# ENHANCING STUDENTS' PROBLEM-SOLVING SKILLS AND ENGAGEMENT IN MATHEMATICS LEARNING THROUGH CONTEXTUALIZED INSTRUCTION

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***ABSTRACT:*** *Contextualized teaching and learning, otherwise called "Contextualized Instruction" (CI), is a methodology that includes dynamic students in the learning process to investigate ideas acquired through the students' information and experience. This study was conducted to: determine the students' problem-solving skills and engagement towards mathematics; determine the level of students' problem-solving skills before and after exposure to Contextualized Instruction (CI); ascertain the level of students' engagement towards mathematics before and after exposure to contextualized instruction; identify the difference in the students' problem-solving skills before and after the exposure to CI; and compare the difference in the students' engagement before and after the exposure to CI. A mixed-method sequential explanatory research design was employed in the study. It was conducted at Loyola High School, Don Carlos, Bukidnon. Students in Grade 8 were the research participants of the study. Results showed that students' problem-solving skills during the pretest were very low, and during the posttest and retention tests they showed high problem-solving skills. Moreover, there was an improvement in students' problem-solving skills based on the mean scores on the posttest and retention tests. Students' mathematics engagement levels in cognitive, affective, and behavioral domains were high at levels before and after the treatment. Thus, there is a significant difference in the students' problem-solving skills before and after exposure to CI. Additionally, there is a significant difference in the students' engagement in mathematics before and after the exposure to CI.*

**Keywords:** *problem-solving skills, mathematics engagement, contextualized Instruction*

## 1. INTRODUCTION

Mathematics is both exciting and challenging. It is essential in our everyday life. To grasp the meaning of mathematics, it is just as vital to comprehend a problem as it is to solve it. It is widely held that problem-solving skills enable people to readily overcome obstacles in their daily lives. One who can solve problems is a self-assured, creative, and autonomous thinker.

Filipino students still have a lot to develop in their problem-solving skills. As a matter of fact, Trends in International Mathematics and Science Study reported that only 19% of Filipino students were on the low benchmark, which means that they had "some basic mathematical knowledge," while 81% did not even reach this level [1]. Researchers finding has shown that 40% of their respondents are below the satisfactory level in translating worded problems due to the following difficulties: carelessness, lack of comprehension, interchanging values, and unfamiliar words [2]. It demonstrates that students are only concerned with solving routine problems and prioritize following a step-by-step approach rather than meaningful learning.

The ability to solve problems is at the heart of human development. Individuals' problem-solving skills and the problem-solving process are essential components of their daily lives. The primary purpose of teaching mathematics is to enable students to solve problems in daily life [3]. Solving mathematical problems is a goal in mathematics education and is useful in everyday life.

While the usefulness of teaching students problem-solving skills in mathematics has largely been acknowledged [4, 5, 6, 7], questions regarding how students engage in mathematics learning remain unanswered. Several studies had been conducted on students' conceptual change or understanding [8, 9], teachers' skills [10-14] contemporary pedagogies [15-25] and other student factors predicting performance [26-29]. But still, it is a challenge for a mathematics teacher to make students highly engaged in learning mathematics. Thus, it requires an effective teaching strategy to make it possible. Can contextualized instruction help in developing students' engagement? This question remains unanswered. Every mathematics learning activity demands students to convey knowledge from the teacher, build the capacity they require and participate directly in gaining knowledge. Student engagement in learning will be supported in achieving learning objectives. Students will gain helpful information that will improve their learning outcomes and achievements. Student engagement in the learning process is measured by three (3) domains: cognitive engagement, affective engagement, and behavioral engagement.

Effective teaching means that worthwhile mathematical tasks are used to introduce critical mathematical ideas and intellectually engage and challenge students [30]. Thus, the researcher seeks to find an intervention that could remediate teachers' and students' teaching and learning problems in mathematics. She endeavored to employ strategies to improve the teaching process and improve students' problem-solving skills and engagement in mathematics, hence, this investigation.

This study would focus on the effectiveness of Contextualized Instruction (CI) because it emphasizes applying such skills and information in a context. Through contextualized instruction, students are actively engaged in learning while assisting them to make meaning out of the information they are obtaining [31]. Students gain this level of understanding by putting their knowledge into practice.

Thus, the purpose of this study was to examine and measure the effectiveness of contextualized instruction in improving the problem-solving skills and engagement of Grade 8 students in mathematics virtual learning.

