claim** - The first rubric described claims broadly without specifying any subject, while the second rubric tied claims to correctness in problem-solving but still kept them generic. Meanwhile, the revised and modified rubric shifted its focus to mathematical claims that are clearly stated, complete, and correct. Hence, the claim criteria became more targeted to mathematics by focusing on precision and clarity, ensuring the claim directly addresses the mathematical question.
- **Evidence** - The original rubrics described evidence broadly as scientific data supporting the claim. Its focus is on whether the evidence was sufficient, appropriate, and free of errors, but with a general perspective. While, the revised and modified rubric moved from general scientific concepts to a more mathematics-specific interpretation, focusing on correct, complete, and sufficient solutions to support the claim.
- **Reason** - The first rubric linked claims to evidence using appropriate scientific principles but did not emphasize clarity or detail. The second rubric described reasoning as the ability to explain the connection between evidence and claims, but did not fully align it with mathematical reasoning. Meanwhile, the revised and modified rubric redefined reasoning by emphasizing a clear, complete, and correct explanation that justifies the mathematical solution, showing the

connection of the claim and evidence on mathematical concepts making it more aligned with mathematical thinking.

Furthermore, the Modified CER scoring rubric provides a framework for assessing student responses in terms of Claim, Evidence, and Reasoning. The point descriptors categorize the quality of students' response into four performance levels: Meeting (3 points), Approaching (2 points), Beginning (1 point), and Not Evident (0 points).

- **Meeting (3 points)**: A "meeting" level indicates that the student has provided a response that fully meets expectations. It demonstrates mastery and shows that the students have a strong understanding of the mathematical concept and can communicate it effectively.
- **Approaching (2 points)**: An "approaching" level shows that students' response is mostly correct but has minor issues. It reflects an understanding of the concept but indicates areas for improvement, such as attention to detail or deeper explanation.
- **Beginning (1 point)**: A "beginning" level shows significant gaps in students' responses. It suggests that the student has an incomplete or flawed understanding of the concept and needs more guidance to improve their reasoning and problem-solving skills.
- **Not evident (0 points):** A "not evident" level shows that the student's response lacks claim, evidence, and reasoning. Its responses are also entirely irrelevant to the problem at all, as well as, the student has not attempted to answer. This indicates no meaningful attempt to engage with the problem or a complete lack of understanding of the task.

Thus, the descriptors provide a structured way to assess how well students can construct and communicate mathematical arguments. Higher scores represent better alignment with the CER framework (Claim, Evidence, Reasoning), while lower scores identify specific weaknesses in their responses.

For inter-rater reliability testing of the rubric, percent agreement for three (3) raters was utilized to measure their level of agreement (Deviant, 2010). The table below presents the agreement: a score of 1 indicates agreement between two raters, while a score of 0 indicates no agreement. Mean percentage is then calculated based on the agreement across the three different raters.

**Table 4.**

*Result of Percent Rater Agreement*

| ***Percent Agreement for 3 Raters*** | | | | |
|---|---|---|---|---|
| Student | R1/R2 | R1/R3 | R2/R3 | Total Agreement |
| 1 | 1 | 0 | 0 | 1/3 |
| 2 | 1 | 1 | 1 | 3/3 |
| 3 | 1 | 1 | 1 | 3/3 |
| 4 | 1 | 0 | 0 | 1/3 |
| 5 | 1 | 1 | 1 | 3/3 |
| | | | ***Percent of Agreement*** | ***73.33%*** |

Results showed a 73.33% agreement among three raters in the overall scores. Both the Claim and Evidence section showed a 60% agreement while the Reasoning Section got a 73.33% agreement. Given the total agreement across the Claim, Evidence, and Reasoning section, this level of agreement is

considered acceptable as Shabankhani (2020) notes that a data agreement above 70% is an acceptable reliability threshold for instruments.

**TTPS-CER Semi-structured Interview**

A semi-structured interview was conducted to investigate the experiences of both the implementing teacher and students regarding the lesson implementation of the TTPS-CER. This instrument consisted of two questionnaires for the teacher and for the students which focuses on their classroom experiences. The interview addresses experiences with the TTPS approach, including aspects such as lesson discussion, student reasoning, and collaboration, providing insights into challenges encountered during implementation. Additionally, it also seeks to examine participants' perceptions and practices with the use of CER assessment.

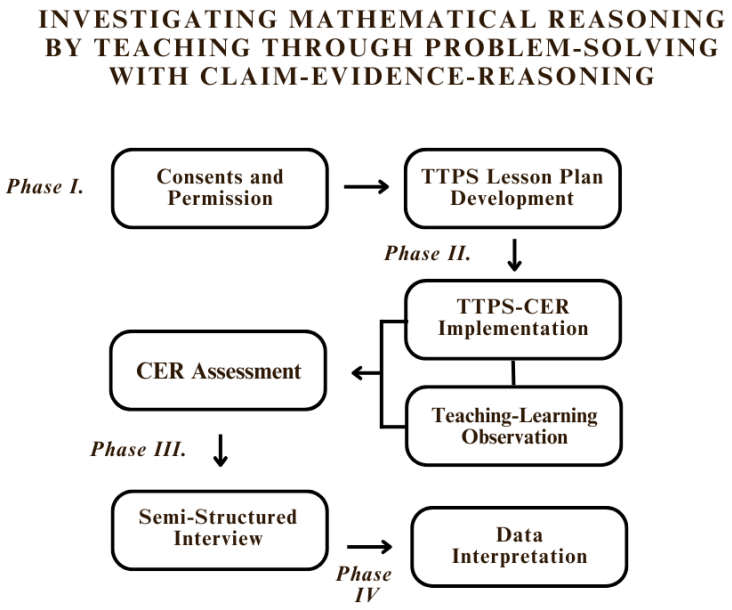
Moreover, to ensure clarity and validity, feedback on the interview questions was sought from two validators. This process enhanced the instrument and ensured alignment with the study's objectives.

**Data Gathering Procedure**

The figure presented below provides an overview of the four phases involved in the data gathering process.

**Figure 2.**

*The flowchart of the data gathering process*




**Phase 1: Pre-implementation**

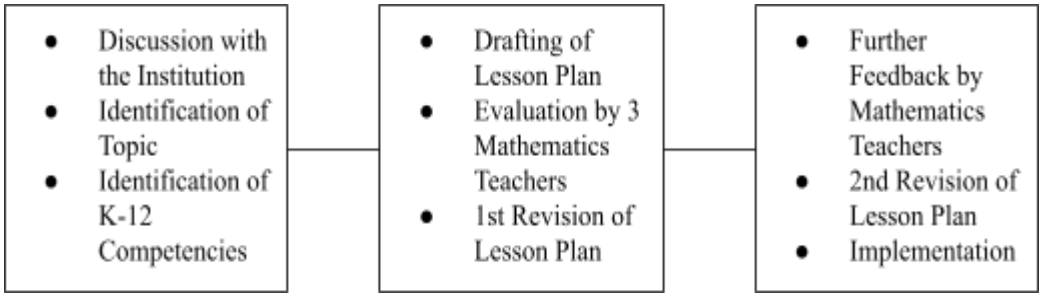
- **Consent and Permissions:** The pre-implementation phase began with securing institutional approval. A formal request letter was submitted to the school principal of the partnered institution, seeking permission to conduct the study. This was followed by an agreement letter outlining mutually beneficial terms and conditions, clarifying that all activities within the school premises were research-related and approved by the principal, subject coordinator, and the researchers. The implementing teacher was selected by the subject coordinator. Conversely, the Grade 7 classroom to be observed was selected

by the implementing teacher, hence, ensuring that schedules and availability were considered. Subsequently, consent letters were given to the implementing teacher, the parents and students to inform the conduct of the study.

- **TTPS Lesson Plan Development:** In developing the lesson plan, the researchers, subject area head, and implementing teacher conducted meetings to meet the desired learning outcomes in accordance with the K-12 curriculum. The lesson plan was a collaborative effort between the researchers and implementing teacher since the crafted lesson plan was also used in other sections of grade 7. The development phases diagrammed below indicated that the lesson plan underwent two revisions to qualify for conduction.

**Figure 3.**

*TTPS Lesson Plan Development Phase*




**Phase 2: Implementation**

- **TTPS-CER Implementation**: The implementation phase involved executing the TTPS-CER framework over five days. The teacher facilitates lessons through problem-solving where students are engaged to collaborate, involve in mathematical discussion with peers and practice reasoning through one's mathematical processes. Classroom activities were also observed via video

recording and note-taking to document interactions and teaching-learning dynamics. Following the lessons, CER assessment was administered.

- **Teaching-Learning Observation:** As the implementation happens, an open structured observation was undertaken that records interactions between student-student and teacher-student. Alongside, it records how students engage with the material, participate in the discussion, and articulate their reasoning to justify their solutions to the problem presented. The 5-day classroom observation was also videotaped with the teacher and students' consent.

**Phase 3: Post - Implementation**

- **Semi-Structured Interviews and Feedback:** Following the 4-day TTPS lesson implementation and the CER assessment, a semi-structured interview was conducted with six participating students involved because of scheduling conflicts, while 20 other students participated via Google form. Meanwhile, a separate interview was conducted to the implementing teacher.

**Phase 4: Data Interpretation**

- **Analysis and Ethical Consideration:** In this phase, all collected data, including observations, assessment results, and interview responses were analyzed. Ethical considerations were strictly followed, ensuring confidentiality, non-disclosure of sensitive information such as student scores, and transparency in research objectives, procedures, and risks.

**Data Analysis**

In analyzing the gathered data, the study used descriptive and thematic analysis simultaneously to corroborate qualitative and quantitative findings.

For the semi-structured interviews and observation, ***thematic analysis*** was used to examine the data gathered. Any data from the teaching-learning observation, such as conversations and interactions from teacher and students helped support the narratives expressed by them. This analysis follows stages namely; familiarization of data, generating codes, searching for patterns or themes in codes, reviewing themes, finalizing themes, and producing reports. To corroborate findings, results from CER assessment were also used to support discussion. CER papers were qualitatively analyzed delving into the many ideas emerged from students' output. Such undertaking provided researchers a more thorough and in-depth discussion necessary for the attainment of the study's objective.

In measuring the test, a ***modified CER scoring rubric*** based from NSTA (2020) and of the partnered institution following a three-point rating scale was utilized. This rating scale was based from Samosa's (2021) four-point CER rating scale. Mean scores were then computed in each section to assess how students are performing in the Claim, Evidence, and Reasoning section based on the weighted mean provided below.

**Table 5.**

*Samosa (2021) CER 4-point Rating Scale Rubric*

| ***Rate*** | ***Interval Range*** | ***Level*** |
|---|---|---|
| 4 | 3.50 - 4.0 | Excelling |
| 3 | 2.50 - 3.49 | Proficient |
| 2 | 1.50 - 2.49 | Developing |
| 1 | 1 - 1.49 | Not Evident |

**Table 6.**

*CER 3-point Rating Scale Rubric*

| ***Rate*** | ***Interval Range*** | ***Level*** |
|---|---|---|
| 3 | 2.50 - 3.0 | Meeting |
| 2 | 1.50 - 2.49 | Approaching |
| 1 | 0.50 - 1.49 | Beginning |
| 0 | 0 - 0.49 | Not Evident |

# CHAPTER 4

# RESULTS AND DISCUSSION

This chapter presents the discussion on the development and revisions of the lesson plans and assessment implemented. This also delves into the findings of both qualitative and quantitative data to provide understanding of the study's outcomes.

## Development of the Lessons

The developed lessons utilizes a problem-solving approach based on the TTPS framework by Buan et al. (2021) which follows 1) problem presentation, 2) student collaboration in exploring and addressing the problem, 3) lesson processing, and 4) summarization. The lesson plan was also a collaborative effort with the implementing teacher since the crafted lesson plan was also used in other sections of Grade 7.

### Identification of the Topics

The topics "Measures of Central Tendency" and "Measures of Variability" are the selected topics based on the shared agreement of the partnered institution. Measures of Central tendency covers the three types of averages specifically, mean, median, and mode while on the other hand, Measures of Variability covers the topic range, variance, and standard deviations, both for ungrouped data, where G7 students are expected to learn.

### Identification of K-12 Competencies and Lesson Objectives Formulation

To ensure that the crafted lesson objectives adheres to the standards for teaching Mathematics, the K-12 Mathematics Curriculum of the Department of Education served as a reference guide. Alignment of the objectives and competencies is shown in the table below.

**Table 7.**

*Identifying Competencies from the K-12 Curriculum*

| **K-12 Curriculum Guide Learning Competencies** | **Learning Objectives for the Lesson Plan** |
|---|---|
| ● Illustrating the measures of central tendency of a statistical data | ● Describe measures of central tendency: mean, median, and mode |
| | ● State the purpose of finding the measures of central tendency |
| | ● Illustrate measures of central tendency of an ungrouped data |
| | ● Analyze data sets to determine which measure of central tendency best represents a statistical data |
| ● Calculating the measures of central tendency of ungrouped data | ● Solve problems involving measures of central tendency |
| | ● Calculate the measures of central tendency (mean, median, and mode) of ungrouped data |
| | ● Calculate values using the given mean, median, and mode |
| ● Illustrating the measures of variability of a statistical data | ● Describe the measures of variability of ungrouped data. |
| | ● Illustrate the measures of variability (range, variance, and standard deviation) of statistical data. |
| | ● Describe the relationship of data, mean, variance, and standard deviation. |
| ● Calculating the measures of variability for ungrouped data | ● Calculate the range, variance, and standard deviation for both sample and population data |
| | ● Solve word problems involving measures of variability |

**Review Process and Revision of the Lesson Plans**

The lesson developed was reviewed in terms of its 1) content and 2) pedagogy conducted by a mathematics teacher with a major in Statistics, a practitioner of employed teaching approach. This was also peer reviewed by two Mathematics teachers from the partnered institution, both of whom have knowledge and familiarity with the approach. In its entirety, this underwent two revisions, incorporating feedback and suggestions from the review process to ensure the mathematical content was accurate, relevant, and aligned with curriculum goals.

**Lesson Plan 1**

**The Learning Objectives for Lesson Plan 1**

The first draft of the Lesson Plan 1 introduces the three measures where students are expected to "define", "calculate", and "solve" the three measures of central tendency, however, as noted by MT1, objectives should be outlined primarily on the deeper understanding, purpose, and usefulness of the topic for students. As suggested, revisions of objectives are shown below.

**Table 8.**

*Revisions on the Learning Objectives for Lesson Plan 1*

| |
|---|
| Comment: Provide learning objectives that introduce what the concept is about, its purpose, and what they can do. **[MT1]** |
| Draft:<br>**Lesson Objectives:**<br>At the end of this lesson, the students will:<br>● Define the mean, median and mode<br>● Calculate the measures of central tendency (mean, median, and mode) of ungrouped data<br>● Solve the rectangular blocks problem using various methods. |

| |
|---|
| 1st Revision:<br><br>**Lesson Objectives:**<br><br>At the end of this lesson, the students will:<br><br>● Define measures of central tendency.<br>● Identify measures of central tendency<br>● State the purpose of finding the measures of central tendency<br>● Illustrate measures of central tendency of an ungrouped data |
| 2nd Revision:<br><br>**Lesson Objectives:**<br><br>At the end of this lesson, the students will:<br><br>● Describe measures of central tendency; mean, median, and mode<br>● State the purpose of finding the measures of central tendency<br>● Illustrate measures of central tendency of an ungrouped data<br>● Solve problems involving measures of central tendency |

**The Utilized Word Problem for Lesson Plan 1**

The second component reviewed by MT1 is the problem. Before, the problem involved stacking play blocks to illustrate the mean, guided by the teacher. However, MT1 noted how it provided very specific instructions, limiting student exploration. It was then revised into an open-ended problem centered on three measures where students can relate to their personal experiences. Another revision such as grammar correction and additional question to practice students reasoning their processes.

**Table 9.**

*Revisions on the Word Problem for Lesson Plan 1*

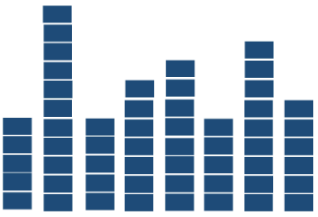
| |
|---|
| Comment: Construct a problem that centers the three measures of central tendency. An ideal problem for TTPS is one that does not tell them what to do. **[MT1]** |

Draft:

**A. Presentation of the Problem**

Problem:

Student A has a box full of building blocks piled in columns. While it was arranged randomly, she began to record the number of piled blocks in each column. Her observations are as follows: 5, 11, 5, 7, 8, 5, 9, and 6. If she decides to rearrange the blocks, determine when the columns will have an equal number of blocks.



1st Revision:

**A. Presentation of the Problem**

Star Apple Academy has to select one pupil to take part in the Math Quiz Bowl. Jacinth and Marco took part in 7 trial quizzes. The following list shows their scores.

| | |
|---|---|
| Jacinth | 23 22 24 23 22 24 23 |
| Marco | 26 22 21 22 20 21 22 |


Who among Jacinth and Marco would best represent the school in the contest?

2nd Revision:

**A. Presentation of the Problem**

Star Apple Academy has to select one pupil to take part in the Math Quiz Bowl. Jacinth and Marco took part in 7 trial quizzes. The following list shows their scores.

| | |
|---|---|
| Jacinth | 23 22 24 23 22 24 23 |
| Marco | 26 22 21 22 20 21 22 |


Who among Jacinth and Marco would better represent the school in the contest? Why?

**The Anticipated Possible Solutions for Lesson Plan 1**

From the changes made in the problem, revisions of possible solutions also followed. The table below shows some of the anticipated solutions or strategies to answer the problem. While the drafted and revised problem contain 4 different solutions, the second revision adds an additional solution as suggested by MT1.

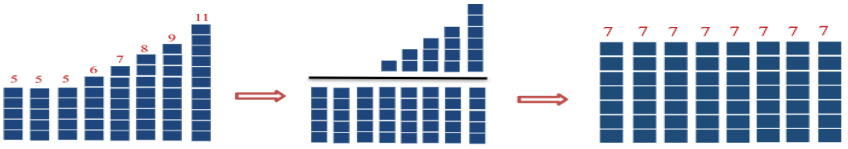
**Table 10.**

*Revisions on the Anticipated Possible Solutions for Lesson Plan 1*

Draft:

Since there are 3 columns with the same number of blocks (5 blocks/column), we can use that as a starting point for all columns.

By doing these, we are able to have 8 x 5 = 40 blocks and a remaining 16 rectangular blocks which we can distribute 2 blocks among all columns.




Thus, there are 7 blocks per column.

**Answer 4: Frequency Table**

Since students already know the frequency distribution table, they can first arrange the

| No. of Blocks | Frequency |
|---|---|
| 5 | 111 |

1st Revision:

her trial quizzes.

From the total scores, students can say that Jacinth got the highest total scores than Marco. Hence, students can conclude that it would be best if Jacinth will represent the school for the Math Quiz Bowl.

**Solution 2: Adding and Dividing**

Since students are already familiar with getting the average, then they can use the concept of average to show which among the two pupils can represent the school. Similar to the answer #2, they can add all the scores and divide by the number of trial quizzes taken.

***Jacinth's Scores:***

*23 + 22 + 24 + 23 + 22 + 24 + 23*

*161/ 7 = **23***

***Marco's Scores:***

*20 + 21 + 21 + 22 + 22 + 22 + 26 = **154***

*154/7 = **22***

Comparing the 2 averages, students can conclude that Jacinth can better represent the school since she got 23, a 1 point higher than Marco's average which is 22.

**Solution 3: Arranging the Numbers**

2nd Revision:

**Solution 4: Locating the Highest Score**

Students may also compare the highest scores between Jacinth and Marco, where Jacinth got a score of **24** and Marco has **26**. Thus, students may conclude that Marco can better represent the school because of the highest score he achieved.

**Solution 5: Locating the Lowest Score**

Students could also reason that Jacinth could perform better since her lowest score is only **22** than Marco who has **20** as his lowest score.

**The Development of Concepts for Lesson Plan 1**

Following the revisions of the problem and possible solutions, MT1 observed that the structure of concept development in the lesson plan appears disconnected from the students' responses. As a result, the table below shows the first revision aimed at ensuring the development of concepts is reflected in the students' ideas, with the teacher acting primarily as a facilitator of learning. Also, the second revision adds a discussion where the teacher presents a dot plot illustration for a specific set of scores, helping students visualize how the three averages (mean, median, and mode) are represented in the data set. Revisions are shown in the table below.

**Table 11.**

*Revisions on the development of concepts for Lesson Plan 1*

Draft:

**For Solution 3:**

*Since there are columns that have the same number of rectangular blocks, then we can use 5 blocks as a starting point for all columns. The remaining blocks will then be distributed evenly so that each column has the same number of rectangular blocks.*

**For Solution 4:**

*Creating a frequency distribution table allows us to record the frequencies of each observation. By doing this, we can divide the total number of blocks by the total number of frequencies recorded.*

**The Mean**

Teacher: Notice that what you are doing is finding the average. By distributing and filling up other blocks with extra ones from other columns allows you to have a fair and equal distribution of the number of blocks and/or weight per column. This is what we call the "mean" or the average.

Ask: Based on your answers, how do you think we can find the Mean?

Teacher: We can find the mean by using a formula:

$$Mean = \frac{Sum\ of\ all\ observations}{Total\ number\ of\ elements} \quad \text{or}$$

1st Revision:

**For Solution 1 and 2: The Mean**

From the 1st and 2nd solutions coming from the students, the teacher can lead the discussion on the concept of **mean** which oftentimes is referred as average. A misconception that most students have.

Teacher: Why did you get the sum of all the scores of the quizzes?

*Response for Answer No. 1: Given that we are tasked to find who can better represent the school, then we can add all the scores for Marco and Jacinth. Doing this, can determine who has higher scores out of all trial quizzes taken and conclude that he/she can better represent the school than the other.*

Teacher: You have almost the same method with other groups, but can you explain what makes your solution different from others?

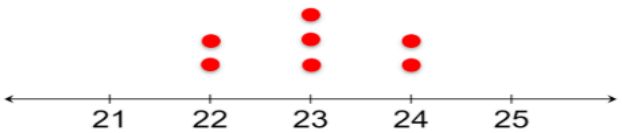
*Response for Answer No.2 : What makes this different is that we have taken into consideration the number of trial quizzes taken by each student. So we add all scores and divide it by 7 trial quizzes so that we can have an average of all the quizzes taken by students. Doing this allows us to generate a score that is close to the data we have, one that is not much far from the data set we have.*

From the answers generated by students, the teacher can scaffold learners to better solve the mean of a particular data set is,

$$\overline{x} = \frac{Sum\ of\ all\ observations}{Total\ number\ of\ observations}$$

2nd Revision:

Ask: Look at the illustration we have, this is the distribution of Jacinth's Scores. What can you observe from her scores?




Students will be able to:

- *Realize that the center of the scores is the 23 which is the most frequent score*
- *Realize that the 23 can also represent the mean which they have solved earlier.*
- *Realize that the 23 is also the median they have identified*

Ask: From the figure shown, what can you tell about the relationship of these three measures?

**The Assessment for Lesson Plan 1**

Assessment towards the end of the lesson was also revised to align more in the intended learning outcomes and the problem first presented. The revision is shown in the table below. Here, the teacher is given two problems for the teacher to choose from to practice students solving the three measures of central tendency to check student understanding of the topic discussed.

**Table 12.**

*Revisions on the assessment for Lesson Plan 1*

Draft:

**F. Assessment (Quiz)**

Two people are working in a factory making parts of cars. The table shows how many complete parts they make in 1 week.

| *Worker* | *Mon* | *Tue* | *Wed* | *Thu* | *Fri* |
|---|---|---|---|---|---|
| Fred | 20 | 21 | 22 | 20 | 21 |
| Harry | 30 | 15 | 12 | 36 | 28 |

a) Find the mean for Red and Harry
b) Who is most consistent?
c) Who makes the most parts per week?

1st Revision:

**F. Assessment (Quiz/Assignment)**

**Problem No. 1**: Mark got the following scores during their second quarter summative quizzes: 24, 26, 18, 24, 19, 23, 20. What is the mean, median and mode of the given scores?

**Problem No. 2:** Two teams are playing against each other in a tug of war. The weights, in kilograms, are as follows:

| ***Team*** | ***Weights (kg)*** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Slytherin | 75 | 74 | 65 | 77 | 78 | 74 | 74 | 67 |
| Gryffindor | 72 | 71 | 66 | 79 | 80 | 81 | 67 | 74 |

What measures of central tendency would best represent this data? Which of the two teams do you think will win?? Justify your answer.

## Lesson Plan 2

### The Learning Objectives for Lesson Plan 2

The drafted learning objectives for Lesson Plan 2 includes behavioral verbs like "calculate" and "illustrate" to help students master the concept. However, as noted by MT1, the objectives were revised to include "analyze," which not only allow students to master finding the three averages but also explore their different characteristics and how each measure best represents a specific data set.

**Table 13.**

*Revisions on the Learning Objectives for Lesson Plan 2*

| |
|---|
| Draft:<br><br>**Lesson Objectives:**<br>At the end of this lesson, the students will:<br>• Calculate the measures of central tendency (mean, median, and mode) of ungrouped data<br>• Illustrate measures of central tendency (mean, median, and mode) of an ungrouped data. |
| 1st Revision:<br><br>**Lesson Objectives:**<br>At the end of this lesson, the students will:<br>• Calculate the measures of central tendency (mean, median, and mode) of ungrouped data<br>• Calculate values using the given mean, median, and mode<br>• Analyze data sets to determine which measure of central tendency (mean, median, mode) best represents a statistical data<br>• Solve problems involving measures of central tendency |

**The Utilized Word Problem for Lesson Plan 2**

The created Lesson Plan 2 initially included two open-ended problems adapted from Sullivan (2004), where students could generate a set of values based on the three measures. However, it was revised to focus on a single problem and its discussion, with the second problem removed. The problems utilized are given in the table below.

**Table 14.**

*Revisions on the Word Problem for Lesson Plan 2*

<table>
<tr><td>Comment: Focus on one single problem for students to work on [MT1]</td></tr>
<tr><td>Draft:<br>Problem No. 1<br>Title: Seven People Went Fishing<br>Problem: Seven people went fishing. The mean number of fish caught was 5, the median was 4, and the mode was 3. How many fish did each person catch?<br>  <br>Problem 2:<br>Problem Manipulation: If six people in the group caught 2, 3, 3, 4, 6, and 8 fishes respectively, how many fishes should the last person catch to make an average catch of 5 fishes on that day?<br>  </td></tr>
<tr><td>1st Revision:<br>Problem No. 1<br>Title: Seven People Went Fishing<br>Problem: Seven people went fishing. The mean number of fish caught was 5, the median was 4, and the mode was 3. How many fish did each person catch?<br>  </td></tr>
</table>

**The Development of Concepts for Lesson Plan 2**

The MT1 acknowledges that the discussion towards the problem presented for Lesson Plan 2 is effective since students can generate many possible solutions and explain their thinking processes. However, as suggested by MT1, discussion should also include questions or examples that extend student thinking and reasoning, specifically whether a specific average can effectively represent a given data set, and align more closely with the objectives.

**Table 15.**

*Revisions on the development of concepts for Lesson Plan 2*

| Comment: Provide situations that Mean or other averages is not a good representation for a given data [MT1] |
|---|
| Draft:<br>**D. Development of Concept**<br>Ask: How many fish did each person catch?<br>Student 1: **6, 3, 3, 4, 3, 8, 8**<br>Ask: How did you get that answer?<br>Student 1: Since the mean is 5, we created 7 numbers that sum up to 35 since 7(5) = 35. The median is 4 so we placed it as the middle value. Then from there, we adjusted numbers to make a mode that is a number that is repeating, in our case, the median is 3.<br>Ask: How about the other group? |
| 1st Revision:<br>Ask: Is it possible to have an answer like these data sets?<br>*Data 1: 0, 0, 0, 0, 0, 0, 35*<br>*Data 2: 0, 0, 0, 4, 4, 7, 20*<br>For Data 1: *0, 0, 0, 0, 0, 0, 35*<br>*Response: Given this data set, it is not possible. While the mean satisfies the given problem, however, the median and mode is completely different. Here the mode and median is 0.*<br>For Data 2: *0, 0, 0, 4, 4, 7, 20*<br>Response: *The mean of this set is 5 and median is 4 but its mode is not 3. So this is not an answer to the problem.*<br>Ask: But is it possible to have like these data sets? Which measure of central tendency would best represent the data? |

### The Assessment for Lesson Plan 2

In similar manner, revisions of assessment towards the for Lesson Plan 2 is shown also in the table below to foster alignment of the discussion.

**Table 16.**

*Revisions on the assessment for Lesson Plan 2*

Draft:

**I. Assessment (Quiz/Assignment)**

Two teams are playing against each other in a tug of war.
The weights, in kilograms, are as follows:

| *Team* | *Weights (kg)* | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Slytherin | 75 | 74 | 65 | 77 | 78 | 74 | 74 | 67 |
| Gryffindor | 72 | 71 | 66 | 79 | 80 | 81 | 67 | 74 |

What measures of central tendency would best represent this data?
Which team then among the two teams do you think will win? Justify your answer.

1st Revision:

**F. Assessment (Quiz/Assignment)**

**Problem No. 1:** Five friends went to a bakery. The mean number of pastries they bought was 8, the median was 7, and the mode was 6. How many pastries did each person buy? Explain.


*Possible Answers:*

**1)** 6, 6, 7, 10, and 11
**2)** 6, 6 , 7, 9, and 12
**3)** 6, 6, 7, 8, and 13

**Problem No. 2:** *In a set of a student grade, the average grade is 89. If the grades of 7 subjects are 85, 90, 95, 86, 85, 88, and 91, what is the grade of the 8th subject?*
*Answer*: 92


## Lesson Plan 3

### The Learning Objectives for Lesson Plan 3

For Lesson Plan 3, the objectives include behavioral verbs such as "describe," "illustrate," and "calculate" to measure variability. However, to add specificity to the intended goals, revisions were made to focus on solving population data, providing a clearer distinction in the content.

**Table 17.**

*Revisions on the Learning Objectives for Lesson Plan 3*

| |
|---|
| Draft:<br>**Lesson Objectives:**<br>At the end of this lesson, the students can:<br>● Describe the measures of variability of ungrouped data.<br>● Illustrate the measures of variability (range, variance, and standard deviation) of statistical data.<br>● Calculate the range, variance, and standard deviation of statistical data. |
| 1st Revision:<br>**Lesson Objectives:**<br>At the end of this lesson, the students can:<br>● Describe the measures of variability (range, variance, and standard deviation) of ungrouped data<br>● Illustrate the measures of variability of statistical data<br>● Describe relationship of the mean, population variance, and standard deviation<br>● Calculate the range, population variance, and standard deviation<br>● Solve problems involving the measures of variability |

**The Utilized Word Problem for Lesson Plan 3**

Moving from the topic measures of central tendency, Lesson Plan 4 delves into the topic measures of variability, with the problem undergoing two revisions due to its limitations for student exploration. According to MT1, while measures of variability can be challenging for TTPS application, the problem to be presented can be aligned to the previous problems, provided that for both groups, they are given the same mean and the word "consistent" is used to show relation to spread or dispersion of data.

**Table 18.**

*Revisions on the Word Problem for Lesson Plan 3*

Comment: Telling them what to do is not ideal in TTPS. [MT1]

Draft:

**Problem:** Mona wants to know the daily average time she spends using her cell phone in a week. As the week ended, she checked on her tracker and found the following data set in minutes.

Create a representation to show the difference between the longest and shortest average time that Mona spends on her cell phone.

| Day | Minutes |
|---|---|
| Sunday | 130 |
| Monday | 292 |
| Tuesday | 125 |
| Wednesday | 64 |
| Thursday | 76 |
| Friday | 238 |
| Saturday | 326 |

1st Revision:

**A. Problem Presentation**

Mrs. Morales is interested to know the performance of two groups (A and B) of her students. She gives them a test of 40 points. The scored obtained by the students of groups A and B in the test are as follows:

Group A: 12, 10, 40, 40, 20, 36, 17, 16, 19, 15
Group B: 26, 27, 20, 21, 20, 23, 25, 20, 25, 18

Which of the two groups performed more better? Why?

2nd Revision:

**A. Problem Presentation**

**Problem:** Mrs. Morales is interested to know the performance of two groups (A and B) of her students. The grades obtained by the students of groups A and B in their subject are as follows:

**Group A: 98, 74, 77, 97, 96, 97, 94, 65, 78, 99**
**Group B: 90, 90, 85, 87, 90, 84, 86, 91, 90, 82**

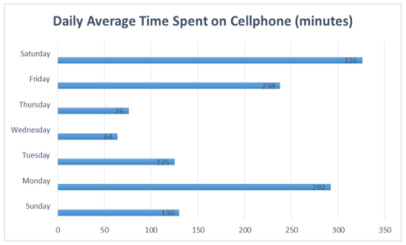
Which of the two groups of students performed more consistently? Why?

**The Anticipated Possible Solutions for Lesson Plan 3**

The table below also shows the changes and additions made with the anticipated possible solutions with regards to the problem.

**Table 19.**

*Revisions on the Anticipated Possible Solutions for Lesson Plan 3*

<table>
<tr><td>Comment: Add another solution based on scores and common sense. [MT1]</td></tr>
<tr><td>Draft:<br><br>Answer 1: Using of Bar Graph<br> 

<br>Answer 2: Using of Number Line<br> 

<br>By using the number line, we arranged the data from the smallest to the greatest. We can see that the smallest number is 64 which is the shortest average time</td></tr>
<tr><td>1st Revision:<br><br>Solution 1: Solving for the Mean<br><br>Group A:<br>Scores: 100, 68, 77, 97, 100, 99, 93, 65, 78, 98<br>Total score: 100 + 68 + 77 + 97 + 100 + 99 + 93 + 65 + 78 + 98 = 875<br>Mean = $\frac{875}{10}$ = 87.5<br><br>Group B:<br>Scores: 90, 90, 85, 87, 90, 84, 86, 91, 90, 82<br>Total score: 90 + 90 + 85 + 87 + 90 + 84 + 86 + 91 + 90 + 82 = 875<br>Mean = $\frac{875}{10}$ = 87.5<br><br>Solution 2: Comparing the Grades<br><br>Group A:<br>High score: The highest score is 100<br>Low score: The lowest score is 65.<br>100 - 65 = 35<br><br>Group B:<br>High score: The highest score is 90.<br>Low score: The lowest score is 82.<br>90 - 82 = 8</td></tr>
<tr><td>2nd Revision:<br><br>Solution 3: Common Sense<br><br>Similarly, students may observe that in Group B, the scores range from 82 to 90, which is a narrower range compared to Group A. They will also notice that all scores in Group B are close to the mean of 87.5. Based on this, students may conclude that Group B is performing better than Group A, as the scores are more consistent, less spread out, and closely centered around the mean.</td></tr>
</table>

## The Development of Concepts for Lesson Plan 3

To help students gain a deeper understanding of measures of variability, the revisions to the discussion not only focus on their ability to

calculate and solve related problems but also presents illustrations such as scatter plots where through teacher guidance, students visualizes and interprets the distribution and spread of data points.

**Table 20.**

*Revisions on the development of concepts for Lesson Plan 3*

Draft:

**C. Development of Concepts**

This time, as the teacher has finished looking around each of the student's answers, he will select a student to explain his/her answer in the class. When necessary, follow-up questions will be raised to the student for guided learning and giving of feedback. Other students who are not called will have the chance to also ask questions or raise clarifications if there are any.

Ask: So, what is the difference between the longest and shortest average time that Mona spends on her cell phone?
Student: 262 minutes, Sir.
Ask: How did you get 262 minutes?

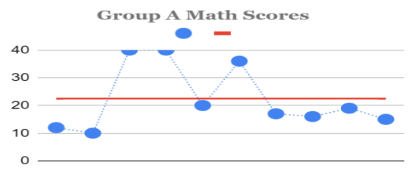
**Solution 1:**
Making use of the previous knowledge learned in the past discussion, we have used the bar graph to represent what is asked in the problem. By making use of the bar graph, we have obtained a difference of 262 minutes. First off, we let the y-axis as the days in a week, while the x-axis is the time or minutes Mona spends on her phone in a day. For the x-axis, we set the interval of 50. Afterward, we designated the time to the interval close to it and then shaded it, and then the rest followed. From there, we can see clearly that there was a big gap between the smallest and longest average time. To find the difference, we

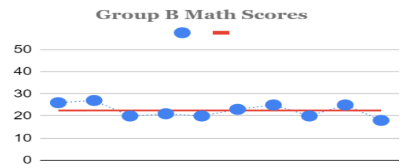
1st Revision:

Technically, to find the range, we make use of this formula:

Range = Highest Score - Lowest Score

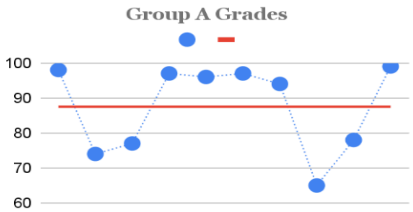
To understand it more, let us look closely and observe this graph.

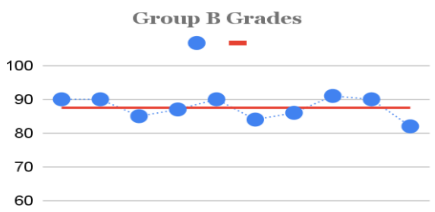



2nd Revision:

*Scatter Plot Illustration for Grades (A and B)*




Ask: Observe the illustrations, what do you notice? What can you say about it?
*Response: I observed that the red line are situated in between the numbers 80 and 90*

## Lesson Plan 4

### The Learning Objectives for Lesson Plan 4

Similar to Lesson Plan 3, the learning objectives for this lesson were revised to provide specific outcomes for students, with a focus on solving measures of variability for sample data.

**Table 21.**

*Revisions on the Learning Objectives for Lesson Plan 4*

| |
|---|
| Draft:<br>Lesson Objectives:<br>At the end of this lesson, the students can:<br>• Describe the measures of variability, particularly the variance and standard deviation of ungrouped data.<br>• Calculate the variance and standard deviation of statistical data.<br>• Describe the relationship of data, mean, variance, and standard deviation. |
| 1st Revision:<br>Lesson Objectives:<br>At the end of this lesson, the students can:<br>• Calculate the sample variance and standard deviation for ungrouped data<br>• Describe the relationship of the mean, sample variance, and standard deviation<br>• Solve problems involving measures of variability |

### The Utilized Word Problem for Lesson Plan 4

Revisions for the word problem for students to work collaboratively follows the feedback from Lesson Plan 3 coming from MT1. As suggested, students value the lesson more when problems are about their grades which they can relate to.

**Table 22.**

*Revisions on the Word Problem for Lesson Plan 4*

Draft:

**A. Problem Presentation**

Problem:

The recent math quiz concluded with different scores coming from a sample of 5 students from Grade 7 Section Gumamela and Section Mirasol.

G7 Mirasol : 22, 34, 37, 38, 21
G7 Gumamela : 17, 22, 25, 16, 32

Compute the mean, variance, and standard deviation.

1st Revision:

**A. Problem Presentation**

Problem: With the concluded academic quarter, a sample of 5 students from Grade 7 Sections Gumamela and Mirasol were evaluated across their performance in the subject Mathematics.

G7 Mirasol : 85, 98, 88, 95, 87
G7 Gumamela : 92, 95, 87, 91, 88

By calculating its variability, which of the two teams displays a more consistent performance?

**Question Prompts Used for Lesson 4**

Upon the review process, consistent use of questions are needed to develop and practice students' reasoning. MT1 noted how questions are still limited. Thus, questions and dialogues embedded in the lesson plan were also revised to provide more opportunities for students to practice articulating their thoughts.

**Table 23.**

*Revisions on the Question Prompts*

| Comment: Questions for mathematical reasoning are limited. [MT1] |
| --- |
| Draft:<br><br>Ask: What can you infer from this data? Notice that the blue circles are the individual scores while the orange line is the computed average. So what can you say based on your observations?<br><br>Ask: What can you say about the relationship between individual scores and their average?<br><br>Student: *The scores of section Gumamela Sir are close to the average line.*<br><br>Ask: What about the other section?<br>Student: *The scores are spread out compared to Gumamela.*<br>Student: It *is far from the average line.* |
| 1st Revision:<br><br>Ask: Now, from the illustrations we have, what do the blue dots represent?<br>*Response: The blue dots represent the individual grades of the 5 students from their respective sections*<br><br>Ask: How about the red line in the illustration?<br>*Response: The red line is close to 90, so I think this is the mean average and based on what we solved earlier, the mean average for both sections is 90.6*<br><br>Ask: What does the chart indicate about the individual grades and the mean average?<br>*Response: The chart indicates how spread out the individual grades are in relation to their mean average for both sections. I think this suggests that if the data is widespread from the mean, it indicates a large sample variance and standard deviation.*<br><br>Ask: Based on what we have solved earlier and the illustration we have, what can you conclude about their variability?<br>*Response: Grade 7 Mirasol has a sample variance of 31.3 and a standard deviation of 5.59, this means that on average, individual grades are 5.59 points away from the mean.*<br>*Response: Grade 7 Gumamela has a 10.3 sample variance and standard dev. of 3.21 which means that individual grades are also 3.21 points away from the mean average.*<br><br>Ask: So which section do you think performed better? Mirasol of Gumamela?<br>*Response: I think it's Grade 7 Gumamela. The grades of five students from Section Gumamela are more consistent because it is closer to the mean average, while the* |

**Claim-Evidence-Reasoning (CER) Math Assessment**

The CER assessment was administered on the fifth day as part of the lesson implementation. Initially, the said assessment consisted of three items, which is typical for the exams given to students. However, based on feedback from the implementing teacher, the assessment was revised to include only two items due to time constraints and concerns about the upcoming periodical exams. The two-item CER assessment was designed to evaluate how well students had grasped the topics in the lesson. It included two word problems related to measures of central tendency and measures of variability, as outlined below.

**Table 24.**

*CER Problem-Solving Assessment*

---

**GENERAL INSTRUCTION:** Read each problem carefully. Answer in CER form.

Essential Question: What mathematical concept is best to use in the following problem?

1. After months of studying earnestly in Math, Aida got grades 95, 89, and 92 in the past 3 quarters. Now, she is determined to maintain an average mean of 93. What grade will she need in the 4th quarter to achieve this goal? What will happen to her average score if her next grade remains at 92?
2. The Debate Club has two teams set to compete in the National Debate Competition. Since only one team can go, they need to decide which among the two teams is the best representative for the club. They compared the number of awards each team won over the past six years.

   Team Alpha: 12, 9, 9, 5, 10, 8
   Team Beta: 7, 5, 6, 8, 8, 10

   Which among the two teams will be chosen to represent the club? Why?

---

In its entirety, the lesson plan created ensures that thoughtful discussions of concepts are at the forefront of student learning. Other forms of revision, not explicitly mentioned, revolve around deepening the discussion of key concepts. The lesson plan is designed to provide opportunities for students to extend their thinking through targeted questions that encourage them to make their reasoning visible and engage in open reflection. With these, multiple questions were embedded all throughout as prompts, guiding students to develop and articulate their reasoning more effectively.

Consequently, the drafted lesson plans and assessments underwent two major revisions where suggestions and feedback coming from MT1 was followed to provide both students and the implementing teacher a detailed outline in the teaching-learning process. Although the suggestions and feedback were solely from the MT1, both MT2 and MT3 of the partnered institutions provided insights in the development of the lessons and the assessment

**Claim-Evidence-Reasoning (CER) Math Assessment**

From the conducted lesson implementation, the table below presents the result of the assessment achieved by Grade 7 students. The results, in mean scores, provide an overview of students' performance in each section of the assessment namely: claim, evidence, and reasoning section.

**Table 25.**

*Mean Score Result of CER Math Assessment*

| Category | Mean Score | Level |
|---|---|---|
| Claim | 1.66 | Approaching |
| Evidence | 1.0 | Beginning |
| Reasoning | 0.66 | Beginning |
| Overall | **1.11** | ***Beginning*** |

In the **Claim** section, results showed an *Approaching* level with $\overline{x} = 1.66$, indicating that while students could make a correct claim, responses often lacked clarity and completeness. Students frequently referred to "measures of central tendency yet failed to specify which among the three mathematical averages was being applied.