## 2. MATERIALS AND METHODS

The study assessed the problem-solving skills and engagement in mathematics learning through CI at Loyola High School for SY 2021-2022. The study made use of a mixed-method sequential explanatory research design was employed in the study. For the quantitative collection of data, a one-shot pretest-posttest was used to determine the effect of CI on students' problem-solving skills and engagement in a mathematics class. A homogeneous class was exposed to the intervention. A pretest-posttest design was used to determine the significant difference in students' problem-solving skills and engagement when exposed to CI.

Before starting the experiment, the class was given a 34-item teacher-made pretest and the Engagement Scale Questionnaire to verify their background on the topics and check their level of engagement in the subject prior to the conduct of the strategy. After the pretest, the students were exposed to contextualized instruction and given a posttest after the intervention. Seven (7) days after the posttest was the conduct of the retention test. Then an analysis of the quantitative data was conducted.

After the analysis, participants for the qualitative data collection were identified based on their scores on the pretest and posttest in problem-solving and engagement level. The interview was conducted through a web interview via Google Meet. Qualitative results were used to further explain this study's quantitative findings, as put forward in the statement of the problem and objectives.

There were two (2) instruments used to gather the quantitative data, namely, the validated teacher-made test and student engagement questionnaire. A validated teacher-made test was used to measure the level of students' problem-solving skills with 34 items covering the topics in the first quarter of grade 7 mathematics: 30 items multiple choice; and 4 items problem-solving. Items were scored 1 for every correct response, and 0 if otherwise for the multiple-choice and 5 for every correct solution for the problem solving, and 0 if otherwise a total of 50 points. Another instrument used in the study was Mathematics Student-report Engagement Scales. It is a 26-item Likert scale with items answered on a five-point scale, from strongly agree to strongly disagree. The scale consists of three domains: cognitive engagement, behavioral engagement, and emotional engagement. The said scale underwent a reliability test. Cronbach's alpha coefficients for cognitive, behavioral, and affective engagement scales were 0.76, 0.82, and 0.80, respectively. A reverse scoring procedure was done for a negative statement. Additionally, the instrument used to gather the qualitative data was the 3-item interview questions.

The participants of this study were divided into two sets: the whole homogeneous class, composed of fifty-three (53) Grade 8 students from Loyola High School who were officially enrolled in School Year 2021–2022 during the first quarter, and six (6) students from the whole homogeneous class, interviewed based on their mean difference (MD) score in problem-solving and engagement; one (1) highest MD, one (1) zero MD or close to zero, and one (1) lowest MD or negative MD.

A designed lesson plan for utilizing contextualized instruction was followed and validated by a mathematics teacher and the school principal. This intervention used a real-life application in every lesson taught to the students.

Prior to instruction, the pretest and engagement scale questionnaires were administered to determine the initial level of the students' problem-solving skills and engagement in mathematics. After all the topics were covered, a posttest (same content as the pretest) was given to determine the students' level of problem-solving skills. The same engagement scale questionnaire was administered to determine the engagement level of the students. The retention test was then administered a week after the posttest was given. Then, an analysis of the quantitative data was conducted.

After all the tests and quantitative data analysis were done, selected students were interviewed via Google Meet to gather qualitative data.

The data collected were tabulated and analyzed using appropriate statistical tools using the software. Descriptive statistics like mean, standard deviation, frequency, and percentage were used to answer the questions on the descriptive levels. A paired-sample t-test was used to determine the significant difference in the students' problem-solving skills and engagement in mathematics. Content analysis was used to analyze whether the qualitative data makes sense and supports the quantitative data collected.

The following rating scale was used to better understand the data:

| Score | Range | Descriptive rating | Interpretation |
|---|---|---|---|
| 40 – 50 | 90%-100% | Outstanding | Very high problem-solving skills |
| 36 – 39 | 85%-89% | Very Satisfactory | High problem-solving skills |
| 30 – 35 | 80%-84% | Satisfactory | Moderate problem-solving skills |
| 25 – 29 | 75%-79% | Fairly Satisfactory | Low problem-solving skills |
| 0 – 24 | 74% and below | Did not meet expectations | Very low problem-solving skills |

| Rating | Scale | Descriptive Rating | Qualitative Interpretation |
|---|---|---|---|
| 5 | 4.51 – 5.0 | Strongly agree | Strongly High Engagement |
| 4 | 3.51 – 4.50 | Agree | High Engagement |
| 3 | 2.51 – 3.50 | Undecided | Slightly High Engagement |
| 2 | 1.51 – 2.50 | Disagree | Low Engagement |
| 1 | 1.00 – 1.51 | Strongly disagree | Very Low Engagement |