Meanwhile, the **Evidence** section was at the *Beginning* level with $\overline{x} = 1.0$, revealing that the evidence or "solution" provided by students was insufficient, limited, often missing, and contained significant errors in calculations which led to incorrect final answers and conclusions. These two sections highlighted the challenges students faced in writing their explanations in the *Reasoning* section of the assessment.

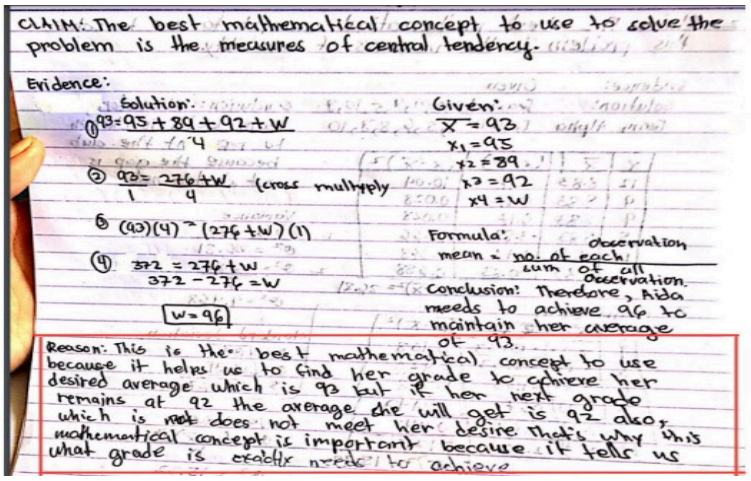
**Reasoning** is at *Beginning* level with $\overline{x} = 0.66$ indicating that it is often repetitive, minimal, and insufficient to justify the claim and evidence presented. Similar findings were reported in studies by Edquilag et al. (2023) and Traut (2017), indicating that while students can state claims and evidence, they struggle to explain and justify the underlying mathematical concepts needed to answer the problem. Edquilag et al. (2023) cites Mcniel (2022) that the reasoning section proved to be the most challenging as most students were seen struggling to explain and justify their answers.

Consequently, the overall assessment achieved $\overline{x} = 1.11$ which suggests that the CER math writing of Grade 7 students is at the *Beginning* level and has not yet met the expectations set by the assessment rubric, indicating a need for further improvement.

**Students' Mathematical Reasoning in CER Assessment**

**Figure 4.**

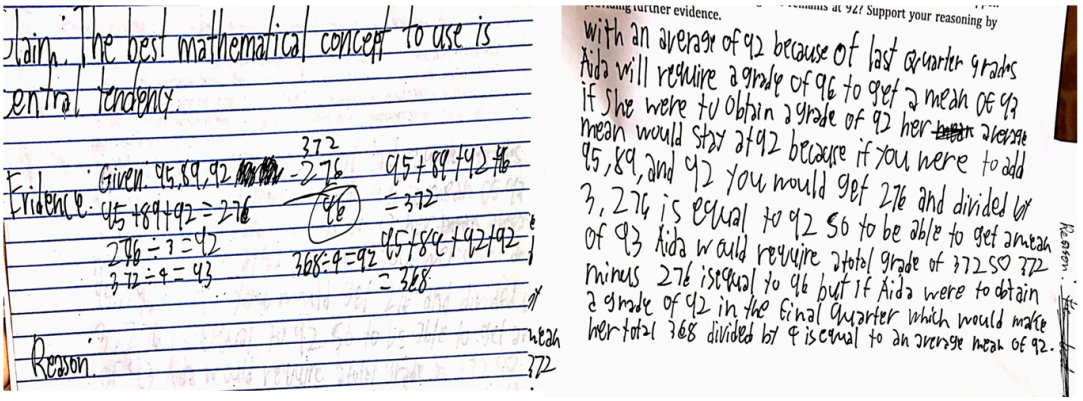
*Sample 1 response for Item 1*




The student's work presented above highlights a solid understanding of applying the concept of measures of central tendency, particularly the mean, to solve a real-world problem. They demonstrate strong algebraic skills, successfully manipulating the formula for the mean to determine the required score. Their calculation of W=96 demonstrates strong procedural knowledge, particularly in applying the formula for the mean and performing algebraic manipulations. This indicates that the student has a solid grasp of mathematical processes and the ability to translate abstract concepts into practical solutions. However, while the student's claim and evidence are clear and correct, the reasoning section falls short of fully connecting the evidence to the claim. The explanation does not explicitly articulate *why* the mean is the most appropriate measure of central tendency to solve the problem, especially in comparison to other measures such as the median or mode.

**Figure 5.**

*Sample 2 response for Item 1*




Based on the figure above, the student presented a clear, and correct explanation of their solution by explaining step-by-step how they were able to arrive at the answer. Using this method does not only build critical thinking; it also promotes persistence in problem-solving. This enhances students' ability to communicate their ideas, as well as provide valuable opportunities for self-reflection of their thought process (Nuraeni et al., 2014).

On the contrary, while a step-by-step explanation could help teachers identify potential misconceptions and errors based on the students' reasoning (McNeill & Krajcik, 2011), overemphasis on the procedural knowledge risks the potential of developing conceptual understanding. Consequently, the student also failed to explain how and why such evidence supports their claim. Hence, this suggests that students' knowledge was still more procedural than analytical, focusing only on following a set of steps without the deep engagement of the underlying foundational concepts of the problem given (Alindra & Ana, 2018).

**Figure 6.**

*Sample 3 response for Item 1*

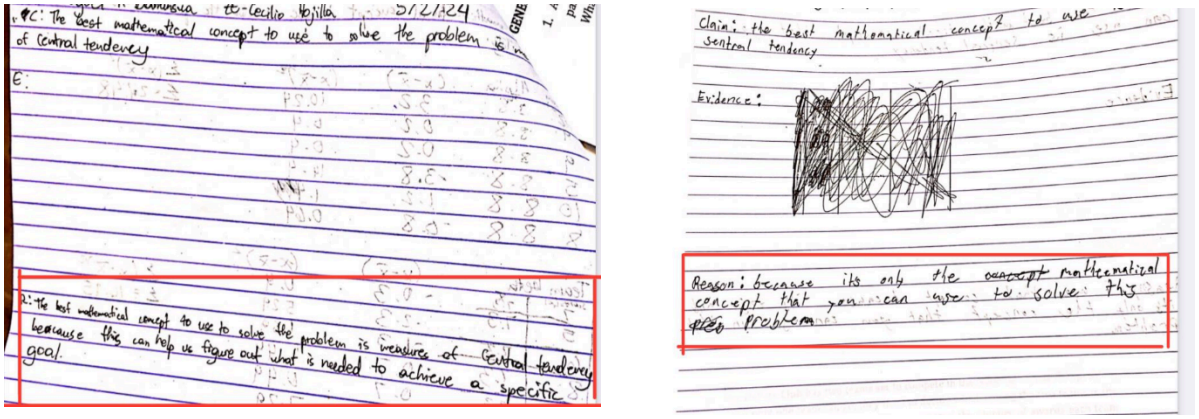



Figure 6 shows that both of the students were able to identify a correct mathematical concept that could be used to solve the problem as shown in the claim section. These students were also able to provide a reasoning, but were unclear and insufficient to connect the claim and evidence. Moreover, an interesting observation was seen - both of the students did not provide any evidence, which was supposed to contain the solution for the problem. This indicates that students might understand what the problem is asking and can provide reasoning but struggle with executing the calculations or applying the methods needed to solve it, hence, they can analyze the problem on a conceptual level, but translating that understanding into numerical solution remains a struggle for them (Bedwards, 2023).

**Figure 7.**

*Sample response for Item 2*

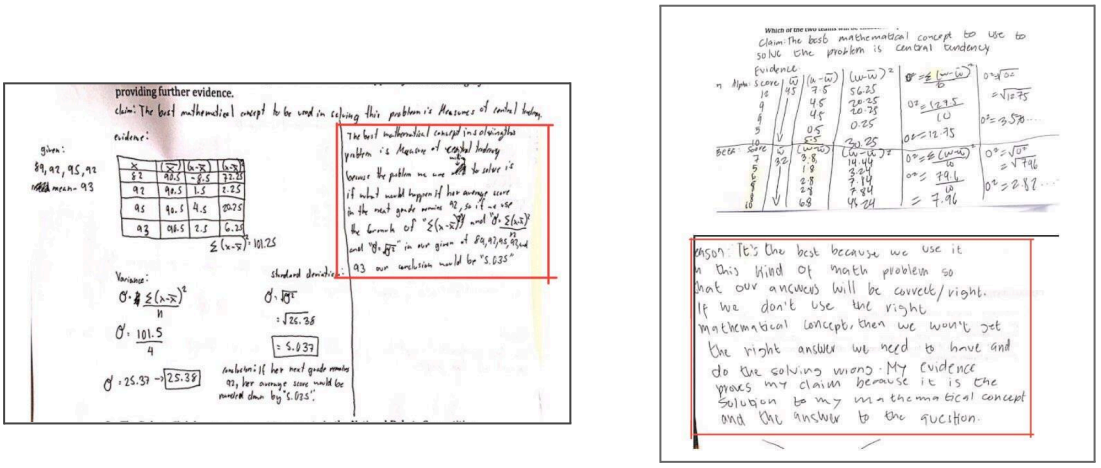



Figure 7 illustrates the students' attempts to apply the concept of measures of central tendency to solve the problem. While the initial idea is present, the explanation lacks clarity. Additionally, the formula was incorrectly written and seems to confuse the concepts of variance and standard deviation when calculating the mean.

Although the students demonstrate familiarity with the formula and procedure, their reasoning and evidence do not support their claim. Both of the students, presented a claim pertaining to measures of central tendency; however, the solution provided in the evidence section detailed a process for solving a problem associated with measures of variability.

Thus, this suggests that there was a mismatch between the answers in claim, evidence, and reasoning, indicating that students lack understanding of the statistical concepts involved. The mismatch also signifies that these students have not yet fully understood the relationships of the concepts discussed, hence, the misconception between the two concepts (Lane-Getaz, 2021;Ismail & Chan, 2015). This aligns with Yasuda (2023), who emphasizes that a failure to connect reasoning and claim suggest

that the student may be relying more on assumptions than in evidence. Lee (2023) added when a student fails to make a connection between the evidence and the claim, it results in difficulty in articulating reasoning.

**Thematic Analysis of TTPS-CER Implementation**

The concluded lesson implementation have shown valuable insights, providing narratives and insights that underscored both the positive and challenging experiences of the participants. Specific codes were identified to develop themes describing the overall narrative in participants' engagement, learning processes, and overall outcomes. The themes, summarized in the table below, illustrate the connection between individual experiences and the objectives of the implementation.

**Table 26.**

*Codes and Themes from Thematic Analysis of the Implementation of TTPS-CER Narrated by Teacher and Students*

| Codes | Themes |
|---|---|
| Students' progress in problem-solving (7)<br>Students' need of guidance (6) | Students' Learning Experience in TTPS |
| Students' fear to communicate their thoughts (6)<br>Students' initiative to ask among peers (4)<br>Peer Support during Group discussions (9) | Student Engagement during Discussion |
| CER is easy (6)<br>CER helps improve reasoning in writing (7)<br>Challenging reasoning section in assessment (7)<br>Students' limited time in the CER assessment (6) | Students and Teacher's Feedback on Practicing CER Assessment |
| Teacher's reflection using TTPS and CER (3)<br>Teacher's openness in learning TTPS (1) | Teacher's Positive Attitude towards TTPS and CER |

**Theme 1: Students' Learning Experience in TTPS**

In the concluded implementation, students in general reported a good learning experience.

> *"My experience with the lesson discussion that happened over the past two weeks have been quite good and fun but also a little bit stressful since I was confused at the new lessons because they seemed difficult but I eventually understood the topics."* **[Arlene]**

> *" ... when we were just tackling a new topic which is the Measure of Central Tendency where sir created the table with the mean, scores, and such. It got my attention because it seemed difficult to do and I was kind of getting worried if I was going to understand it or not but I eventually learned that it was not that difficult as it seems."* **[Gwen]**

Along with others who shared their positive experience, some students who found the lesson confusing and hard also shared their narratives. For instance,

> *"The process of learning the lesson was hard because it was confusing and complicated but I still learned*" **[Nessa]**

> *"[It was] very fast since we learn only one lesson in two days and it's quite challenging for us when it comes to quizzes.* **[Elle]**

Moreover, according to the teacher, for certain students, the presence of open-ended problem tasks prompted their interest to progress in problem-solving even before the lesson was formally discussed.

> "*In terms of the approach, mas nakita nako ilang eagerness nga makabalo unsaon pag answer. Katung sa presenting the problem, nag build na silag hala unsaon kaha ni pagsolve? Unsa kahay answer ani? Or sailang huna huna ba is makahatag silag answer. Ginachallenge nila ilang self ba."* **[IT]**

For instance Glenn, one of his students, shared,

> *"When Sir showed us the problem first, it sparked an interest on how to get the answer because it was limitless and there were lots of possible solutions, it really got my interest and attention."* **[Glenn]**

In the same way, some students also agreed by expressing,

> *"My learning experience during the lesson discussion that got my attention and interest was when I understood the lessons clearly and was excited to answer [more]problems."* **[Bryan]**
>
> *" The measures of central tendency were interesting since they were easy to solve."* **[Sam]**
>
> *" [I like] measures of central tendency because I'm interested to compute my grades",* **[Von]**

Furthermore, although the students have shown interest in solving problems, the teacher observed that proper guidance and support from teachers were still needed before students begin to think critically on their own.

> *"... sa ilang level, ibuild pa dapat ang critical thinking. So ang mostly dapat is maghatag patag information saila. Although kailangan jud nga at some point is sila ang magthink sa ilang mga answers, pero wala paman gud silay foundation sa mga lessons. ... Lisod ibuild nga dapat saila jud mogikan ang answers kay ang ilang foundation is low pa. Kailangan pa ipolish. Bisan ganig pag solve sa simple equations, dili sila kasolve. Maglisod pa sila."*

Thus, the teacher's observation that students still struggle with basic concepts such as solving simple equations indicates that without sufficient support, their progress in problem-solving will be hindered. This aligns with the research by Hattie (2015), who emphasizes that teacher guidance and support serves to provide the scaffolding necessary for students to gradually build confidence in their learning. With ongoing teacher support and guidance, students can progressively develop the skills needed to tackle problems independently.

**Theme 2: Students Engagement during Discussion**

During discussions, particularly when recalling a lesson, many students would actively engage to communicate their ideas when asked to explain a process and define previously discussed concepts. However, consistent participation and efforts to

articulate reasoning all throughout came only from the same group of individuals. It was observed that students seated in front were the ones who often explain their ideas and solutions, while students at the back remain silent, distracted, and inattentive. As observed by a student, she expressed,

> *"makontrol ra jud ang kasaba pero mohilom jud ang klase everytime mangutana si teacher."* **[Mary]**

Accordingly, this noticeable behavior is rooted in students' fear to communicate their thoughts particularly during teacher-student discussions. Below are narratives expressed by students upon interview,

> *"Mahadlok kay basin mali"* **[Mary]**

> *"I'm scared if the teacher is going to choose a student to answer the problem without even discussing it and I'll get nervous if the students will look at me as if I failed the subject."* **[Mark]**

The above narratives indicate that fear contributes to students' reluctance to participate in teacher-student discussions to which the teacher agreed stating,

> "*Ang mga students man gud is mahadlok pajud sila mo istorya sa ilang thoughts[in front] ... which is kailangan pajud ibuild ilang confidence."* **[IT]**

Although this is evident inside the classroom, the teacher shared how students would take initiative to ask questions and clarify concepts that they haven't understood among their peers.

> *" ... same person rajud ang motingog pero ang naka ayos is katung di pud kabalo is mangutana saila like giunsa nimo pagkuha, [or] hala lahi lagi tag answer. Maobserve nako sa ila nga naa silay initiative."* ***[IT]***

Additionally, this initiative happens during small group discussions, where students' interaction does not only focus on the topic itself, but also involves offering help, guidance and support towards their peers. This aligns with Vygotsky (1962) and Albay (2020) who emphasized that students learn best when they interact and

communicate with others who are more knowledgeable, be it teachers or peers. In connection, according to Jane,

> *" ... ato nga time kay galisod jud ko ug sabot dayun akong mga groupmates kay bright man jud sila so ilaha jud kong gitudloan. Naa silay mga notes so gitudloan jud ko nila step-by-step."* **[Jane]**

Conversely, Bryan shared his experience of assisting others, stating,

> "*...I felt like an expert when they asked, and I explained to my seatmate and other classmates on how to solve a problem or to discuss/explain to them in simpler terms."* **[Bryan]**

Similarly, despite recognizing his own limitations, Sam noted,

> "*I taught my classmate the part that he doesn't understand even if I'm not good at teaching but still he needs help."* **[Sam]**

All these narratives underscores the role that peer support plays especially during small group discussions, promoting an environment where students feel more comfortable to ask questions. This is supported by the findings by Albay (2020), who highlighted the importance of collaborative learning and peer support to enhance student engagement.

**Theme 3: Students and Teacher's Feedback on Practicing CER Assessment**

Students in general have expressed their preferences in using CER as it helps them explain their solutions in problem-solving tasks. The following students have shared that,

> *"Mas sayon ang CER kay naa ra saimong self unsa imong iingon nga opinion. Mas nindot kay sa CER maingon nimo tanan."* **[Jane]**

> *"I find (CER) easier to answer, it helps us explain why we used such a solution/way."* **[Arlene]**

> *"CER always goes in one direction and we don't have to be like 'why is it like this?' because we literally practiced a lot of times."* **[Cyril]**

These narratives suggest that CER allows them to articulate their ideas, not limiting them to stick to one way of solving problems. Through repeated practice of CER, students have already internalized the structure in writing its three components. Similarly, two other students have expressed that when practiced further, this could provide them the opportunity to improve the way they write their reasoning.

> *"In CER you can improve how to write an essay of your reason"* **[Sam]**

> *"CER helps you improve your writing as it allows you to explain your point. It gives you a chance to further reason out your opinion on something."* **[Blake]**

As students use CER, it helps them develop mathematical communication literacy needed for problem solving (New York Science Teacher, 2023). On the other hand, while students display positive feedback on CER, some also shared how providing reasons in their mathematical processes can be challenging for them.

> *"…when you answer the reason part you need to reason out why your evidence is connected to your claim which is sometimes challenging."* **[Christine]**

> *"The disadvantage of using Claim-Evidence-Reasoning (CER) is when the students lose how to reason it out."* **[Bryan]**

Some students suggest that difficulty in reasoning may be due to a lack of understanding of the concepts involved in the problem. They stated,

> *"When I was having a hard time focusing and understanding some topics, I couldn't reason clearly."* **[Gio]**

> *" ... my reasoning was challenged the moment that I did not understand the whole concept of why it is used.*" **[Tristan]**

Such challenge was evident in the assessment where students' struggle with specificity and justification particularly in the reasoning section. In addition to the challenges associated with completing CER tasks, students also reported the limited time allocated during assessments. During quarterly exams, they described the

assessment as time-consuming given the requirement to finish the math text within a limited period.

> *"It's very time-consuming. I can barely finish the two CER's in an hour and now I have to do it 3 times."* **[Blake]**

This concern was also evident during the assessment after the five-day lesson discussion as they faced similar difficulties due to a shortened time limit.

> *"Dili siya lisod pero nakulangan mi sa time kay 20 minutes lang ang gihatag."* **[Jane]**

These responses indicate that insufficient time allocated for assessments impedes students' ability to complete tasks effectively.

In spite of these challenges, the teacher emphasizes how helpful CER assessment was in capturing the depth of student learning as it provides insight into students' understanding of the topic. Srougi et al., (2014) underscores the importance of a consistent assessment framework where students are able to voice out well informed opinions grounded on deeper understanding of concepts, hence, practicing them to reason in support of the claims, arguments, and evidences they presented.

Such perceptions were also attributed to the institution's consistent use of CER as an assessment tool. Edquilag et al. (2023) agrees that over time, students' mathematical writing - particularly their mathematical reasoning - improved significantly in both quality and depth. This improvement stems from the continuous practice of students and the support received from the school community. The adjustments and modifications made to align assessments with the CER framework resulted in positive outcomes, that is, a more organized and systematic approach to problem-solving.

**Theme 4: Teacher's Positive Attitude towards TTPS and CER**

Taking into account everything that transpired, the teacher expressed a positive attitude on the concluded implementation. According to the implementing teacher, the integration of TTPS and CER shaped the overall teaching-learning process. The teacher believed that,

> *"With TTPS you can master the content and understand how the lesson or concept applied, not just for the sake of solving."* **[IT]**

He added,

> *"Kay dili naman gud presented ang unsay dapat nila imemorize, sila nay mangitag way nga dapat makakita jud ko ani given the problem, which is mas ayos siya because makadiscuss sila and marecall nila ang previous lesson, murag naa nay mastery dayun after na discover nila."* **[IT]**

This highlights how the approach engages students with meaningful, real-world problems that promote mathematical discussions through exploration and collaborative problem-solving. It breaks from the traditional math learning, which often relies on rote memorization, and instead fosters active learning, providing students with opportunities to enhance critical thinking, present ideas, and thus, develop a deeper understanding of mathematical concepts (Matthews, 2024).

> *"Because of the TTPS, makabalo sila sa importance sa lesson murag kabalo sila mag differentiate nganong when ang mean or median gamiton which is helpful siya sa CER especially sa reason nga part."* **[IT]**

As students learn to appreciate and delve deeper on the content because of TTPS, the challenge of assessing now lies in the CER assessment that puts emphasis on justification, critical thinking, and clear communication of ideas (McNeill & Krajcik, 2011).

> *"Ilang claim nga part is given na, pero ang sa reason part is mas dira ang challenge kay iexplain nila nganung kato nga concept ang gamiton to solve the problem. And na cater na pud sya dra sa TTPS."* **[IT]**

The teacher also noted that CER gives way in understanding students' comprehension of the topic enabling them to identify areas where students struggle or excel most.

> *"Helpful sya because dra nimo makita how well they have learned the topic kung unsa jud ilang understanding, kung shallow raba kaha ilang understanding. So base sailang reasons didto sa CER, makita nimo kung ang students nakasabot ba sa concept o wala."* **[IT]**

This aligns with TTPS as it requires to not only present the concept and evidence used, but also put emphasis on how students explain their thought process, which serves as a key part of developing strong mathematical reasoning (Mukuka et al., 2023).

Finally, the teacher revealed that despite the challenges he and his learners faced with the employed teaching approach, he is open to the opportunity to learn and refine his instructional practices. He stated,

> *"Yes, I am open to learning more about the TTPS approach because it helps deepen understanding of the lessons. It allows me to determine their stage in the learning process, whether they are still developing, have reached mastery, or have no prior knowledge of the topic."*

The teacher believes that only by mastering the content could actually teach students effectively. Not only can it provide an authentic learning experience but also improve the pedagogy of teachers in the mathematics classroom. This reflection aligns with Buan et al. (2021), where the approach enabled teachers to critically analyze their strengths and weaknesses, test new ideas, and adapt changes to further improve teaching practices.

# CHAPTER 5

# SUMMARY OF FINDINGS, CONCLUSION, AND RECOMMENDATIONS

This chapter presents the summary of the findings, conclusions, and recommendations derived from the overall results of the study.

## Summary of Findings

### 1. Lesson Plan Development

The study provided insights into the development and implementation of lesson plans using the TTPS approach, aligned with the CER framework. The iterative development process of the lesson plans, which underwent two revisions, ensured alignment with curriculum goals and addressed student learning gaps. It focused on topics such as Measures of Central Tendency and Measures of Variability. These revisions incorporated feedback from the mathematics teacher who has years of experience in teaching the subject to refine content and pedagogy. Central to the lesson plans was the inclusion of open-ended problems, which allowed students to explore multiple solutions and develop their reasoning. Initial overly structured tasks were replaced with more exploratory problems to encourage independent thinking. Initial lesson plans lacked sufficient prompts to promote reasoning, but later on, addressed by adding targeted questions that encourage deeper thinking.

### 2. Students' Mathematical Reasoning through CER Assessment

- Students achieved an overall score categorized as "Beginning" based on the modified CER rubric, with $\overline{x} = 1.11$, indicating that they have not met yet the criterias set in the assessment rubric, hence, a need for further improvement.

- **Claim**: Results have revealed that students were at the approaching level when it comes to providing a Claim, having $\overline{x} = 1.66$ which indicates that students could make a correct claim, however, their responses were incomplete and lacked clarity.
- **Evidence**: Results have revealed that students were at the beginning level with $\overline{x} = 1.0$ in providing the Evidence, which means that the evidences students provide were insufficient, limited, incomplete, and contains significant errors in calculations.
- **Reasoning**: Results have revealed that students were at the beginning level with $\overline{x} = 0.66$ in providing the Reasoning, which indicates that their explanations were often repetitive, minimal, and insufficient to justify the claim and evidence.

**3. Teacher and Student Perceptions with the Implementation of TTPS-CER**

- The implementing teacher expressed a positive attitude towards TTPS and CER but noted the need for greater scaffolding due to students' low foundational knowledge and limited experience with problem-solving approaches in learning math.
- The teacher recognizes that his students are capable learners but are yet to build one's confidence to fully participate particularly in reasoning their ideas and processes during lesson discussions

- Students appreciated the collaborative and exploratory nature of TTPS as it provided them the opportunity to interact, openly communicate, and support each other.
- Utilization of CER as mathematics assessment received positive feedback and perception from both the teacher and students. Students believe that it can help improve their ability in writing one's reasoning. While the teacher noted how the assessment challenges students to reason their understanding of the problem, the concept (claim) and solutions (evidence) they presented.
- Students highlighted challenges in finishing the CER assessment particularly in completing the assessment due to time constraint.
- The TTPS-CER allowed the teacher to gain insights of how students approach problems, interpret concepts, and construct reasoning, enabling him to know whether students have learned the topic or not.

**Conclusion**

The findings of the study shows that the integration of TTPS approach and CER provide valuable insights on the mathematical reasoning among grade 7 students, including the students' math performance in CER assessment, their learning experience and engagement as the two approaches were implemented. It also provided information about the teacher and students' feedback on practicing CER assesment in math classroom, as well as the teacher's attitude towards TTPS and CER.

Moreover, the TTPS approach promotes active engagement, collaboration, and exploration, which encourage students to develop deeper conceptual understanding by working on real-world problems. While, the CER framework provides a structured

process for students to articulate their mathematical thinking systematically, emphasizing the importance of claims, evidence, and reasoning in problem-solving. The study also revealed challenges, such as students' persistent difficulties in articulating reasoning, limited foundational knowledge, and fear of making mistakes during collaborative and individual tasks.

**Recommendation**

1. It is recommended to allocate adequate CER assessment time.
2. It is recommended that teachers practice teaching mathematics through problem-solving approach in delivering the lessons for the students to be used by the approach.
3. For further study, it is recommended to examine the long-term impact of TTPS and CER integration on students' mathematical reasoning and overall academic performance.
4. For further study, it is recommended to investigate the effectiveness of TTPS and CER across different grade levels and to identify scalability and adaptability.
5. The researchers would like to propose that teachers undergo training on Teaching Mathematics through Problem-Solving, paired with Claim-Evidence-Reasoning as the assessment.

# APPENDICES

# APPENDIX A1

Request Letter to LSA Principal

Mindanao State University
**ILIGAN INSTITUTE OF TECHNOLOGY**
College of Education
*Department of Science and Mathematics Education*

March 04, 2024

**CONCEPCION D. UY**
Principal
La Salle Academy

**Subject:** Requesting Permission to Conduct Research

**Dear Mrs. Uy,**

**Greetings of Peace!**

We, the **3rd-year BSED Mathematics students** of Mindanao State University - Iligan Institute of Technology are conducting our research entitled **Investigating Mathematical Reasoning Skill by Teaching Through Problem-Solving (TTPS) with Claim-Evidence-Reasoning (CER).** In this regard, we would like to ask permission from your good office to allow us to conduct our data gathering in your school.

The primary objective of this study is to document the suitability of Teaching through Problem-solving (TTPS) - a problem-solving teaching strategy, with the Claim-Evidence-Reasoning (CER) as an assessment tool to measure students' mathematical reasoning skills of Grade 7 students. Since one of our researchers is a Junior high school completer and has experienced CER assessment in your academic institution, we believe that your institution will provide valuable context for our research. Rest assured that the data to be collected will be taken with utmost confidentiality. Thus, we humbly request your formal approval to proceed with the study. We are open to any guidelines or recommendations you may have regarding the process.

Your positive response to this request will be a great contribution to our study and will highly be appreciated. We hope that this letter merits your kind approval.

Respectfully yours,

The Researchers

MARCO G. BONITA  JACINTH EVE R. DELA CERNA  IVAN GLENN MARK S. JAMACA

**Noted by:**

**ROVIC E. PEROCHO, MSciEd**
Thesis Adviser

**DOUGLAS A. SALAZAR, Ph.D**
Chairperson, DSME

**Recommending Approval:**

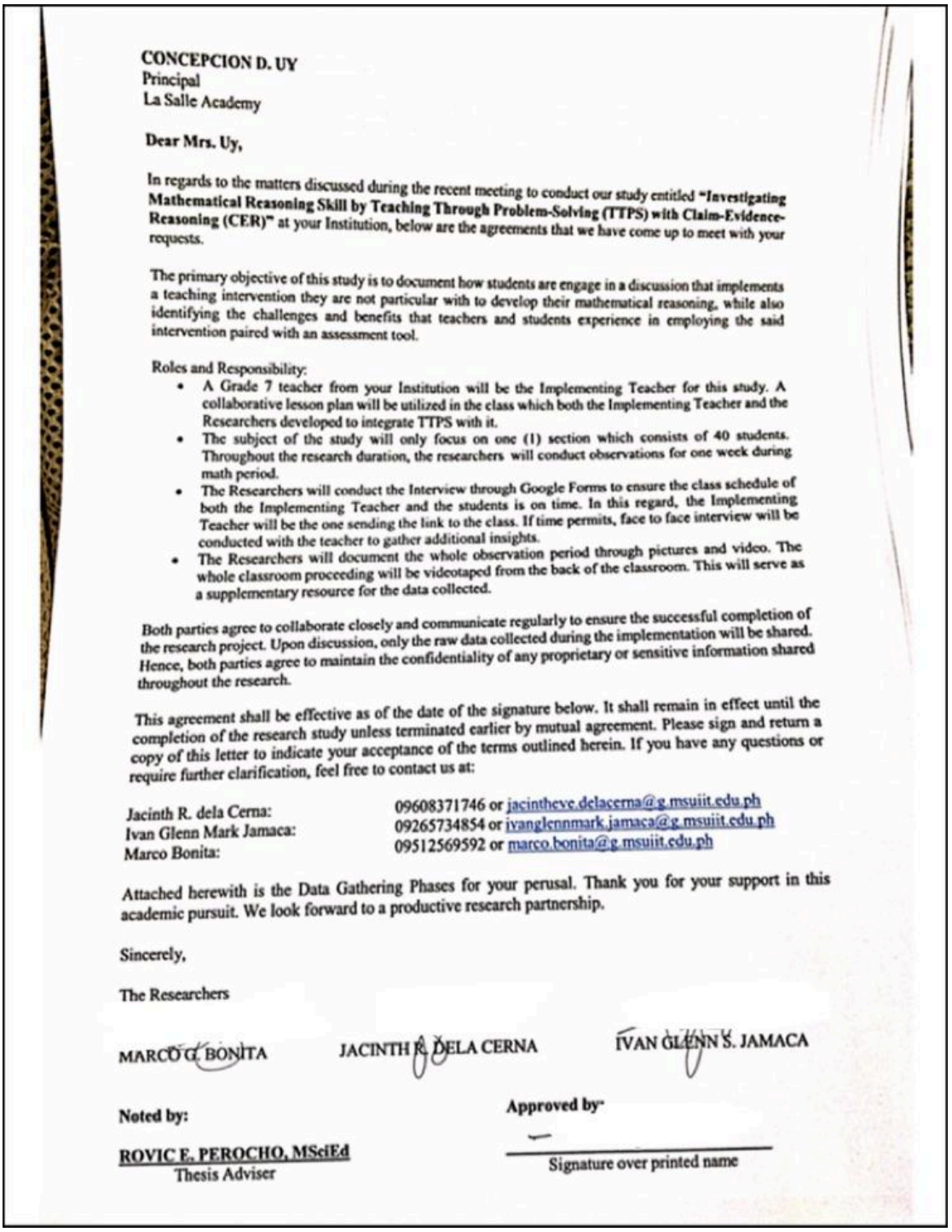
**MONERA A. SALIC-HAIRULLA, Ph.D**
College of Education, Dean

**Approved by:**

_____
Signature over printed name

# APPENDIX A2

Agreement Letter of the Institution and the Researchers



**CONCEPCION D. UY**
Principal
La Salle Academy

**Dear Mrs. Uy,**

In regards to the matters discussed during the recent meeting to conduct our study entitled **"Investigating Mathematical Reasoning Skill by Teaching Through Problem-Solving (TTPS) with Claim-Evidence-Reasoning (CER)"** at your Institution, below are the agreements that we have come up to meet with your requests.

The primary objective of this study is to document how students are engage in a discussion that implements a teaching intervention they are not particular with to develop their mathematical reasoning, while also identifying the challenges and benefits that teachers and students experience in employing the said intervention paired with an assessment tool.

Roles and Responsibility:

- A Grade 7 teacher from your Institution will be the Implementing Teacher for this study. A collaborative lesson plan will be utilized in the class which both the Implementing Teacher and the Researchers developed to integrate TTPS with it.
- The subject of the study will only focus on one (1) section which consists of 40 students. Throughout the research duration, the researchers will conduct observations for one week during math period.
- The Researchers will conduct the Interview through Google Forms to ensure the class schedule of both the Implementing Teacher and the students is on time. In this regard, the Implementing Teacher will be the one sending the link to the class. If time permits, face to face interview will be conducted with the teacher to gather additional insights.
- The Researchers will document the whole observation period through pictures and video. The whole classroom proceeding will be videotaped from the back of the classroom. This will serve as a supplementary resource for the data collected.

Both parties agree to collaborate closely and communicate regularly to ensure the successful completion of the research project. Upon discussion, only the raw data collected during the implementation will be shared. Hence, both parties agree to maintain the confidentiality of any proprietary or sensitive information shared throughout the research.

This agreement shall be effective as of the date of the signature below. It shall remain in effect until the completion of the research study unless terminated earlier by mutual agreement. Please sign and return a copy of this letter to indicate your acceptance of the terms outlined herein. If you have any questions or require further clarification, feel free to contact us at:

Jacinth R. dela Cerna: 09608371746 or jacintheve.delacerna@g.msuiit.edu.ph
Ivan Glenn Mark Jamaca: 09265734854 or ivanglennmark.jamaca@g.msuiit.edu.ph
Marco Bonita: 09512569592 or marco.bonita@g.msuiit.edu.ph

Attached herewith is the Data Gathering Phases for your perusal. Thank you for your support in this academic pursuit. We look forward to a productive research partnership.

Sincerely,

The Researchers

MARCO G. BONITA JACINTH R. DELA CERNA IVAN GLENN S. JAMACA

**Noted by:**

**ROVIC E. PEROCHO, MSciEd**
Thesis Adviser

**Approved by:**

Signature over printed name

## APPENDIX A2 (Continuation)

**Subject:** Phases of Data Gathering

The research entitled, **"Investigating Mathematical Reasoning Skill by Teaching Through Problem-Solving (TTPS) with Claim-Evidence-Reasoning (CER)"** will follow the necessary procedures and phases described below:

**Phases 1: Planning**

a. Giving of Consent Letters to the following concerned parties:
   - School Principal
   - Implementing Teacher
   - Parent-Child Consent Form

b. Lesson Development using TTPS centered on Math Reasoning in collaboration with the Implementing teacher.

**Phase II: Implementation**

a. Administer a CER Pre-test assessment before TTPS implementation.
b. Implementation of a 5-day lesson plan adapted for TTPS.
c. Conduct observations while the TTPS teaching intervention is ongoing.

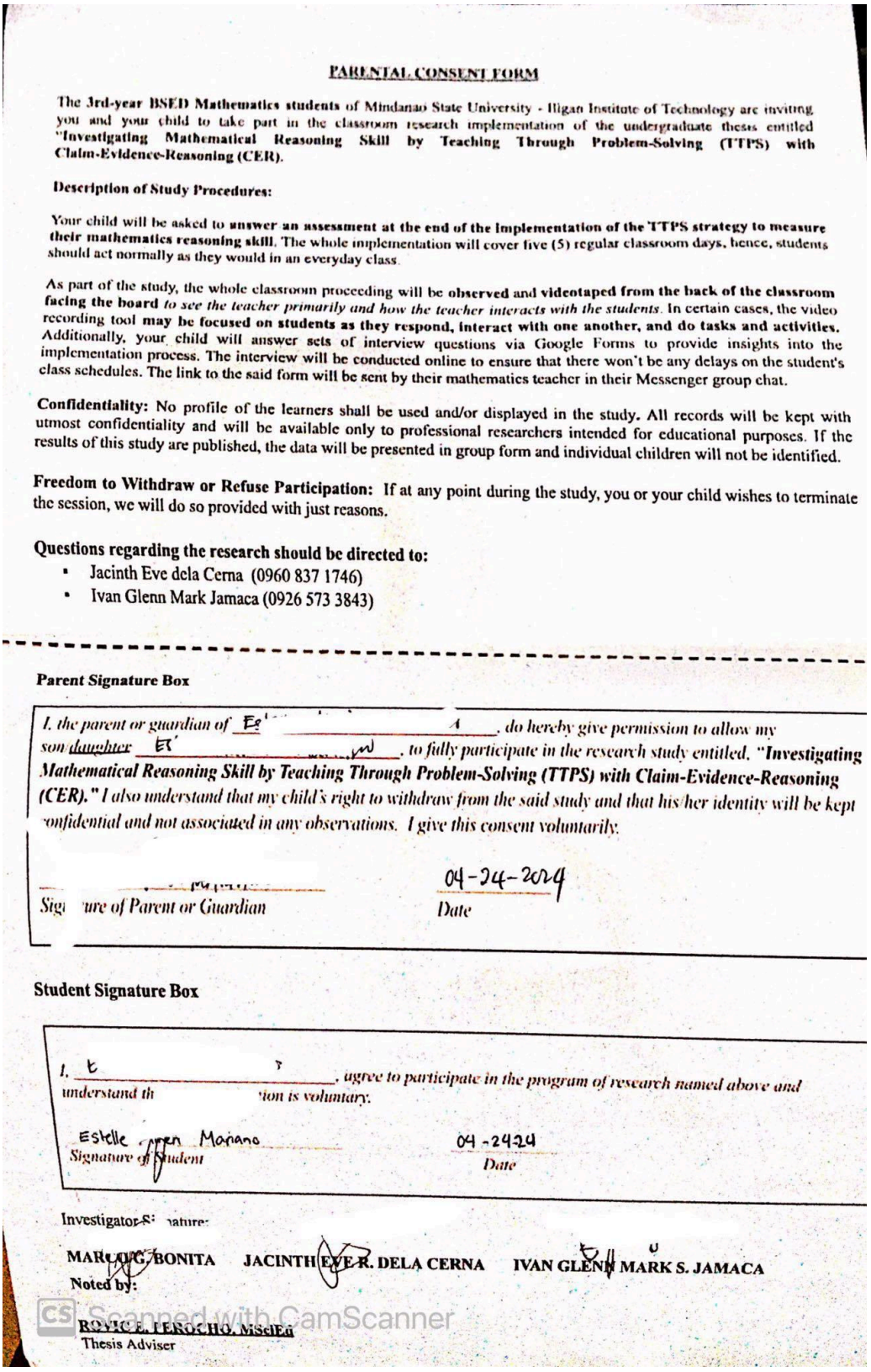
**Phase III: Post-Implementation**

a. Administer Post-test CER assessment after the TTPS implementation.
b. Conduct Focus Group Interview for Teacher and Students (through Google Forms)

Rest assured that the research will adhere to ethical standards, and all information collected will be treated with the utmost confidentiality and used solely for educational purposes.

# APPENDIX A3

Parent-Student Consent Letter



**PARENTAL CONSENT FORM**

The **3rd-year BSED Mathematics students** of Mindanao State University - Iligan Institute of Technology are inviting you and your child to take part in the classroom research implementation of the undergraduate thesis entitled "**Investigating Mathematical Reasoning Skill by Teaching Through Problem-Solving (TTPS) with Claim-Evidence-Reasoning (CER).**

**Description of Study Procedures:**

Your child will be asked to **answer an assessment at the end of the implementation of the TTPS strategy to measure their mathematics reasoning skill.** The whole implementation will cover five (5) regular classroom days, hence, students should act normally as they would in an everyday class.

As part of the study, the whole classroom proceeding will be **observed** and **videotaped from the back of the classroom facing the board** *to see the teacher primarily and how the teacher interacts with the students*. In certain cases, the video recording tool **may be focused on students as they respond, interact with one another, and do tasks and activities.** Additionally, your child will answer **sets** of interview questions via Google Forms to provide insights into the implementation process. The interview will be conducted online to ensure that there won't be any delays on the student's class schedules. The link to the said form will be sent by their mathematics teacher in their Messenger group chat.

**Confidentiality:** No profile of the learners shall be used and/or displayed in the study. All records will be kept with utmost confidentiality and will be available only to professional researchers intended for educational purposes. If the results of this study are published, the data will be presented in group form and individual children will not be identified.

**Freedom to Withdraw or Refuse Participation:** If at any point during the study, you or your child wishes to terminate the session, we will do so provided with just reasons.

**Questions regarding the research should be directed to:**

- Jacinth Eve dela Cerna (0960 837 1746)
- Ivan Glenn Mark Jamaca (0926 573 3843)

**Parent Signature Box**

*I, the parent or guardian of* Es _____ A, *do hereby give permission to allow my son/daughter* Es _____ W, *to fully participate in the research study entitled, "**Investigating Mathematical Reasoning Skill by Teaching Through Problem-Solving (TTPS) with Claim-Evidence-Reasoning (CER).**" I also understand that my child's right to withdraw from the said study and that his/her identity will be kept confidential and not associated in any observations. I give this consent voluntarily.*

*Signature of Parent or Guardian* — *Date* 04-24-2024

**Student Signature Box**

*I,* E _____ r, *agree to participate in the program of research named above and understand th* _____ *ion is voluntary.*

Estelle [illegible] Mariano — *Signature of Student* — *Date* 04-2424

Investigator's Signature:

MARLON G. BONITA JACINTH EVE R. DELA CERNA IVAN GLENN MARK S. JAMACA

**Noted by:**

ROVIC E. TEROCHO, MSciEd
Thesis Adviser

# APPENDIX A4

Letter to the Mathematics Teacher to Review the Lesson Plan

April 15, 2024

**GRACE LIWANAG, MSciEd**
Associate Professor V
MSU-IIT Integrated Development School

**Subject:** Request Letter for Tool Validation

**Dear Ma'am,**

**Greetings of Peace!**

We, the **3rd-year BSED Mathematics students** of Mindanao State University - Iligan Institute of Technology are conducting our research entitled **Investigating Mathematical Reasoning Skill by Teaching Through Problem-Solving (TTPS) with Claim-Evidence-Reasoning (CER).** One of the research instruments that will be utilized in this study is the researcher-made lesson plan. This instrument will be used for the conduct of the 5-day implementation of the TTPS approach to document how this can practice the reasoning skills of learners. This will also aid in determining the possible challenges and benefits experienced by both the teacher and the students, upon implementation of the TTPS approach. In view of this, the researchers would like to ask for your expertise to validate our research instrument, specifically as a (1) content evaluator of the lesson plan and (2) assessment evaluator to qualify for conduction. We believe that your experience in the field of education especially on Statistics and Probability can contribute meaningfully to the success of this study.

Attached herewith is the validation sheet with the lesson plan for your perusal. We are open to hearing any suggestions and comments in the hope of improving this research instrument. Looking forward to your positive response. Thank you and God bless!