## 3. RESULTS AND DISCUSSIONS

This section presents the analysis and interpretation of data gathered from the respondents, which are relevant for testing the hypotheses of the study. Tables and other figures are also shown in this chapter to give a convenient analysis of the data. The order of presentation follows the sequence of the objectives identified in the study.

### 3.1 Students' problem-solving skills

Table 1 presents the level of problem-solving skills of students in their pretest, indicating the frequency and percentage of the scores and qualitative interpretation.

**Table 1. Level of Students' problem-solving skills in the pretest**

| Range | CONTEXTUALIZED INSTRUCTION | | Qualitative Description |
|---|---|---|---|
| | F = 53 | % | |
| 90% - 100% | 0 | 0% | Very High Problem-Solving Skills |
| 85% - 89% | 0 | 0% | High Problem Solving Skills |
| 80% - 84% | 2 | 4% | Moderate Problem Solving Skills |
| 75% - 79% | 0 | 0% | Low Problem Solving Skills |
| 74% and below | 51 | 96% | Very Low Problem-Solving Skills |
| Mean = 20.75 (Very Low Problem-Solving Skills) | | | |

As illustrated in table 1, 96% of the students had very low problem-solving skills in the pretest, and 4% had moderate problem-solving skills. The group had a mean score of 20.75, equivalent to a mean percentage score (MPS) of 39.16, which indicates that the scores of the students did not meet the expectations or had very low problem-solving skills. The researcher discovered that participants could not solve the questions well through a deep checking of the students' written works, which were the solutions to pretest questions. They could not give a complete solution to each question and could not answer all the pretest questions. Figure 1 shows the pretest solutions of some students.

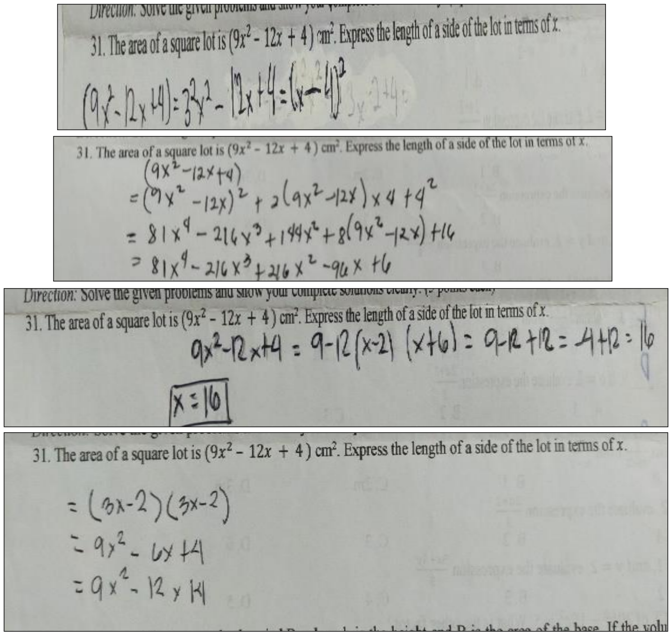



**Figure 1. Students' problem-solving written outputs (pretest)**

Students have a little background on some of the topics since they encountered algebraic expressions in 7th grade, but they could not solve them correctly. The interview responses of the participants elaborated on their written outputs as follows:

*"Uhmm.. Before pa sa klase, familiar lang ko sa algebraic expressions kay naagian nako sa grade 7 pero dili kaayo ko kablo mo solve kay dili ko kabalo mag analyze sa problem. Ug sa uban topics, dili ko familiar" (Before the start of the class, I am familiar with algebraic expressions since I encountered them in my 7$^{th}$ grade but I cannot solve them because I don't know how to analyze them. And I am not familiar with the other topics.)*

*-Participant 1*

*"Naa koy idea gamay sa mga topics. Kadumdum ko kay na discuss ni sa among grade 7" (I have few ideas about the topics. I have remembered it since it has been discussed in Grade 7.)*

*-Participant 2*

The students' prior knowledge was the basis for the results of their pretest. However, learning competencies were not met by the students. Students' performance level in the pretest was deficient as previously observed [32]. Moreover, these findings are expected due to the insufficient basic foundation of students. More so, they have no foundation for the concepts yet. Similarly, students' poor performance in mathematical problem-solving is due to the lack of mathematical skills needed to solve problems, and they do not know how to apply these skills to particular problem situations [33].