Respectfully yours,

The Researchers

MARIA G. BONITA JACINTH EVE A. DELA CERNA IVAN GLENN MARK S. JAMACA

**Noted by:**

**ROVIC E. PEROCHO, MSciEd**
Thesis Adviser

# APPENDIX A5

Letter to Teachers to Validate the Interview Questionnaire

May 01, 2024

**JOAN ROSE LUIB**
College of Education - DSME

**Subject:** Request Letter for Tool Validation

**Dear Ma'am/ Sir,**

**Greetings of Peace!**

We, the **3rd-year BSED Mathematics students** of Mindanao State University - Iligan Institute of Technology are conducting our research entitled **Investigating Mathematical Reasoning Skill by Teaching Through Problem-Solving (TTPS) with Claim-Evidence-Reasoning (CER).** One of the research instruments that will be utilized in this study is the researcher-made interview questionnaires. This instrument will help determine the possible challenges and benefits experienced by both the teachers and the students, upon implementation of the TTPS with CER assessment. In view of this, the researchers would like to ask for your expertise to validate our research instruments to qualify for conduction. We believe that your experience in the field of research and education can contribute meaningfully to the success of this study.

Attached herewith is the validation sheet with the interview questions for your perusal. We are open to hearing any suggestions and comments in the hope of improving this research instrument. Looking forward to your positive response. Thank you and God bless!

Respectfully yours,

The Researchers

MARCO G. BONITA JACINTH EVE R. DELA CERNA IVAN GLENN MARK S. JAMACA

# APPENDIX A6

Letter to Teachers for Inter-Rater

July 24, 2024

**MS. ANGELOU C. ENTIA**
Initao College

**Subject:** Request Letter for Tool Validation

**Dear Ma'am/ Sir,**

**Greetings of Peace!**

We, the **3rd-year BSED Mathematics students** of Mindanao State University - Iligan Institute of Technology are conducting our research entitled **Investigating Mathematical Reasoning Skill by Teaching Through Problem-Solving (TTPS) with Claim-Evidence-Reasoning (CER).** One of the research instruments that will be utilized in this study is the researcher-made CER grading rubric. To ensure the inter-reliability of the crafted rubric, we would like to ask for your expertise in checking five (5) CER quiz papers conducted using the rubric we have made. Your experience in the assessment of Claim Evidence and Reasoning will be of help specially in determining the level of agreement between other raters we also have invited in ensuring the reliability of the instrument. Thus, we believe that your valuable input is crucial in achieving our research goals and ensuring that our findings are comprehensive and meaningful.

Attached herewith are the 5 CER quiz papers of students for your perusal. We are open to hearing any suggestions and comments in the hope of improving this research instrument. Looking forward to your positive response. Thank you and God bless!

Respectfully yours,

The Researchers

MARCO G. BONITA JACINTHEVE R. DELA CERNA IVAN GLENN JAMACA

**Validated by:**

ANGELOU C. ENTIA, LPT

**Designation:** INSTRUCTOR

# APPENDIX B1

Lesson Plan 1-4 (Initial Draft)

## LESSON PLAN

**Lesson Plan in Mathematics (Day 1)**

**Lesson:** Measures of Central Tendency: Mean, Median, and Mode
**Grade Level:** Grade 7
**Strand:** Statistics and Probability
**Competency Code:** M7SP-IVf-1

**Lesson Objectives:**

At the end of this lesson, the students will:

- Define the mean, median and mode
- Calculate the measures of central tendency (mean, median, and mode) of ungrouped data
- Solve the rectangular blocks problem using various methods.

**About the Lesson:**

This lesson discusses the measures of a central tendency of statistical data. In this lesson, students will be able to define the concept of central tendency measures; mean, median, and mode. The students will be presented with a problem that will allow them to engage in the discussion, become critical, and practice their reasoning skills. Thus, the students' approaches in solving the said problem will serve as the basis for building the lesson.

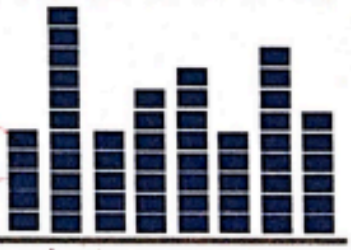
**Instructional Procedure:**

Ask the students to group themselves into four (4) with their classmates close to their seats or adjacent to them. Let them settle for the instructions first. Afterwards, they are posed with a problem where they will engage and discuss in groups to answer the problem presented to them. As they try solving the problem, students become critical thinkers. After answering the problem, every group will share their answers to the class, explaining their thought processes and how they arrive with such answers.

**A. Presentation of the Problem**

Problem:

Student A has a box full of building blocks piled in columns. While it was arranged randomly, she began to record the number of piled blocks in each column. Her observations are as follows: 5, 11, 5, 7, 8, 5, 9, and 6. If she decides to rearrange the blocks, determine when the columns will have an equal number of blocks.



# APPENDIX B2

Lesson Plan 1-4 (1st Revision)

**Lesson Plan in Mathematics (Day 1)**

**Lesson:** Measures of Central Tendency: Mean, Median, and Mode
**Grade Level:** Grade 7
**Strand:** Statistics and Probability
**Competency Code:** M7SP-IVf-1

**Lesson Objectives:**

At the end of this lesson, the students will:

- Define measures of central tendency.
- Identify measures of central tendency
- State the purpose of finding the measures of central tendency
- Illustrate measures of central tendency of an ungrouped data

**Instructional Procedure:**

Ask the students to group themselves into four (4) with their classmates close to their seats or adjacent to them. Let them settle for the instructions first. Afterward, they are posed with a problem where they will engage and discuss in groups to answer. After answering the problem, every group will share their answers with the class,

**A. Presentation of the Problem**

---

Star Apple Academy has to select one pupil to take part in the Math Quiz Bowl. Jacinth and Marco took part in 7 trial quizzes. The following list shows their scores.

| | |
|---|---|
| Jacinth | 23 22 24 23 22 24 23 |
| Marco | 26 22 21 22 20 21 22 |


Who among Jacinth and Marco would best represent the school in the contest? Why?

---

# APPENDIX B3

Final Lesson Plan 1-4 (2nd Revision)

**Lesson Plan in Mathematics (Day 1)**

**Lesson**: Measures of Central Tendency: Mean, Median, and Mode
**Grade Level**: Grade 7
**Strand**: Statistics and Probability
**Competency Code**: M7SP-IVf-1
**Prerequisite Concepts/Skills:**

- Arithmetic Operations, and
- Basic Concept of Average

**Lesson Objectives:**

At the end of this lesson, the students will:

- Describe measures of central tendency; mean, median, and mode
- State the purpose of finding the measures of central tendency
- Illustrate measures of central tendency of an ungrouped data
- Solve problems involving measures of central tendency

**About the Lesson:**

The lesson introduces the measures of a central tendency for ungrouped data. In this particular lesson, students will be able to describe the three measures and how each measure is used to summarize and represent the data. The students will be presented with a problem that will allow them to engage in the discussion, become critical, and practice their reasoning skills. Thus, the students' approaches in solving the said problem will serve as the basis for building the discussion of the intended topic.

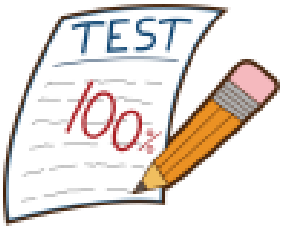
**Instructional Procedure:**

Ask the students to group themselves into four (4) with their classmates close to their seats or adjacent to them. Let them settle for the instructions first. Afterward, they are posed with a problem where they will engage and discuss in groups to answer. After answering the problem, every group will share their answers with the class.

**A. Presentation of the Problem**

---

Star Apple Academy has to select one pupil to take part in the Math Quiz Bowl. Jacinth and Marco took part in 7 trial quizzes. The following list shows their scores.




| | |
|---|---|
| Jacinth | 23 22 24 23 22 24 23 |
| Marco | 26 22 21 22 20 21 22 |

Who among Jacinth and Marco would better represent the school in the contest? Why?

---

## APPENDIX C1

Claim-Evidence-Reasoning Assessment (Initial Draft)

About the Assessment:

The assessment is a 3-item Claim-Evidence-Reasoning (CER) test. Using this as an assessment tool centers the reasoning of the students, providing them the opportunity to explain their thought process as they relate it to the claim, supported with the evidence. Additionally, the test consists of word problems that cover the topic from measures of central tendency to measures of variability. In grading the answers of the students, a modified CER rubric was used.

---

**GENERAL INSTRUCTION:** Read each problem carefully. Answer in CER form.

1. Jessie wants to get an accurate picture of household salary in her neighborhood. The salaries are as follows:

| | | |
|---|---|---|
| Php 35, 000. 00 | Php 27, 000. 00 | Php 43, 000. 00 |
| Php 18, 000. 00 | Php 100, 000. 00 | Php 39, 000. 00 |
| Php 23, 000. 00 | Php 27, 000. 00 | Php 33, 000. 00 |

   Find the mean, median, and mode. What measure of central tendency would then best represent the data? Justify your answer.

2. After weeks of studying earnestly in Math, Aida scored 25, 19, 18, 24, and 15 on the past five quizzes. Now, she is determined to maintain an average score of 21. What score will she need in her next quiz to achieve this goal? What if her next score is 22, will her average score decrease or increase?

3. The Debate Club has been participating in local and national debate tournaments for five years. Each year, they recorded the number of awards they won. The following are the recorded number of awards won each year respectively: 12, 15, 7, 20, and 10.
   a. Calculate the variance and standard deviation of the number of awards won each year.
   b. Based on your analysis, conclude whether the Debate Club's performance in winning awards exhibits high or low variability over the five years.

---

## APPENDIX C2

Claim-Evidence-Reasoning Assessment (1st Revision)

About the Assessment:

The assessment is a 2-item Claim-Evidence-Reasoning (CER) test. Using this as an assessment tool centers the reasoning of the students, providing them the opportunity to explain their thought process as they relate it to the claim, supported with the evidence. Additionally, the test consists of word problems that cover the topic from measures of central tendency to measures of variability. In grading the answers of the students, a modified CER rubric was used.

---

**GENERAL INSTRUCTION:** Read each problem carefully. Answer in CER form.

1. Jessie wants to get an accurate picture of the daily allowance her group of friends is receiving on a daily basis. Their daily allowance are as follows:

   | | | |
   |---|---|---|
   | Php 100. 00 | Php 100. 00 | Php 50. 00 |
   | Php 150. 00 | Php 100. 00 | Php 50. 00 |
   | Php 150. 00 | Php 500. 00 | Php 100. 00 |

   Which measure of central tendency would then best represent their daily allowance? Justify your answer.

2. After months of studying earnestly in Math, Aida got grades 95, 89, and 92 in the past 3 quarters. Now, she is determined to maintain an average grade of 93. What grade will she need in the 4th quarter to achieve this goal? What will happen to her average if her next grade remains at 92? Support your reasoning by providing further evidence.

3. The Debate Club has two teams set to compete in the National Debate Competition. Since only one team can go, they need to decide which among the two teams is the best representative for the club. They compared the number of awards each team won over the past six years.

   Team Alpha: 12, 9, 9, 5, 10, 8
   Team Beta: 7, 5, 6, 8, 8, 10

   Which among the two teams will be chosen to represent the club? Why?

---

## APPENDIX C3

Claim-Evidence-Reasoning Assessment (2nd Revision)

About the Assessment:

The assessment is a 2-item Claim-Evidence-Reasoning (CER) test. Using this as an assessment tool centers the reasoning of the students, providing them the opportunity to explain their thought process as they relate it to the claim, supported with the evidence. Additionally, the test consists of word problems that cover the topic from measures of central tendency to measures of variability. In grading the answers of the students, a modified CER rubric was used.

---

**GENERAL INSTRUCTION:** Read each problem carefully. Answer in CER form.

1. After months of studying earnestly in Math, Aida got grades 95, 89, and 92 in the past three quarters. Now, she is determined to maintain an average grade of 93. What grade will she need in the 4th quarter to achieve this goal? What will happen to her average if her next grade remains at 92? Support your reasoning by providing evidence.

2. The Debate Club has two teams set to compete in the National Debate Competition. However, only one team can go, they need to decide which among the two teams is the best representative for the club. They compared the number of awards each team won over the past six years.

   Team Alpha: 12, 9, 9, 5, 10, 8
   Team Beta: 7, 5, 6, 8, 8, 10

   Which among the two teams will be chosen to represent the club? Why?

---

# APPENDIX D1

CER Modified Scoring Rubric (Initial Draft)

**Modified Claim-Evidence-Reasoning Grading Rubric in Mathematics**

| Criteria | 4pts | 3pts | 2pts | 1pt | REMARKS |
|---|---|---|---|---|---|
| **Claim** | Clearly states a mathematical claim that is specific and concise which presents the problem. | Makes a claim that is accurate but lacks clarity and depth. | Provides a partially accurate claim but lacks clarity and does not completely answer the question. | The mathematical claim is unclear, inaccurate, or missing. | Clearly states a mathematical claim that is specific and concise, presenting the problem accurately. |
| **Evidence** | Provides strong and relevant mathematical evidence that is substantial and directly supports the claim. | Provides relevant mathematical evidence and calculations supporting the claim. | Provides limited or weak mathematical evidence that is partially relevant to support the claim. More evidence could be included. | Provides insufficient or no mathematical evidence presented. You can omit this sentence. | |
| **Reasoning** | Demonstrates a coherent explanation or reasoning for all pieces of evidence demonstrating an in-depth understanding of the problem and its processes. | Demonstrates logical-mathe matical reasoning connecting the claim and evidence. | Demonstrates limited reasoning for some, but is inconsistent with the evidence and claim presented. | Little to no mathematical reasoning is provided and is insufficient to claim and evidence presented. | |

**Comments/Suggestions:**

To make checking of papers easier, you can use a 3-point scale.

# APPENDIX D2

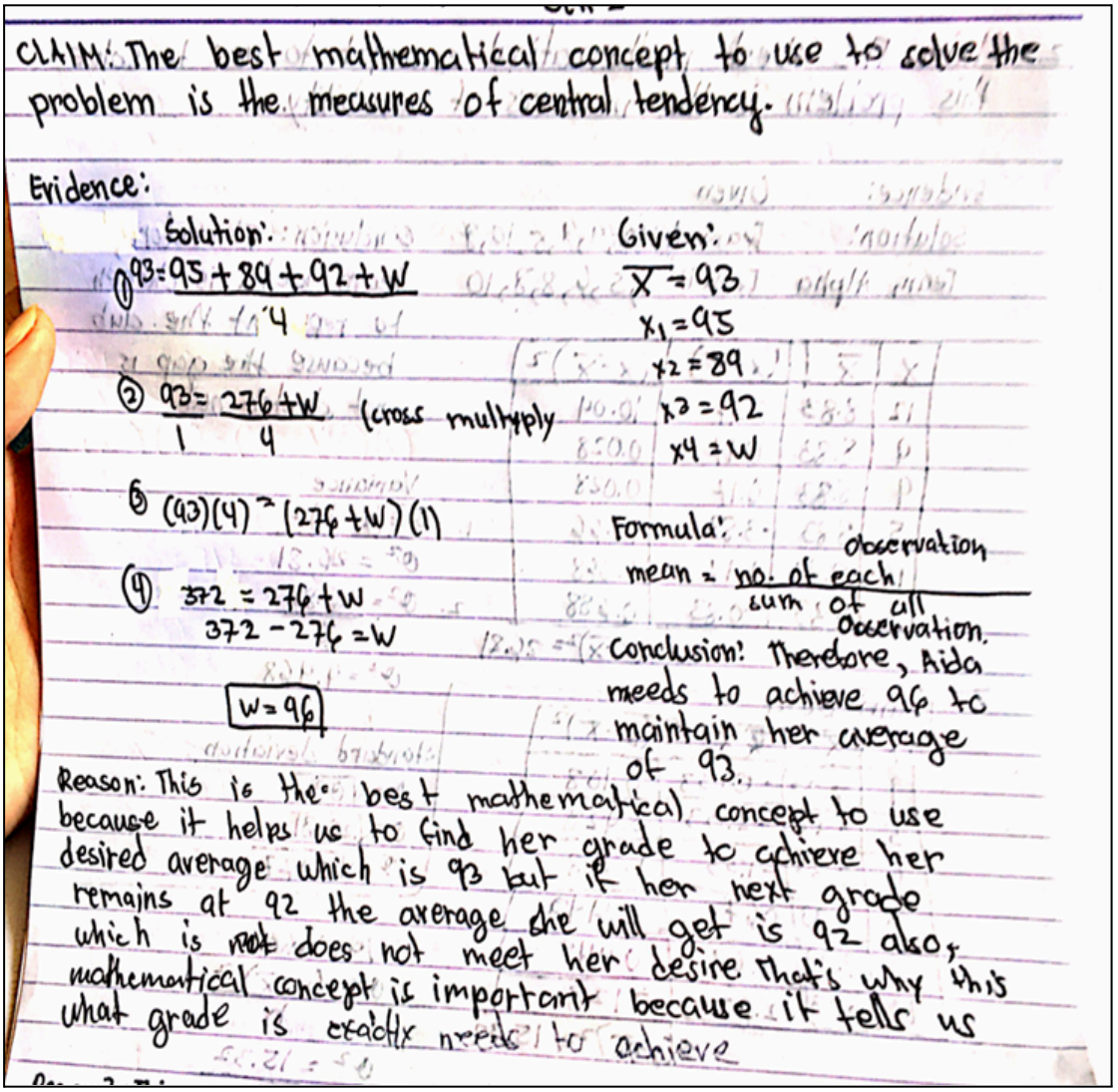
CER Modified Scoring Rubric (Final Revision)

| *Criteria* | *Meeting (3)* | *Approaching (2)* | *Beginning (1)* | *Not Evident (0)* |
|---|---|---|---|---|
| **Claim** | States a mathematical claim that is clearly stated, complete, and correct. | States a mathematical claim that is partially correct or incomplete. | States a mathematical claim that is incorrect. | Does not make a claim. |
| **Evidence** | Provides mathematical evidence where the solution is correct, complete, and sufficient to support the claim. | Provides mathematical evidence where the solution is correct but incomplete and contains minimal error. | Provides mathematical evidence where the solution contains significant errors leading to incorrect answers which does not support the claim. | Does not provide evidence. |
| **Reasoning** | Provides a clear, complete, and correct explanation which shows the connection of the claim and evidence based on mathematical concepts. | Provides correct explanation but lacks clarity in showing the connection of the claim and evidence. | Provides unclear, insufficient, and incorrect explanations failing to connect the claim and evidence. | Does not include reasoning. |

# APPENDIX E1

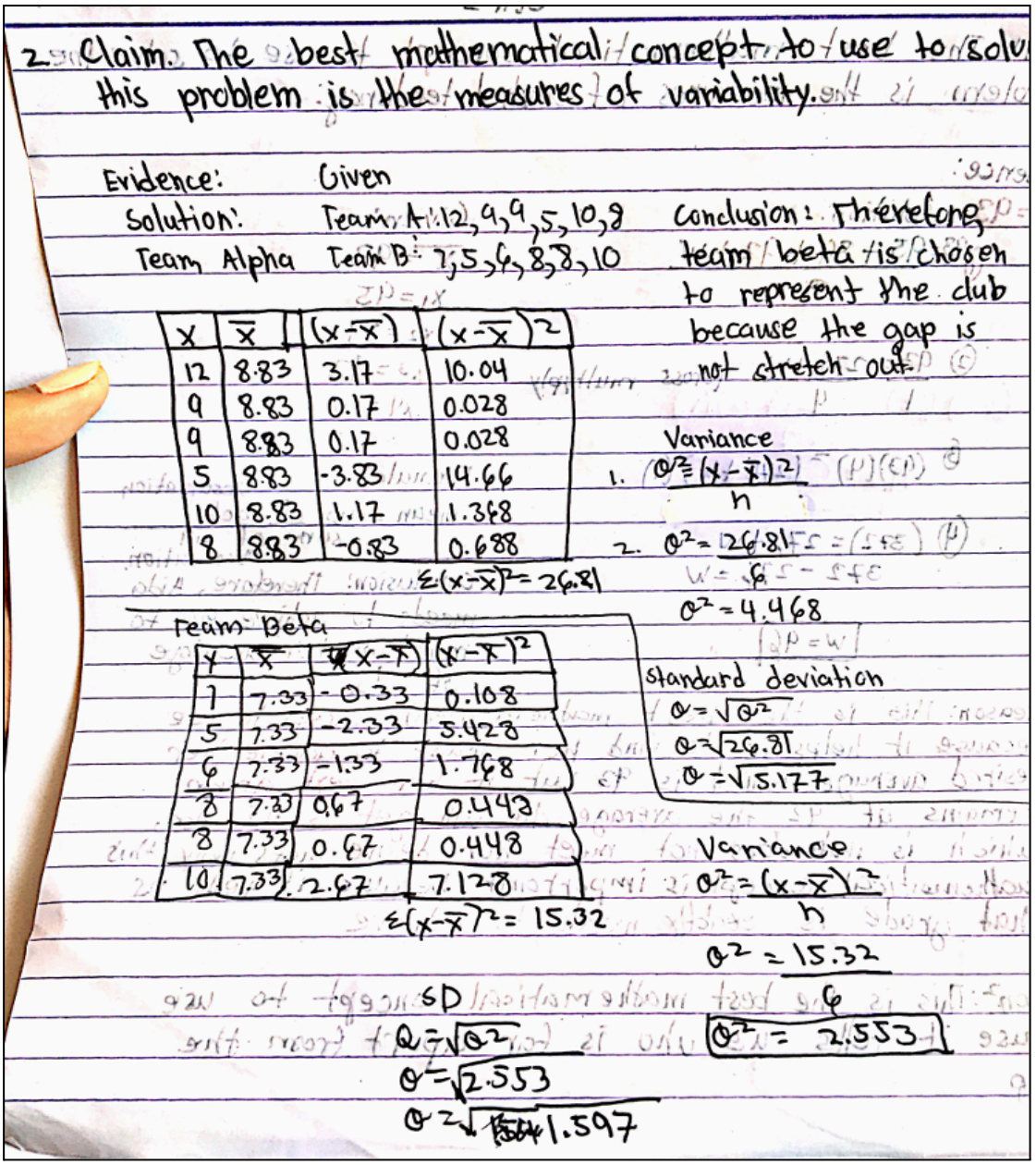
Sample Student Copy of CER Assessment

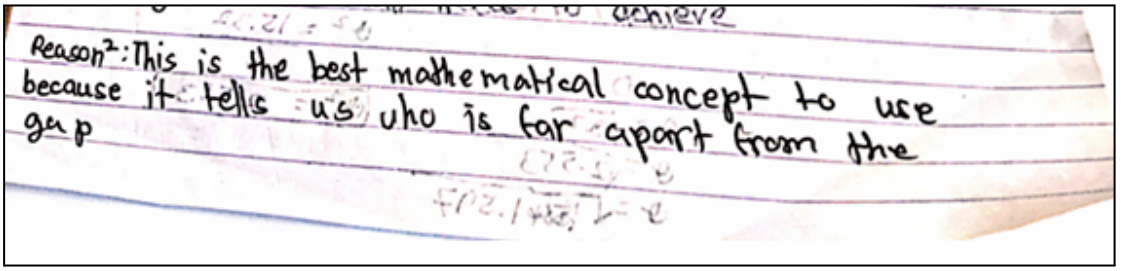
**Item No. 1**



**APPENDIX E1 (Continuation)**

**Item No. 2**



# APPENDIX E2

Math CER Scores of Grade 7 Section Cecillio

| | ITEM 1 | | | ITEM 2 | | |
|---|---|---|---|---|---|---|
| Student No. | CLAIM | EVIDENCE | REASONING | CLAIM | EVIDENCE | REASONING |
| S1 | 1 | 1 | 1 | 2 | 2 | 0 |
| S2 | 3 | 3 | 3 | 3 | 2 | 2 |
| S3 | 3 | 1 | 0 | 3 | 1 | 0 |
| S4 | 2 | 0 | 1 | 0 | 0 | 0 |
| S5 | 3 | 3 | 0 | 1 | 1 | 0 |
| S6 | 2 | 1 | 1 | 1 | 1 | 0 |
| S7 | 1 | 2 | 1 | 0 | 1 | 0 |
| S8 | 1 | 0 | 0 | 0 | 0 | 0 |
| S9 | 2 | 0 | 1 | 0 | 0 | 0 |
| S10 | 0 | 0 | 0 | 1 | 1 | 1 |
| S11 | 3 | 1 | 0 | 3 | 3 | 2 |
| S12 | 3 | 0 | 0 | 1 | 3 | 1 |
| S13 | 3 | 1 | 1 | 3 | 3 | 1 |
| S14 | 3 | 0 | 0 | 3 | 2 | 0 |
| S15 | 0 | 0 | 0 | 0 | 1 | 0 |
| S16 | 0 | 0 | 0 | 1 | 1 | 1 |
| S17 | 3 | 2 | 3 | 3 | 1 | 0 |
| S18 | 1 | 1 | 1 | 1 | 1 | 1 |
| S19 | 1 | 0 | 1 | 1 | 2 | 2 |
| S20 | 3 | 0 | 0 | 1 | 0 | 0 |
| S21 | 2 | 0 | 0 | 1 | 0 | 0 |
| S22 | 3 | 3 | 2 | 1 | 1 | 1 |
| S23 | 1 | 1 | 1 | 1 | 1 | 0 |
| S24 | 1 | 1 | 0 | 1 | 1 | 0 |
| S25 | 3 | 3 | 3 | 0 | 0 | 1 |
| S26 | 3 | 1 | 1 | 1 | 1 | 1 |
| S27 | 3 | 0 | 1 | 3 | 2 | 0 |
| S28 | 3 | 0 | 0 | 3 | 3 | 2 |
| S29 | 1 | 1 | 0 | 0 | 0 | 0 |
| S30 | 1 | 0 | 1 | 3 | 0 | 1 |
| S31 | 1 | 1 | 1 | 1 | 1 | 0 |
| S32 | 3 | 1 | 1 | 3 | 2 | 0 |
| S33 | 0 | 0 | 0 | 3 | 1 | 1 |
| S34 | 0 | 0 | 0 | 1 | 1 | 0 |
| S35 | 2 | 2 | 2 | 2 | 2 | 1 |
| S36 | 1 | 1 | 0 | 3 | 1 | 0 |
| S37 | 1 | 1 | 1 | 0 | 0 | 0 |
| S38 | 3 | 1 | 2 | 1 | 1 | 0 |
| S39 | 3 | 0 | 1 | 3 | 2 | 2 |
| S40 | 0 | 0 | 0 | 1 | 1 | 1 |

## APPENDIX E3

Percent Agreement for Three Raters

*Result of Percent Agreement Per Section*

| ***CLAIM*** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Student No. | J Rater 1 | A Rater 2 | M Rater 3 | R1/R2 | R1/R3 | R2/R3 | Total Agreement |
| 1 | 3 | 3 | 1 | 1 | 0 | 0 | 1/3 |
| 2 | 2 | 1 | 1 | 0 | 0 | 1 | 1/3 |
| 3 | 1 | 1 | 1 | 1 | 1 | 1 | 3/3 |
| 4 | 3 | 3 | 1 | 1 | 0 | 0 | 1/3 |
| 5 | 1 | 1 | 1 | 1 | 1 | 1 | 3/3 |
| | | | | | | ***Percent of Agreement*** | ***60%*** |

| ***EVIDENCE*** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Student No. | J Rater 1 | A Rater 2 | M Rater 3 | R1/R2 | R1/R3 | R2/R3 | Total Agreement |
| 1 | 3 | 3 | 3 | 1 | 1 | 1 | 3/3 |
| 2 | 1 | 2 | 2 | 0 | 0 | 1 | 1/3 |
| 3 | 1 | 1 | 1 | 1 | 1 | 1 | 3/3 |
| 4 | 2 | 2 | 3 | 1 | 0 | 0 | 1/3 |
| 5 | 1 | 2 | 1 | 0 | 1 | 0 | 1/3 |
| | | | | | | ***Percent of Agreement*** | ***60%*** |

| ***REASONING*** | | | | | | | |
|---|---|---|---|---|---|---|---|
| Student No. | J Rater 1 | A Rater 2 | M Rater 3 | R1/R2 | R1/R3 | R2/R3 | Total Agreement |
| 1 | 3 | 3 | 1 | 1 | 0 | 0 | 1/3 |
| 2 | 1 | 1 | 1 | 1 | 1 | 1 | 3/3 |
| 3 | 1 | 1 | 1 | 1 | 1 | 1 | 3/3 |
| 4 | 0 | 0 | 0 | 1 | 1 | 1 | 3/3 |
| 5 | 3 | 2 | 3 | 0 | 1 | 0 | 1/3 |
| | | | | | | ***Percent of Agreement*** | ***73.33%*** |

## APPENDIX E3 (Continuation)

*Overall Result of Percent Agreement for CER Scoring Rubric*

| ***Percent Agreement for 3 Raters*** | | | | |
|---|---|---|---|---|
| Student | R1/R2 | R1/R3 | R2/R3 | Total Agreement |
| 1 | 1 | 0 | 0 | 1/3 |
| 2 | 1 | 1 | 1 | 3/3 |
| 3 | 1 | 1 | 1 | 3/3 |
| 4 | 1 | 0 | 0 | 1/3 |
| 5 | 1 | 1 | 1 | 3/3 |
| | | | ***Percent of Agreement*** | ***73.33%*** |

## APPENDIX F1

Validated Interview Questions for Teacher (Final)

1. During the teaching-learning process, what were the advantages you encountered?
2. How do you think these factors influenced the overall learning experience for the students?
3. During the teaching-learning process, what were the challenges you encountered?
4. How do you think these factors influenced the overall learning experience for the students?
5. In what ways do you think this TTPS approach encourages students to think critically when solving mathematical problems?
6. In which part of the lesson implementation did the students engage with the most?
7. How would you describe the student's participation in response to the implemented strategy?
8. How do you think the strategy influenced their involvement in the learning process?
9. Can you recall any instances where students were able to confidently explain their thoughts without hesitation?
10. What do you think enabled them to express their ideas clearly?
11. How do you think the TTPS approach encourages students to engage confidently with their peers when solving math problems?
12. Reflecting on your experience, how has the TTPS approach supported the development of students' reasoning?
13. Reflecting on your experiences, how helpful for you as a teacher is the CER assessment in capturing the depth of students' reasoning and thought processes?
14. Reflecting on your experiences, how has the use of TTPS with CER helped students develop their reasoning?
15. Are you open to learning more about this teaching approach and to participate in professional development to improve your skill?

## APPENDIX F2

Validated Interview Questions for Students (Final)

1. How was your experience with the lesson discussion that happened over the past two (2) weeks?

2. What are your observations from the lesson discussion?
3. Are there any topics that need deeper discussion? What are those?
4. Which part of the lesson or activity do you find challenging?
5. In connection with the previous question, did this challenging activity/lesson made you strive harder to learn? How?
6. Were you given the opportunity to reason or express your ideas in explaining math concepts?
7. When was the moment you feel that your reasoning skills was challenged?
8. In connection to the previous question, was there a moment where you feel like an expert and was able to reason out correctly? Can you share to us the details?
9. Did you feel engaged during class activities? If so, provide some examples
10. Were you able to interact and collaborate with your classmates? How did your collaborative work go?
11. Provide situations from your learning experience during the lesson discussion that got your attention and interest. How did it got your attention and interest?
12. With the way your teacher delivered your lesson, how do you think did if affect your learning experience?
13. Over the past two (2) weeks. are there any positive changes that happened in your classroom during class discussion? If yes, can you provide examples?
14. What do you think is/are the advantage(s) of using Claim-Evidence-Reasoning (CER)?
15. What do you think is/are the disadvantage(s) of using Claim-Evidence-Reasoning (CER)?
16. Can CER help you improve your reasoning skills? If yes, why do you say so?
17. Would you recommend CER to be use in a mathematics classroom?

## APPENDIX F3

Face to Face Student Interview Transcription

Q: Kamusta ang klase sa math?

*Jane: 50-50*
*Alicia: Okay*
*Mary: Sayon pinakauna, nagkalisod na dayun sya hinay hinay*

Q: Unsay na notice ninyo katung kamulo mig observe?

***Mary: makontrol ra jud ang kasaba pero mo hilom jud ang klase everytime mangutana si teacher.***

Q: Unsay way ni sir sauna basta magklase?

*Jane: Math trivia, recall, then lesson, introduction sa topic, ...*

Q: Kumbaga si sir jud ang mag una sa klase?

Jane: *Yes*

Q: So unsay nanotice ninyo sa klase before ug katung naa nami nag-observe?

Mary: *Masuko si sir, mag walk-out*
Bench: *Wala ko kasabot sa klase gamay*
Jane: *Di man jud ni sya makasabot kay matulog ra man ni sya*

Q: Pero katung nagdiscuss na si sir and naa nami? Mas nasabtan ba ninyo ang lesson?

*(All Students in the room agreed)*

Q: Nganu man in what way?

Jane: *Kay basta si sir alexis ang teacher masabtan jud namo kay basta dili namo masabtan ang lesson iya mi iask, iyaha gud nang ibalik ang lesson para samoa hangtud sa maksabot mi*

Q: Dayun, kamusta man tung problem nga gi present, wala ramo galisod?

Mary: *Naglisod gamay pero sa paghelp ni sir samoa, makasabot ra pud mi*

Q: Unsay mas prefer ninyo collaborative or individual lang?

Bench: *Collaborative*
Alicia: *It depends. Kay naay times nga mas prefer nako sya if ako ra isa especially if ma feel nako nga pabigat ra sila. Pero katung nag group mi kay okay ra kay akong mga ka group is mga brayt man pud.*

Q: Kinsay mo agree sa iya nga nga ganahan ug collaborative? Kinsay mas mo pili?

Bench: *Para macheck nako akong answer sa answer sa uban. Like makatabang pud sya*

Q: Sa inyong mga kagrupo, mo tudlo ba sila sainyo?

Dave: *Dili*

Mary: *Sometimes sir kay mag ask pud ko saila*

Q: Sa imong mga kagrupo? Kamusta man?

Mary: *Akoy mo answer*

Q: And then? Muhatag silag input?

Mary: *Usahay ra*

Q: Pero ma feel ba ninyo nga sa collaborative kay mas maka communicate mo with others?

All: *Yes*

**Jane:** ***Yes kay makaopen minded. Especially if imong kagroup ilaha jud iingon ilang side, ilang opinyon, saimoa. Mas nagets nimo dayun ang problem. Ato nga time kay galisod ko ug sabot dayun akong mga groupmates kay bright man jud sila ilaha jud kong gitudloan. Naa silay mga notes so gitudloan jud ko nila step-by-step***

Q: Kang sir unsa inyong nanotice? Usual ba nga practice kanang ipatindog mo para iexplain inyong answer?

Jane: *Mostly in.ana ang teachers sa lasalle kay ipa in.ana jud mi arun makabalo sila kung asa ra taman among nasabtan*

Q: Mas ganahan mo anang ihatag sa ang problem daan?

Bench: *Dili*

Jane: *Para sakoa yes*

Q: Nganuman?

Jane: *Kay kuan, kanang, arun makita nga kabalo naba ko daan sa problem*

Q: So mas prefer nimo nga dili sa introduce ni teacher ang topic?

Jane: *Yes, kanang explore-explore lang sa. Explain lang dayun*

Q: Katung nagklase si sir, wala bamo makafeel ug kahadlok nga ay basin wrong akong answer?

**Alicia:** ***Makafeel pero depende if ang same rakog answer sakong classmate, dili rako makulbaan***

Q: Personally, unsay mga challenges nga na feel nimo sa klase?

Dave: *Wala ko kasabot kay natulog man ko*

*Bench: wala ko kasabot kay wako kapaminaw*

Q: Kamusta man ang CER?

All: *Very good*

Q: Feel ninyo nga mas maka explain mog tarung sa CER?

Mary: *Yes*

**Jane:** ***Mas sayon ang CER kay naa ra saimong self unsa imong iingon opinion. Mas nindot kay Sa CER kay maingon nimo tanan***

Q: Kinsay moprefer [ganahan] ug CER?

All: CER (All students agreed)

Alicia: *Sa CER sir kay magsolve mi tapos explain dayun*

Q: Katung nag CER ta sa thursday, kamusta man? Lisod?

**Jane:** ***Dili sya lisod pero nakulangan mi sa time kay 20 minutes lang ang gihatag***

Mary: *Lisod pud sya sir basta walay calcu*

Q: Pero ang katung problem unsa man?

Alicia: *Dali raman sya sir kay kabalo naman mi unsaon pagsolve. Ang lisod lang jud kay ug wakay calcu like samong uban classmates waka answer kay wala ka dala.*

Q: Sa klase, dimo mahadlok explaining in front?

**Mary:** ***Mahadlok kay basin mali***

*Dave: Basin wrong*

Bench: *Basin kataw.an*

Q: Close mo sa inyong classmate?

Alicia: *Dili kaayo*

Q: So factor ba sya nga dili mo close especially during collaboration?

Mary: *sa akong experience, if naa kay history sa imong classmate and makagroup nimo sya awkward kayo, dika ganahan mo participate kay naa siya.*

**APPENDIX F4**

Google Form Student Interview Transcription

1. How was your experience with the lesson discussion that happened over the past two (2) weeks?
    - my experience was good
    - It was ok although it was a little hard to understand the certain topics and was very time consuming to answer it was fine and went well.
    - It was great I learned alot.
    - Fun
    - It's still the same, it was nice but at the same time my classmates are also annoying(its kinda embarrassing 'cause there was some visitors from the other school recording us)
    - The lesson was a bit easy to understand but i had to practice more for me to really know and to understand more
    - He discuss the lessons very good and I understand them all.
    - Ok
    - It was good but it started to get really confusing somehow but I managed to understand it.
    - good and nervous.
    - Good
    - My experience with the lesson discussion that we tackled over the past two weeks was nice, even though I am having a hard time understanding the lesson because of the pressure of the questions.
    - My experience with the lesson discussion that happened over the past two weeks was great and hard at the same time.
    - It was hard but also fun because I learned a lot from it
    - ***My experience with the lesson discussion that happened over the past two weeks have been quite good and fun but also a little bit stressful since I was confused at the new lessons because they seemed difficult but I eventually understood the topics. [Arlene]***
    - It was nice seeing other people in the class but also it was not quite nice when one of the kuya's was staring at my activity so I got a bit pressured in answering the problem.
    - My experiences with the lesson discussion that happened over the pass 2 weeks is good because the lesson is easy to gets and it clearly discuss the topic
    - It was good, the lesson was kinda hard but I managed to understand it.
    - i learned a lot like central tendency
    - It was good

2. What are your observations from the lesson discussion?
    - ***Very fast since we learn only 1 lesson in 2 days and it's quite challenging for us when it comes to quizzes. [Elle]***
    - Sir Alexies showed us the problem first before introducing how to solve it.
    - Very lively
    - ***The process of learning that lesson was hard because it was confusing and complicated but I still learned it (not fluently btw) [Nessa]***
    - It was a bit confusing at first
    - I have no observations on our discussion of the lesson.
    - It was fine to me.
    - Fun and hard a bit
    - I observed in the first CER we needed to Divide, multiply, and multiply and in the second CER we needed to add and divide
    - a little bit hard but i do my best to answer it.
    - I sometimes don't get it so that's why I ask from my classmates.
    - I observe that every slide has multiple questions on it.
    - My observations from the lesson discussion are when my teacher (Sir Alexies) was teaching us what our lesson is about, classmates and I doing the groupwork, boardwalk, and oral recitation.
    - I observed good discussion and it help focused on learning the topics
    - My observations from the lesson discussion that the topics seemed quite hard to do at first but it is really not that hard and it is very easy if you just listen and understand it. I also observed that some of my classmates weren't really paying attention to the discussion and just talking with their seatmates that is not math related.
    - Nice, because the lesson that we discuss are so really great because it has an clearly explanation
    - I have learned about more mathematical concepts such as pie charts or graphs and measures of central tendency.
    - I observed that most of it was easy enough for me to understand
    - they are for the up coming CER
    - It was easy

3. Are there any topics that need deeper discussion? What are those?
    - No. I learned them clearly.
    - There’s no need for a deeper discussion since I understand them
    - None because all of the discussions were understandable
    - No, I understand them all.
    - No, for me there aren't any topics that needs deeper discussion.

- Not really since I understood the topics.
- Maybe nothing
- No
- No
- None.
- None
- None
- Nothing
- There are and those are central tendency and measures of variability since some students are very slow in getting the idea of the certain topic.
- Mean, median,and mode because some of us haven't quite figured it out yet
- I believe that is the central tendency.
- The topics that need deeper discussion are the measures of central tendency.
- Variability

4. Which part of the lesson or activity do you find challenging?
    - None
    - I find the Measures of variability interesting
    - The one I said earlier central tendency and measures of variability
    - Nothing I studied them and fully understood them.
    - Central tendency
    - measure of central tendency, median, mode
    - Nothing
    - CER
    - Probably memorizing what part was for or what step was next
    - The mean,median & mode. the part of the lesson that I find challenging is the median.
    - Solving
    - I found all of the lesson challenging but despite that, I still understand it.
    - The lesson or activity I find challenging is groupwork activity.
    - Maybe not the activities last week but when it will be pt time, I know I will have a hard time
    - The part of the activity that I found challenging was when we needed to find the grade that the person in the problem needs to find the average of __. It was challenging because I didn't know the formula on how to solve that problem.
    - I can't do it without a calculator

5. In connection with the previous question, did this challenging activity/lesson made you strive harder to learn? How?
    - None
    - yes,it made me want to understand and solve more math problems.
    - Yes, because I need to have good grades to make my parents not disappointed.
    - No but i still strived to learn harder.
    - Yes because this will be needed in the exam
    - kind of, because it was complicated.
    - I tried harder by studying on how to answer it and by also asking my classmates questions on how to get the answer
    - Yes, because if I find the challenge very hard to understand I will study harder.
    - It made me realize there's more to math.
    - Kinda because when I couldn't understand it I took notes from YouTube, My friends, and I Corrected my mistakes whenever I realized I made one.
    - not really but i always forgot the formula sometimes.
    - Yes, because my math grades need to be improved.
    - It made me strive harder to learn because I don't easily get it but I don't want to be left behind.
    - Yes, because we tried to guess what the right answer or the formula was. So, we tried to solve the problem that was being presented on the board.
    - Maybe because if we will have a group activity some os the members wont cooperate so it will be a hard time answering by our own
    - No, not really. I was already information loaded and I feel like my head is about to explode from all of the topics that sir discussed so I didn't really care to learn since I understood how to answer that kind of problem. I understand the way on how to solve the problem and I found it quite easy to solve so I was settled with that information. Therefore, it didn't made me strive harder to learn more.
    - Yes, to have a good grade and pass the exam.
    - it was hard so I needed to study hard
    - Yes

6. Were you given the opportunity to reason or express your ideas in explaining math concepts?
    - Yes
    - Yes.
    - Yes

- No
- No, since I barely even give opinions to others.
- no and never.
- Yes during the exams while explaining in the reason
- No
- If you were talking about the CER than kinda but I couldn't finish my conclusion
- by answering it properly even tho i forgot other formula to answer.
- No
- Sorry, I have not given the opportunity to reason or express my ideas in explaining math concepts. I was listening to the teacher so that I would understand and let my classmates answer it.
- Maybe
- Yes, I was given the opportunity to reason or express my ideas in explaining math concepts but I didn't answer since I don't know how to explain or I simply did not know.
- None
- Sometimes

7. When was the moment you feel that your reasoning skills was challenged?
    - the moment on the exam on why it is the best mathematical concept to use
    - The exam since we ran out of time because of the pie graph.
    - Hmm When Sir Alexies asked how we got the answer for the problem.
    - When we answered our teachers question
    - I don't I could remember it
    - When the topic was a bit confusing to understand
    - No
    - Measure of central tendency activities
    - When i answer the solution first even i have a reason to say but i forgot it because i try answering the question first.
    - Probably when doing exams
    - ***My reasoning was challenged, the moment that I did not understand the whole concept of why it is used. [Tristan]***
    - Sorry, I do not remember the time when was the moment I feel that my reasoning skills was challenged and I did not pay attention to it.
    - ***When I was having hard time focusing and understanding some topics, I couldn't reason clearly [Gio]***
    - The moment that I felt that my reasoning skills was challenged was when it was when we had a CER quiz and I had to reason out on why

that mathematical concept is the best concept to use in that problem so I really felt challenged in that moment.
- when I am writing my CER
- During the exam
- None
- when it was my time to answer
- When exam

8. In connection to the previous question, was there a moment where you feel like an expert and was able to reason out correctly? Can you share to us the details?
    - no when I answer I dont feel like an expert because of self doubt
    - No
    - No, since I had a very hard time trying to process how to make it a 100% in a graph.
    - Yes. Because an expert knows better than me.
    - No
    - Nope.
    - No because there are times that the cer topic is hard to explain in the reason
    - Yes, because the lessons are very easy to me when i understand it.
    - Yes
    - The measures of central tendency was where I could reason out my answer and I felt like I was an expert to the lesson already.
    - Yes, sometimes because I answer them at the same time so that i can really express my reasoning.
    - I don't feel like an expert in math class
    - There was a moment that I felt like an expert when I understood the measure of variability and could answer it without taking a look at my notes.
    - Sorry, I did not pay attention to it, and I was focused listening to the teacher and what my classmates said.
    - Yes, since after that hard time, I was able to give out my reasons and details
    - No, there wasn't a moment where I felt like and expert and was able to reason out correctly.
    - ***The only time that I felt like an expert is when they asked and I'll explain to my seatmate and other classmates on how to solve a problem or to discuss/explain to them on simpler terms the lesson. [Bryan]***
    - Because you need to explain clearly

- Yes, I felt like I could reason out my claim and evidences like I was an expert at reasoning.
- None
- Yess

9. Did you feel engaged during class activities? If so, provide some examples.20 responses
    - yes,when we try to solve the measures of central tendency
    - Yes, when having group reports.
    - Yes. When we had a group activity.
    - Yes when we answered measures of variability
    - i'm not sure
    - Yes during group activities,
    - Yes, because in all the activities I always do my part.
    - yes like when teacher made us do fun activities
    - Pie graph/pie chart and the measures of central tendency.
    - yes but not really cause i cant answer properly the other formula ig.
    - Yes, because we can answer the activities
    - I feel engaged during class activities, like when my teacher called me to answer the table on the board.
    - Yes, because I am happy to help my classmates to know what the answer was.
    - Yes I do feel engaged like focusing and be able to be more cooperative and participate more
    - No, I didn't feel engaged during class activities because everytime Sir. Alexies would call me is that I wouldn't know the answer.
    - No
    - Not really
    - yes like when we used calculators
    - yes because i need my brain to answer so i have to look in
    - No sometimes only

10. Were you able to interact and collaborate with your classmates? How did your collaborative work go?
    - yes in group activities
    - Yes, sometimes it goes well and sometimes doesn't since some students don't take responsibility seriously.
    - Yes. We worked together so get the answers.It was fun and interesting.
    - Yes,Good
    - yes and it was doing fine.