Table 2 presents the students' levels of problem-solving skills in their posttest, indicating the frequency, percentage of scores, and qualitative interpretation.

**Table 2. Students' Level of Problem Solving Skills in the posttest.**

| Range | CONTEXTUALIZED INSTRUCTION | | Qualitative Description |
|---|---|---|---|
| | F = 53 | % | |
| 90% - 100% | 35 | 66% | Very High Problem-Solving Skills |
| 85% - 89% | 11 | 20% | High Problem Solving Skills |
| 80% - 84% | 4 | 8% | Moderate Problem Solving Skills |
| 75% - 79% | 1 | 2% | Low Problem Solving Skills |
| 74% and below | 2 | 4% | Very Low Problem Solving Skills |
| Mean = 45.26 (High Problem Solving Skills) | | | |

The table shows that in the posttest, 66% of the students had very high problem-solving skills, 20% had high problem-solving skills, 8% had moderate problem-solving skills, 2% had low problem-solving skills, and 4% had very low problem-solving skills. The group obtained a mean score of 45.26, equivalent to an MPS of 85.40%, indicating a result of high problem-solving skills. The data implies that 96% of the students passed the posttest, which means that they scored above 75% on the problem-solving test. Moreover, the MPS conveys that students obtained high problem-solving scores after exposure to CI.

The students could still remember the topics discussed in the first quarter, specifically: factors of polynomials and rational algebraic expressions. The students indicate that they learned more from the lessons after exposure to CI, as follows:

*"Uhmm. I learned a lot from the topics discussed. I also like the way the teacher delivers the lesson because it is based on our experiences and real-life situations. Now, I finally understand rational algebraic expressions."*

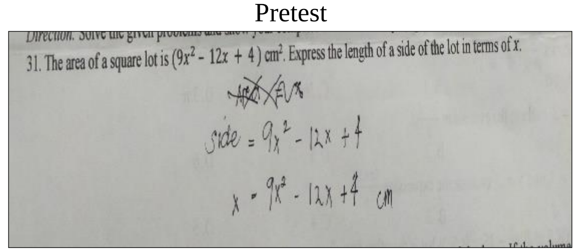
*-Participant 1*

*"Giganahan ko mag tuon ug math karun. Giganahan ko sa strategy gigamit sa teacher. Ni arang-arang akong skills sa pag solve" (I enjoyed learning math this time. I like the strategy that the teacher employed. My skills in solving had improved.)*

*-Participant 2*

Participants 1 and 2 claimed that they liked the teacher's discussion because it was based on their personal experiences and real-life situations. These interview responses also elaborate on the beauty of CI being utilized by the teacher in teaching the subjects. Although before the implementation, most of the students had very low problem-solving skills, as indicated in table 1, after the intervention, students had achieved passing scores, as shown in their posttest scores. This result shows a change in students' problem-solving skills. Figure 2 shows the pretest and posttest solutions of a student.

Pretest




Posttest

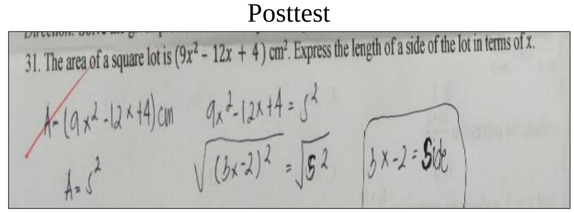



**Figure 2. Sample student's output in problem-solving (pretest vs. posttest)**

As reflected in Figure 2, the student was able to get a correct answer during the posttest as expected. Moreover, as claimed in the interview, this change is attributed to the CI used by the teacher. This is the main reason why students have absorbed the ideas or concepts that result in them having a better score than on their pretest.

However, two (2) students still have very low problem-solving skills. Based on the interview conducted, the students do not have a good foundation in mathematics and are not good at analyzing problems.