- I was able to collaborate with my classmates and by collaborating with them they also got some ideas from my help
- Yes, because in the end our ideas are working good.
- yes and it went good
- We were able to study before the test with each other's notes and we also copied it just Incase
- fun and good.
- Yes, and it went pretty good because of their help.
- Yes, we were able to interact and collaborate with my classmates when my teacher let us think about how to solve that certain problem, and our collaboration was good since everyone helped.
- Yes, because the collaborative work was okay because we helped each other, but somehow, some of our answers were vague and not sure about it. Because we are trying to find the right answers.
- Yes but sometimes no since some of my members wont really cooper but we did find a way to present something
- Yes, I was able to interact and collaborate with my classmates as they were ready to listen onto eachothers opinion on what the possible answer is. Our collaborative work went kind of nice.
- By cooperating
- Yes, it went good. Some knew the answer
- yes and it was good enough
- it go good my classmates are fun
- Yes we help each other out

11. Provide situations from your learning experience during the lesson discussion that got your attention and interest. How did it got your attention and interest?20 responses
    - when it was our next topic that sir discussed which is measures of variability it made me interested to learn it because it was so interesting.
    - Well maybe the same topic I talked about earlier since it was very Complicated to answer.
    - ***When sir showed us the problem first it sparked an interest on how to get the answer because it was limitless and there was alot of possible solution and it really got my interest and attention. [Glenn]***
    - Measures of central tendency because of exam
    - I don't think there's that situation.
    - **Measures of central tendency because I’m interested to compute my grades [Von]**

- It got my attention and interest because i was able to learn a new topic and it made me intrested to learn it more
- Every time the lesson kinda hard it will caught my attention and interest to learn harder.
- Standard Deviation because there is square root.
- First I knew what I was doing but it started to get confusing so I studied until I understand it.
- i got the attention and interest of the lesson from the 3person at the back from other school when they video us because they told us to listen and enjoy learning the math.
- ***My learning experience during the lesson discussion that got my attention and interest was when I understood the lessons clearly and was excited to answer problems. [Bryan]***
- I got my attention and interest when my friend answered the unknown or right answer to the problem, so her answer was right. And so did the teacher that he discussed what was her answer and gave us a formula about it.
- My experience was fun and hard at the same time so it got my attention when we were doing an activity since it help me understand and communicate with my classmates
- ***The situation from my learning experience during the lesson discussion that got my attention and interest is when we were just tackling on a new topic which is the Measure of Central Tendency where sir created the table with the mean, scores, and such. It got my attention and interest because it seemed difficult to do and I was kind of getting worried if I were going to understand it or not but I eventually learned that it was not that difficult as it seems. [Gwen]***
- the mean,median,mode because I'm enjoying to listen the topic because it is easy to gets how to solve the problem
- ***The measures of central tendency was interesting to be since it was easy to solve. [Sam]***
- the median mode and mean because it did make sense
- when we where discussing about the mean cause i don't know how to find the average of something

12. With the way your teacher delivered your lesson, how do you think did if affect your learning experience?
    - the way my teacher delivered the lesson did not affect my learning experience but it did made me understand the lesson easier
    - The way he delivers it is very clear but the same time also confusing to some.

- It helped me positively because it helped me learn more.
- Made it more fun
- challenging, complicated, hard...really had to understand but I tried my best to learn it...
- It helped my learning experience because it made me more intreseted in learing the lesson
- I understand them all
- It made me better
- He taught us how to do it the right old fashioned way instead of the lazy way by using high tech(calculators)
- it affect my learning experince good and so happy because i understand the two lesson from 4thquarter and i hope and pray that i can't join the summer lesson at the ending of school year.
- Yes
- The way that my teacher delivered our lesson positively affected my learning experience, as his delivery skills were good and he answered my confusions.
- I think that he did affect my learning experience because it is really helpful and giving us the opportunity to understand the topic well.
- It affect my learning experience by making me more focused
- Sir. Alexies is really good at teaching. He makes sures that everybody understands the topic and is able to answer problems. By that it has affected my learning experience greatly. I am always able to understand the topic even if I am confused is that I still get the main points on how to solve and what the topic is.
- I think did if affect my learning experience because I understand clearly the topic or lesson that we discuss because my teacher delivered clearly
- It was good, my math teacher is good at explaining things.
- it was good
- when math comes around the subject it is always fun

13. Over the past two (2) weeks. are there any positive changes that happened in your classroom during class discussion? If yes, can you provide examples?20 responses
    - No
    - No
    - I don't really observe our class that much since it's pretty much the same day after day after day.
    - Yes like teamwork.
    - Yes,It became easier to understand

- yes like sometimes my classmates, they're peaceful
- Me and my classmates were doing and helping eachother with the activity that we given to us
- yes I learned to handle pressure
- Nope not really
- ***yes, they listen properly and they also understand the lesson and I teach wajid the part that he don't understand even I'm not good at teaching but still he needs help. [Sam]***
- I don't know if there is any changes
- Yes, there were so many questions that could practice your thinking skills.
- Sorry, there are no positive changes that happened in my classroom during the class discussion because some of my classmates were not listening and misbehaved. While the others are listening and well-behaved.
- Maybe yes, since some of them were participating and answering
- No, for me I haven't seen any positive changes that happened in my classrooms during class discussion besides my classmates greeting the people who were observing us.
- yes, they concentrating in discussion and participating
- I don't think so.
- because of the calculator everyone was able to understand the lesson properly
- yes the class got more silent cause the teacher is always mad at us

14. Among the two choices, why did you choose such choice?
    - I prefer Option A more because I need to understand the topic and know how to solve it before answering an example problem.
    - Since when introducing a topic before doing the lesson it makes it more easier to understand it's problem.
    - B because that's what sir Alexies did and it helped us to better understand the topic and it helped us learn more about it.
    - Because it is what our teacher do
    - ***Because I'm scared if the teacher is going to choose a student to answer the problem without even discussing it and I'll get nervous if the students will look at me as if like I failed the subject [Mark]***
    - Because introducing the topic first we would know what the topic is all about and we can also know how to do the topic before we do it on our own
    - I choose A because I find it easier in that way.

- ***I don’t know. If the teacher calls me to show my solution based on my understanding of the problem, I will be embarrassed in front of the class. [Dan]***
- Because a teacher is providing us info about the topic.
- A so that when he sees our answers he knows who understands it and who doesn't
- i chose option A because its more nice so that we can understand the lesson and we can also answer it properly
- A - because I helps the student know what the topic is and the teacher will provide more explanations.
- I prefer option A because I could be ready after my teacher discusses the topic and can answer his questions.
- I choose option A because it is really helpful to introduce the topic and discuss the content/topic. So that we will understand more and gain knowledge about it.
- I choose letter A since for me it will help some students understand more than summarizing it all I think the topic should discuss first before solving or finding a way to answer it
- I chose option A because for me, I am quite slow if I am learning something that is new to me by myself. I am not able to comprehend and understand the lesson as it makes me confused. So, I would prefer option A over B.
- I choose option a because you need to introduce your topic, content before you present the problem because we were getting curious what topic is all about
- A because students need to learn first about the topic before answering one so that they can understand how the topic works.
- <A> because it doesn't make sense asking your students to find the solution for a problem that your haven't discussed yet leaving your class confuse, because they dont know what to do, and already expecting them to answer is crazy
- cause i cant answer it if i dont know how to do it
- I chose option B because for me it is easy to understand

15. What do you think is/are the advantage(s) of using Claim-Evidence-Reasoning (CER)?
    - more on learning how to solve the problem
    - The advantages of it is to explain further more your answer and briefly explaining it.
    - It improves your thinking skills and reasoning and overall understanding and the answers our just limitless.

- Can help you improve your skills of finding answers in a text
- it's good and a lot easier i guess.
- Cer makes me understand the concept more
- The advantage of it to me, I find it easier to answer
- **I find it easier to answer, it helps us explain why we used such a solution/way. [Arlene]**
- for me the CER is fun and good but sometimes i forgot my claim but its okay atleas i answered properly the other text ig.
- It's easy
- ***CER always goes in one direction and we don't have to be like "why is it like this?!? I don't remember learning this?!?" Because we literally practiced a lotta times.*** **[Cyril]**

- The advantage of using CER is it practice your critical thinking and can expand your learning as it asks why.
- The advantages of using Claim-Evidence-Reasoning (CER) are helpful to the students, underatand the concept well, gain knowledge about it, and serve as critical-thinking skills.
- The advantages are it will gain our knowledge on doing essay and it will gain our knowledge on solving as well
- The advantages of using CER is that it allows you to prove your point and it allows you to express your opinion on something.
- ***In CER, you can improve how to write an essay of your reason [Sam]***
- To answer a CER itself, answering the essential question, backing up the claim with evidences and reasoning it all out.
- we are able to use it in irl situations and it imrpoves debating
- CER is everywhere like lawyers and more
- Using Cand E in cer 8s

16. What do you think is/are the disadvantage(s) of using Claim-Evidence-Reasoning (CER)?
    - None
    - Well it's very time consuming knowing we only have a 1hr limit with 2 problems.
    - Nothing honestly.
    - Sometimes might be too complicated
    - the reason part is hard to answer.
    - Few solving exercises
    - The disadvantage is you need to think harder about what you will write.
    - Sometimes hard.

- ***The three texts. It's very time consuming. I can barely finish the 2 CER's in an hour and now I have to do it 3 times?!? My time and energy would be gone by the time I've finished the exam and then I have to do another one. [Blake]***
- CER can be a valuable tool for teaching scientific reasoning and communication skills, it is important for educators to use it thoughtfully and supplement it with other instructional approaches to ensure a comprehensive understanding of scientific concepts.
- The reason must be long
- I do not think that CER has any disadvantages.
- ***The disadvantage of using Claim-Evidence-Reasoning (CER) is when the students lose how to reason it out. [Bryan]***
- Maybe there's none
- For me, there aren't any disadvantage/s of using CER.
- NONE
- When writing a CER, you might feel your hand getting tired and hurting from writing whole CER.
- thinking too had will make you dizzy
- The advantage of using claim

17. Can CER help you improve your reasoning skills? If yes, why do you say so?20 responses
    - it can help on improving why you chose that mathematical concept.
    - Yes, since when the days goes by we start to get used to it.
    - Yes. Because it improves my thinking skills.
    - ***Yes because when you answer the reason part you need to reason out why your evidence is connected to your claim which is sometimes challenging [Christine]***
    - maybe because i can't think of an explaination(basta yun sagot ko sa claim dko maexplain)
    - Cer helps me improve my reasoning skills because it can help explain the topic
    - Yes, because this can help me improve my essay writing skills.
    - Yes because you simply need to explain the claim
    - Yes because when we practice CER we can determine what reason or evidence would fit right with my claim.
    - YES, so that i can explain my answer effectively
    - Yes, because you would not find the questions hard
    - Yes, because it helps me think why that happen and what are the reasons.

- Yes, CER helped me improve my reasoning skills because it gains my knowledge, intellect, and critical/analytical-thinking skills.
- Yes since reasoning will improve our understanding and it will help us improve on making an essay or paragraph
- ***Yes, CER helps you improve your reasoning skills as it allows you to explain your point. It gives you a chance to further reason out your opinion on something. [Blake]***
- YES BECAUSE YOU CAN HAVE A LEARNING OF HOW TO PROPERLY WRITE AN ESSAY
- Yes, it can improves my reasoning skills and my essay writing while also improving my handwriting.
- yes because it helps us what to look for when arguing with someone
- yes cause you need to explain the reason
- Yes

18. Would you recommend CER to be use in a mathematics classroom?
    - Yes
    - Yes
    - No since it's still the same process of how you do it in a normal quiz although it needs explaining and its very time consuming because of how the problem needs to be solved.
    - Yes Because we need to justify our answer.
    - yeah i think because multiple choice is harder 'cause every question is always solving
    - Yes because cer can help us explain the topic further
    - Yes, because it is much easier to answer.
    - I guess
    - for me its okay and a little bit no.
    - Well, I would recommend it before exam days because some of my classmates do not like CER sometimes, but I would recommend it before exam days when it is time to practice.
    - Yes so that we can learn how to solve more and explain better
    - Yes, I would recommend CER to be used in a mathematics classroom as it improves your reasoning skills and allows you to explain why you chose to use a specific formula or a mathematical concept to solve a problem.
    - Maybe

## APPENDIX F5

Face to Face Teacher Interview Transcription

Question: Kamusta ang klase/experience so far?

*Teacher: My experience is  ang pagdeliver sa lesson is naa syay difficulty kay first dili ako ang nagprepare, mao jud na ang challenge, dili ko kabalo unsaon pag approach kay dili ako ang nagprepare sa lesson. Pero somehow, okay raman pud ang flow sa inyong gihatag nga guide sa lesson plan.*

Q: Familiar ka sa TTPS? Nakapractice na ba ka ani, like problem-solving in assessments?

*T: Familiar ko ani pero dili kaayo nako siya ginagamit. Kuan man gud, especially sa ilang level, ibuild pa dapat ang critical thinking. So ang mostly dapat is maghatag patag information saila. Although kailangan jud nga at some point is sila ang magthink sa ilang mga answers, pero wala paman gud silay foundation sa mga lesson. Especially pandemic, lisod ibuild nga dapat saila jud mogikan ang answers kay ang ilang foundation is low pa. Kailangan pa ipolish.*

Q: So feel nimo mao na ang challenges nga maidentify nimo?

*T: Oo, kay bisan ganig pag solve sa simple equations, dili sila kasolve. Maglisod pa sila.*

Q; Pero sa approach (TTPS)  alone? Unsa ang possible difficulties?

*T: Ang difficulty siguro is varied ilang answers. Unsaon pagkuha, unsaon pag connect sa ilang mga answers nga galahi lahi, given nga limited ang time.*

Q: So galisod kag summarize sa ilang answer. Pero nice man to sir no nga ma allow ang learners to think critically, and mas makareason sila?

*T: Ayos sya nga sila jud, ang gina practice pud dre is sila dapat ang modiscover which is kani  nga strategy sila lang jud alone. Samoa is naa lay scaffold from teachers*

Q: Kamusta man ang mga bata?

*T: Nabag.ohan sila kay "bakit sir naay nagvideo everyday" kay wala sila naanad nga naay magtan.aw sa likod.*

Q: In what ways do you think this TTPS approach encourages students to think critically when solving mathematical problems?

*T: Siguro is katung sa problem, Kay dili namn gud presented ang unsay dapat nila imemorize, sila nay mangitag way nga dapat makakita jud ko ani given the problem, which is mas ayos sya because narecall nila ang previous lesson murag naa nay mastery dayun after na discover nila*

Q: So mao pud na ang isa ka advantage sir no? Unsa pa kaha sir aside ana?

*T: Ang mga students man gud is mahadlok pajud sila moistorya sa ilang thoughts pero with the strategy, kanang ay possible diay nga in.ani nga answer which is kailangan pajud ibuild ilang confidence*

Q: How do you think the strategy/approach influenced their involvement in the learning process?

T: *In terms of the approach, mas nakita nako ilang eagerness nga makabalo unsaon pag answer. Sa presenting the problem, nag build na silag hala unsaon kaha ni pagsolve? Unsa kahay answer ani? Or sailang huna huna ba is makahatag silag answer. Ginachallenge nila ilang self ba.*

Q: How would you describe the student's participation in response to the implemented strategy?

*T: Kung iobserve nako same person rajud ang motingog pero ang naka ayos is katung dipud kabalo is mangutana saila like giunsa nimo pagkuha, hala lahi lagi tag answer. Maobserve nako sa ila nga naa silay initiative.*

Q: Do you think the TTPS approach encourages students to engage confidently with their peers when solving math problems?

*T: Yes at some point. Kay although ang uban mahadlok sila mawrong ilang answers pero with the help sailang classmates katung naa nay mga idea kay maguide jud sila*

Q: Na feel ba nimo sir nga establish ilang relationship sailang classmates?

*T: Naa siguro pero selected lang*

Q: Reflecting on your experience, how has the TTPS approach supported the development of students' reasoning?

*T: Because of the TTPS makabalo sila sa importance sa lesson, murag kabalo sila mag differentiate nganong or when ang mean gamiton or median napud which is helpful sya sa CER especially sa reason nga part. Ilang claim nga part is given na pero ang sa reason part is mas dra ang challenge kay iexplain nila nganung kato nga concept ang gamiton to solve the problem. And na cater na pud sya dra sa TTPS*

Q:  And based sa CER nga nahitabo, na feel ba nimo sa ilang answer nga maka explain jud silag tarung?

*T: Nakaexplain sila pero siguro ang problem is dili nila mamaster or mamanipulate  ang formula.*

Q: Reflecting on your experiences, how helpful for you as a teacher is the CER assessment in capturing the depth of students' reasoning and thought processes?

*T: Helpful sya because dra nimo makita how well they have learned the topic kung unsa jud ilang understanding, kung shallow raba kaha ilang understanding. So base sailang reasons didto sa CER, makita nimo kung ang students nakasabot ba sa concept o wala.*

Q: Reflecting on your experiences, how has the use of TTPS with CER helped students develop their reasoning?

*T: With TTPS you can master the content and understand how the lesson or concept applied, not just for the sake of solving.*

Q: Are you open to learning more about this teaching approach and to participate in professional development to improve your skill?

T: *Yes, I am open to learning more about the TTPS approach because it helps deepen understanding of the lessons. It allows me to determine their stage in the learning process, whether they are still developing, have reached mastery, or have no prior knowledge of the topic.*

# APPENDIX G1

Observation Transcripts from Day 1 - 5

**DAY 1**

**Time Started: 2:40**

2:42 - Math Trivia
2:43 - Presentation of Learning Targets/Competency
2:44 - Problem Presentation

- Teacher groups the students according to their seat plan.
- They are given instructions to answer the problem for 10 minutes.

Group 1:

*Student 3: Unsaon nato neh? Si Ban atung pillion kay naay 26?*
*Student 4: Si Ban kay naay dako nga score nga 26. Pero gamay sya'g score*
*Student 3: So atung pillion si Ellaine?*
*Student 5: Oo si Ban dako iyang grado sa 1st pero niubos, mas taas si Ellaine*

2: 54 - Lesson Processing

- Teacher ask every representative of the group to share their ideas in solving the problem. Most of the group answered Ellaine.

Group Answers:
Group 3 answered that they got the answer by getting the average.
Group 4: added all the scores and divided it by 7.
Group 5: observed the data and notice its consistency - "more consistent"
Group 6: added all the scored then divided it by 7 (the same with group 4)
Group 7: added all scores and compared which among the group got higher score (161 vs 154).

*Teacher: How do you conclude that ellaine is better?*
*Teacher: How did you know nga niimprove? What is your basis?*
*Student: Calculate the average. Adding all scores, divide by 7*
*Teacher: Why divide by 7?*
*Student: It is because it has 7 quizzes*
*Teacher: Who agrees that we need to divide it by 7?* - the students were able to mention and bring up average.

*How do we find the average?*
*Student: divide your total scores by 7.*
*Teacher: What if there* are only 5?

Average = sum of all observations / ??

*Teacher: What should be put in the denominator?*
*Student: number of observations*

*S: Based on the problem, what are their averages?*
*S5: 23*
*S4: 22*

The teacher proceeds by mentioning the **"mean"**.and "measures of central tendency". The teacher explains the Mean further.

The teacher asked another group.

- A student was also able to mention the word "repeating"
- Common scores = 23 (elaine)

*Teacher: How will you say that Ban has lesser scores even if he has a high score?*
*Student: tan.aw rako sa table. Nay 3 ka 23 and nay 3 ka 22*
*Teacher: The common score for Ellaine is 23 and the common score for Ban is 22.*
*Student: the number that appears most higher*

*Teacher: Based on this, who is better?*
Students answered that Elain is better. They made the realization that the number that appears often is better.

3: 11 - Following, the teacher proceeds to introduce **Mode.**

*Teacher: Based on the data, we can see who's better by looking at the number that appears most.*

*Teacher: On your notebook, try to arrange the data from highest to lowest. Compare the highest score and the lowest score.*

A student mentioned to subtract the highest number to the lowest number.
A student mentioned the "range", yet the teacher did not yet entertain the concept of range stating that they are not finding the range.

*Note: On the LP Day 1, the implementing teacher changed the names for the reason that there are students who have the same names.*

- Some students were not as attentive and participative as the others.

*Teacher: Since we already arranging the data from highest to lowest, how*

*can we identify which student is better?*
*Student: com*pare the scores to which is bigger.

Students were having a hard time identifying the concept of **median**. Students suggested to use different math operations such as addition, subtraction, multiplication, and division.

*Teacher: We can also identify which is better by comparing the scores in the middle part. What is the middle score then?*
Students identified the number placed in 4th place. They were able to mention the median numbers.

T*eacher: how did you identify the median?*
*Students actively responded that to identify the median, they should arrange the data, then identify the middle value.*

*Summary: teachers recap the concept of mean, median and mode. (Teacher-centered)*

**Time Ended: 3:20**

*Note: on the last slide, the teacher provided a summary of the lesson, specifically its definitions.*

*POST LESSON DISCUSSION:*

- Lesson objectives were presented in which students read it aloud which gave them an idea on the topic to be discussed. However, balag nabasa na nila ang objectives, students were still not able to make use of the keywords as a clue to what the discussion is all about.
- The students focused on comparing the scores mostly
- Most students were passive learners, unlike the ones who were actively engaging and participating in the class discussion.
- There was a minimal engagement among the students

TO IMPROVE:

- Teacher wasn't able to present the illustration which was supposed to open the discussion about the objectives, stating the purpose of why we need to get the measures of central tendency.

NOTE:

- Need to emphasize that average is not the mean. Average refers to the central point of the data which caters the mean, median, and mode.

**DAY 2**

**Time Started: 9:10**

9:11 – Math Trivia Time
9: 13 - Recall of Previous Topic
*T: What is the topic last meeting?*
*S: Mean, Median, and Mode*
*T: What is mean?*
*S: Plus and divide kung pila kabook*
*T: how about median?*
*S: Divide by two!*
*T: Do we need to divide by two if median is odd?*
*S: No*
*S: Sir diba iarrange sa?*
*T: yes, we need to arrange it first. Then after arranging?*
*S: Find the middle value!*
*T: How about mode?*
*S: Numbers that appears often/commonly appearing*

9: 16 - Presentation of Learning Targets/Competency

9: 20 - Problem Presentation
- The students were not as active unlike the other day - they are mostly quiet during the discussion.
- The teacher asks the class what are the given, then proceeds on asking a student to write the given number on the board.

9: 23 - Students Collaborate with Peers
- The teacher instructed the class to go to their groups for their group activity
- The students were given 10-minutes to discuss their answers with their group. During the activity, the students in some groups were not discussing with each other. They were observed to do the group activity on their own.
- Commonly, students were doing the solving/calculations individually even if it is supposedly a group activity. ***But there was one group who was really doing the task as a group.*** They were discussing their answers with each other and took part in the learning process such that the members were contributing on developing their ideas in order to navigate how to answer the problem presented.

*S1: Nganung nay 8?*
*S2: Para mahimong 35 and the mean is 5!*

It can be observed that students in general have difficulty in solving the problem. So the teacher gave questions.

*T: What are the ways to find the mean? How will you find the mean?*
Convo from other Group:
*S: If mean is 5 tas 7 sila ka tao, unsaon?*

After the activity, the teacher asked each group to write their answers on a ¼ paper. Later on, it was collected. He proceeds on collating each of the groups' answers on the board.

Different from day1, the teacher changed his strategy to cater all answers of students to avoid consuming time given that it is limited. So what he did was to create a table so that all answers can be seen on the board.

Group 3 and 4 have the same answers: 3, 3, 3, 4, 7, 7, 8

*T: Who are group 1? What is the first thing to do?*
*S: Find the given*
*T: Then?*
*S: The mode and median*
*S: Median is  4 and Mode is 3*
*S: Make sure the sum is 35*
*T: how about group 3?*
*S: Mode is 3 and Median is 4. So gigamit namo ang median and mode*
*T: So what did you do?*
*S: Duha ka 3 and duha ka 7 but to make mode 3, mag add kag another 3.*
*T: How to find other values?*
*S: Write any number as long as the sum is 35. So we can divide it by 7.*

Other groups:

*Teacher: how did you get the answer?*
*Student: apply the given*
*Teacher: what given?*
*Student: the mode and the median*
*Teacher: how did you find the remaining numbers?*
*Student: by looking for numbers that when you add it all together, it is equal to 35.*
*Teacher: why do we need to have 35?*
*S: so that if you divide it by 7, then you will get the mean which is 5.*

- While the student was explaining their answer,, some students were not paying attention.

*T: how did you used the mode to find the answer:*
*S: 3 is the mode that should appear most often in the data.. If there is two 3's and two 7's, then it means that 3 is not the only mode present on the data.*
*T: how about the remaining number?*
*S: write any number that when you add it, it is equal to 35.*
*T: can we write two 3's only?*
*S: no*

*T: why?*
*S: because of the restriction*
*T: what if we used only two 3's? What would be the remaining number?*
*S: 1*

The teacher asked the students if the same applies (or happens) if they have different set-up (arrangement)?

*2 + 3 + 3 + 4 + 6 + 8 + 9*
*1 + 3 + 3 + 4 + 7 + 8 + 9*
*0 + 3 + 3 + 4 + _ + _ + _*

*Teacher: can we include zero?*

The students don't know the answer.

- This time, most of the students were not participating. They were mostly writing, some were doing their own thing at their respective seats.
- Most students who were participative were students seated at the front.

*T: can we consider this as an answer 6, 3, 3, 4, 3, 8, 8 also ?*

*Teacher:Is it possible to have an answer like this data set also?*
*Data 1: 0, 0, 0, 0, 0, 0, 35*
*Student: no! Because there is a restriction wherein 4 should be the median, and 3 should be the mode.*
The teacher asked again the question.
*Students: NO!*
*Students: we follow the restrictions*
*Teacher: so what is the median and the mode if thats the case?*
*Students: 0 is the median, and 0 is the mode*
*T: although we can get a mean of 5, we cannot satisfy the problem.*

*T: how about this* 0, 0, 0, 4, 4, 7, 20 ?
*S: no japon sir!*
*T: what will be the mode?*
*S: 0*
*T: why is it?*
*S: because it is the number that appears most often*

*T: How does this imply? Nganung magkuha man tag mean, median, and mode?*
Students are silent. Thinking. The teacher then gives another example.

*T: How about sa allowance 50 pesos tanan inyo allowance and then nay isa kay 100. Can we use mean to represent the data?*
*V: No sir, kay mo skew ang data.*

J: *Mas mo dako ang mean nila!*
T: *Yes, we cannot use mean since nay dako nga number. Gagmay ra kayo (50) tapos nikalit lag taas (100)*
A: *There is a number that is significantly bigger*
*T: yes nay outlier*
*T: So when is the median best to use?*
*A: when there is outlier?*
*So find only the middle value?*

*T: When is the best time to use the median?*
*S: when there is an outlier?*

The teacher was able to emphasize that mean, median, and mode can help find the average.

*T: How about mode? When is the best time when we can use the mode?*

Here the teacher gives examples about popular songs. The teacher mostly discusses at this point to make learners understand when to use mode.

9: 48 - Lesson Summarization

*T: What area is confusing for you?*
*T: Going back to the problem, which measure of central tendency would best represent the data?*
*S: median*
*S: mean!*
*S: mean, because we can multiply the mean by the number of people*
*S: mode, because it appears the most*
*T: why is it that no one answered the median?*
*S: median, kung naay outlier numbers that is significantly than the others*

**Time Ended: 9:50**

POST LESSON DISCUSSION:

- The discussion today was insightful and inquiry-based to capture students' understanding of the lesson. There are some who practice thinking critically and communicating their answers to other students and the teacher. Students were able to mention skewness of data and concept of outlier. However, participation is mostly passive especially to less engaging students.
- The teacher was also not able to include all details in the lesson plan given the limited time. He is still testing how to better summarize all ideas from students.
- Question: Is a 40-minute discussion a good amount of time for math class?

**DAY 3**

**Time Started: 8:25**

8:26 – Math Trivia
8:27 – Recall of Previous Lesson

*T: What was the topic yesterday?*
*S: Mean, median, and ode?*
*T: So when to use mean?*
*S: If there is no outlier?*
*T: What about the median?*
*S: When there is outlier*
*T: How about mode?*

8:30 – Problem Presentation

- The students on their own seats are trying to find ways to solve the problem. This problem was in continuation to the lesson plan on day 2. He uses the assessment in lesson plan day 2 to further the learning of students in measures of central tendency.

  *Answer #1 : 6 6 7 11 10*
  *Answer #2: 6 6 7 9 12*
  *Answer #3: 6 6 7 8 13*
  *Wrong Answer #4: 6 6 7 6 15*

- At this point the teacher is satisfied with the answers coming from students. So there were no questions on how they found the answers.
- However, the teacher gave further questions to know more about how deep their understanding is on the lesson especially those less engaging students.

  *T: Can we use 6 6 6 from the data? (the student is silent) So he called a friend.*
  *S: Yes*
  *T: Can you show your answer?*
  *The student showed his answer*

  Student's Answer: 6 6 7 6 15
  (Answer is incorrect because the median is not 7)
  *T: Question, can we get a median that is 7? Arrange your data*
  After arranging, the student then realized why his answer was incorrect.
  *T: So why no?*
  *S: Because 6 is our middle number.*
  *T: how about mode?*
  *S: Yes*
  *T: So can we use another number 6? Is this a solution to the problem?*
  *All Students: No*

*T: How about 5 6 7 9 13? Can we get the mean and median?*
*S: yes, but the mode will not satisfy the problem since there is no mode.*

8:40 – Problem Presentation

- Teacher presented another problem to be finished for 5 minutes. The problem is about delving more to the topic of mean. If given the mean, and there is a missing data, they are tasked to find that missing data/value.

Time: 8: 45 Lesson Processing

*T: How do you solve for the mean? What is the process?*
*T: The students then answered the teacher on what they know.*

The teacher at this point gave a formula

$$Mean = \frac{\sum xi}{n}$$

Based on observation, the students wondered about the symbol of the notation. Some were confused. Even with the problem, they were confused how to solve it so they only assumed that they were to find the meaning.

*T: You are not finding the mean! You are tasked to find the 8th grade*
*T: What's the process of finding the mean?*
*S: Sum of all divided by total number of observations*
*T: What are the given?*
*S: mean is 89 and there are 8 subjects. So n=8.*

Note: Observing the students, some are just inattentive and just playing around. So the teacher focused more on students who might have ideas. He allowed a particular student to show his solution on the board.

Generated Solution:

(89)(8) = 712 (mean ***x*** no. of subjects)
85+90+95+86+85+88+91 = 620 (total grades of 7 subjects)
712 – 620 = 92

Checking:

85+90+95++86+85+88 + 92 = 712
712/8 = 89

*Student Explanation: I assume that we have to add all their grades and then subtract it by the mean multiplied by the number of subjects in total. That's why 92.*

The teacher explains further so that learners can follow what their classmate is trying to say.

8:59 Summarization

The summary is in the form of a quiz or assessment to let the teacher know whether all students have learned what they discussed today.

It can be noted that while the students are answering, the teacher roams around and from time to time would give feedback whether the learners are on the right track. He would immediately address if there are problems or confusions coming from students .

**Time Ended: 9:10**

*POST-LESSON DISCUSSION*

- Contrary to this study's framework, the teacher shifted to an activity that is not collaborative without even informing us.
- We can sense that the teacher is agitated or stressed.
- The strategy today was *Doing board work to let students show and explain*

**DAY 4**

**Class started - 2:46 PM**

2:48 - Math Trivia

*T: How to solve the mean? (Students recalled the formula introduced to them yesterday)*
*T: How about median?*
*S: Arrange the number from lowest to highest and find the middle*
*T: How about the mode?*
*S: The frequent used number*

2:50 - Presentation of Learning Target: introduction of Measures of Variability

2:51- Problem Presentation

The teacher presented a problem.

- Allow students to answer the problem individually. While they were answering, the teacher was roaming around the classroom.
- Some of the students were discussing how to solve the problem.

T: Are you done?
Students: no!

*** after a while ***

*T: What are the steps you did?*
*S: arranged it from highest to lowest.*
*S: arranged it to lowest to highest*
*T: why?*
*S: so that i can know the lowest*
*T: Then what did you do next? What group performed better?*
*S: group b., kay gamay ra ang 63 nila nga score. While, sa group a kay ana-ana (inconsistent)*
*T: What else?*

The teacher randomly called a student to answer.

*S: by finding the mode*
*T: why did you use the mode to compare the two groups? When is the best time to use the mode?*
*S: ayaw nalang, sir.*
*T: what comes to your mind to solve the problem and compare the two groups?*
*S1: their modes*
*S2: We divide them all*
*S3: compare them using the mean*
*T: What did you use?*
*S1: 87.5 (Group A)*
*S2: 87.5 (Group B)*

*T: Since you got the same mean, wha*t did you do to compare the two groups?
Students weren't able to explain their answer.
The teacher goes back to the students' answers (getting the lowest to highest score)

*T: What is the concept where we can use the lowest and the highest scores?*
*Students: The Range*
*T: How can we solve for the range?*
*S: Subtract the lowest scores from the highest scores*
*T: What is the range for group A?*

**100 - 65 = 35 ***
S: 35

T: how about the group b?
*** 91 - 82 = 9 ***
S: 9!

*T: based from the ranges in the group, which is better?*
*Students? GROUP A*
*Students: GROUP B*
*T: why, group A?*
*S: mas taas siyag range*
*T: Why B?*
*S: because it have smaller gaps*
*T: Range is used to know if nag stretch or scatter ba atong data or wala*
The teacher explicitly introduced the measures of variability.

*T: arrange the scores in a table*

*T: what is the value of the mean that you got earlier?*
*S: 87.5*
*S1: sir, kanang bar *taas sa x* kay apil na?*
*T: unsa mana ang x-bar?*
*Students: the mean*

- Some students were not active and paying attention to the discussion.
- A student was called but was hesitant to answer on the board.
- The teacher asked the class who can finish the remaining data on the board.
- Some students who were sitting at the back were sleeping, while others were talking with each other.
- While the student who volunteered was answering on the board, the teacher was roaming around the classroom.
- Minimal student-teacher interaction
- Minimal interaction on the topic
- Some students were scribbling on their notes

When answering on the board, the teacher asked the student of its process. However, instead of allowing the student to explain her answer or how she did it, the teacher himself explained it to the students. The teacher proceeds on discussing the measures of variability (lecture mode).

*S: unsaon mana Sir? - (*when the teacher told the class to square the answer from the previous step.)
*S: sir ang negative kay mahimong positive?*

The teacher clarifies again what it means (x - x (bar) ^ 2). Students were confused on what to do, particularly in squaring the difference. While some used the scientific calculator, there were students who were confused on how to use it.

T: if you are using a sci-cal, then mo fraction inyong answer, then use S → D para mahimong decimals
*S: unsay meaning sa s, sir? (referring to the S in the S → D)*

T: *didn't answer*

** as we roamed around to observe, some of the students' notebooks were empty. They did not know what to do.

*T: who got the same number as your classmates? How did you get your answers?*

*T: what do you mean by this symbol? (∑). This is called the summation; meaning you have to add all the numbers.*
*T: what is now the total?*

Some students were confused on how to use the ∑.

*S: 1, 762.5*
*T: what is the use of the making of the table?*
*T: one mistake from this table. Then the variance will be wrong also.*
*T: what is the value of n?*
*S: 10*
*T: why?*
*S: because that is the number of observations*

*STANDARD DEVIATIONS*
*T: we cannot solve the standard deviation unless we solve the variance*
*T: what is the difference of their formula (in terms of symbol)?*
*S: wala nay squared*

*Note: There were students who were not familiar with rounding up*

T: mao pa ni ang Group A.
After they finished computing the values for Group A, the teacher gave Group B as their assignment.

**3: 20** Summarization
*T: what are the other ways of comparing data?*
*Students: variance!*
*T: what else?*
*S: range.*

**Time Ended: 3:25**

*General Observation:*

- The discussion was okay but the teacher does not do collaborative activity anymore.
- While the discussion was not entirely TTPS, it was still okay since variability topic may be difficult to do especially for Grade 7 students.

**Day 5**

**Time Started: 2: 46**

The class do their usual routing, math trivia, and recall. At this point, the teacher asked them if they have answered their assignment yesterday.

- Teacher asked their assignments
- Teacher asked to exchange with their seatmates.
- Students are having conversations with their peers. Some are playing
- Teacher ask them to settle down.
- Teacher ask random students to complete the table just like yesterday.

**2:50:** Continuation of Previous Discussion

While the students are busy checking the papers, the teacher is constantly roaming around to check whether they are on the right track following the discussion yesterday.

Realization:
Checking the answers of their peers with the teacher roaming around giving feedback is also a way for them to make sure if their answers are correct. They are able to give feedback to their classmates and realize what is wrong or what is missing in their solutions. The teacher afterwards went in front.

*T: Before we proceed, how did we get the scores here?*
*S: Its for group B*
*T: How about these? How to solve for the mean?*
*S; Its sum of observations divided by the number of observations.*
*T: What is ( x – x-bar/mean)?*
*Y: you subtract the scores to the mean*
*T: After that? What is (x – x-bar/mean)$^2$ ?*
*Y: We square the answer from ( x – x-bar/mean*)

It can be observed that the questions raised by the teacher are just the formula or algebraic expressions on the table. This is just to know whether all students understand the meaning of it, so that they can finish answering the table successfully.

**2:55**

*T: How about the variance? How did you solve it? (The teacher randomly calls for students to solve the variance.*

*T: Where is your notebook Rachel?*

It can be observed that this student has no notes. She basically has no idea. Rather than making her go to the board, the teacher makes her sit and asked for another student. But this student has a mistake on his formula. So the teacher asked what is wrong in his formula. The teacher then turns to the class.

*T: Sakto ba class iyang formula? Naay mali? Aha dapit?*

The students then helped the classmate in front and says that its missing the symbol of summation, that is the sum.

**3:00**

The teacher then calls another student to finish what the other student started. So the student solved for the variance. Afterwards, he then again calls another student to solve for the standard deviation.

*T: how about for standard deviation?*

**3:02**

It can be observed that the teacher is somehow scolding them or reminding to do their assignments because he has observed that some did not do their assignment. He also questioned the student on his solution in finding standard dev.

$\sigma\sqrt{\sigma^2} = \sqrt{8.85}$ ------ $\boldsymbol{\sigma = 2.97}$

*T: What's missing in your formula Stell?*

The students is completely oblivious of his mistake in the solution so that class is helping them by giving feedback to make him realize. Again, the teacher reminds them to be cautious in their solution because they might get errors or worse mark their paper wrong.

*T: Return the paper to the owners.*

**3:07**

After getting the variance and standard deviation, the teacher presented the illustration. The illustration is a chart that visualizes how close the individual scores of group A and B to the average line which is the mean. This way we can explain further by observing the chart.

*T: So who performed better?*
*Y: B since it is close to one another*
*T: Who says B?*
*Z: A sir*

*T: Why do you say so?*
*Z: Because they have higher scores*
*S: B ko sir because they have lesser gaps. the standard deviation and variance are lower. So group B.*

*T: Okay. Look at the figure, unsa nang red line?*
*S: Passing scores*
*T: Is it passing scores?*
*S: Consistency?*
*T: Again, what is the red line?*
*F: Average? The average scores of their grades?*
*T: Unsa nga average? Try to understand the data? Unsa nang red line?*
*G: Median*
*T: Is it the median?*
*T: Again, whats the process of solving variance? What concept did we use?*
*G: Dividing the number of observations*
*D: Is it the stand.dev?*
*T: What is the stand dev?*
*D: 2.97*
*H: But its above, the red line is passing*
*M: sum of all scores*
*T: So what do you think is the red line?*
*F: Mean*
*T: Is it the mean or not?*
*Some students; It's the mean!*
*T: Why do you think it's the mean?*
*F: Because it the average*
*W: Diba part mana sa Central Tendency*
*T: Meaning mao na ang center point*
*T: Dra makita kung ga scatter ba ang scores. Kung ga scatter ba sila or wala.*
T: So who performed better
G: B sir kay close silage gaps sa mean.

**3:14 Another problem was presented.**
*T: How is the problem different from we have earlier?*
*S: Dili sila same ang total*
*T: yes, you have understand the problem. Why man?*
*S: Gahaponj kay 10 karun 5.*
*T: So unsa kahay difference saila formula?*
*B: Is it the formula?*

Teacher introduces another formula, that is form sample data. While the formula discussed yesterday is for the population data.

*T: since we are talking about sample? What's sample again?*
*G: Selected only*
*T: Do you choose all of them as sample?*
*All: No*
*H: so nganong naay n-1?*
*T: Nganu kaha?*
*I: Biggest data for the sample size sir?*
*T: yes*

**3:25** In your notebook answer this for 5 minutes. (Lesson Summarization)
While answering, the teacher announces that there will be CER quiz on Thursday.

**Time Ended 3:26**

Akong naobserve is since lisod man nga topic ang variability, giusab napud niya iyang approach for the last two days. Gatawag lang syag students in front to solve one part of the solution (table) and then manawag napud sya to continue. Ga explain pud sya especially sa mga formula kay medyo tricky jud dre nga part. Makalibat or prone to making errors. Although ni ingon man pud tung isa ka validator namo nga mo shift jud daw ug teacher centered somehow like mo discuss na jud ang teacher kau lisod ang topic, so nothing to worry.

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