> *“Hmm. Ma’am, bugok gyud ko ug math ma’am. Bisan unsaon nako ug paminaw kadjut ra nako ma dumduman. Malimtan na dayun nako. Nindotan ko sa atong klase mam pero di ko ka answer inig mag test nata. Di sad ko kabalo mag analyze ug problem” (I am not good in math, ma’am. No matter how hard I tried to listen, I could still forget it. I like our class ma’am but I cannot answer in the assessment. Also, I don’t know how to analyze problem.)*
>
> *-Participant 6*

As explained by Participant 6, he is not good at mathematics. He tried his best to remember the concepts but could not possibly do it. Indeed, some factors could explain the low problem-solving skills of students. Yet, the most significant challenges students face in solving mathematical problems stem from a lack of understanding of the problem in terms of their ability to analyze the problem and identify the given and their ability to remember [34].

Nevertheless, the majority of the participants improved their scores in the posttest. Improvement is expected because they now know the concept. However, it is noteworthy to mention that one of the reasons students tend to remember their lessons and obtain high posttest scores is the use of CI, as elaborated by Participants 1 and 2. These findings are supported by researchers, who found that groups of students exposed to different teaching environments increased their content knowledge and had higher posttest scores after the treatment [19]. Additionally, students’ problem-solving skills improved after the treatment [35].

Table 3 presents the level of students’ problem-solving skills in their retention test, indicating the frequency, percentage of scores, and qualitative interpretation. Data shows that 68% of students had very high problem-solving skills, 19% had high problem-solving skills, 7% had moderate problem-solving skills, 2% had low problem-solving skills, and 4% had very low problem-solving skills. Retention test results showed high problem-solving skills of the students having a mean percentage score of 85.33.

**Table 3. Level of students' problem-solving skills in the retention test.**

| Range | CONTEXTUALIZED INSTRUCTION | | Qualitative Description |
|---|---|---|---|
| | F = 53 | % | |
| 90% - 100% | 36 | 68% | Very High Problem-Solving Skills |
| 85% - 89% | 10 | 19% | High Problem Solving Skills |
| 80% - 84% | 4 | 7% | Moderate Problem Solving Skills |
| 75% - 79% | 1 | 2% | Low Problem-Solving Skills |
| 74% and below | 2 | 4% | Very Low Problem-Solving Skills |
| Mean = 45.23 (High Problem-Solving Skills) | | | |

The result suggests that students, when exposed to CI, had a better capability of retaining or holding the essential concepts or ideas previously learned. Moreover, students’ problem-solving skills were sustained in the retention test with a slight difference of 0.07 in the mean posttest scores. As responded by the students during the interview, the increase can be explained by the strategy employed by the teacher, which they liked because they could relate to it.

The result conforms to the study [33] which observed that those students exposed to an exciting teaching strategy like the enhanced gradual release of responsibility instructional model (EGRRIM) improved their problem-solving skills in the posttest and retention test. A similar study revealed that students performed better in the posttest and retention tests [36]. It is also supported by research results that students exposed to different teaching environments showed increased content in knowledge and higher retention after the treatment [37].

<u>Students’ Engagement in Mathematics</u>

Every mathematics learning activity demands students to convey knowledge from the teacher and build the capacity they require and participate directly in gaining knowledge. Engagement in Mathematics is used to verify that CI can help maximize the learning towards the subject.

The research started by identifying the students’ level of problem-solving skills. This was done through Mathematics Student-report Engagement Scales [37]. The scale consists of three domains: cognitive engagement, affective engagement, and behavioral engagement. The results of the engagement of students in Mathematics before and after exposure to contextualized instruction are shown in tables 4 and 5.

<u>Students’ Engagement in Mathematics before the Intervention</u>

Table 4 shows the mean scores of the students’ engagement in mathematics before the intervention. Before the intervention, five items in the cognitive engagement have higher means which are the following: "I try to connect what I am learning to things I have learned before" (4.21), "I try to understand my mistakes when get something wrong" (4.21), "I go through the work for math class and make sure that it's right" (4.15), "I think about different ways to solve a problem" (4.13), and "I would rather be told the answer than have to do the work*" (3.60), which are all qualitatively described as high engagement. On the other hand, three negatively-stated items in the cognitive engagement category fall into the slightly high engagement level. The overall mean in cognitive engagement is 3.75, indicating that students had high engagement before the intervention.

Based on the results, students displayed an eagerness to learn mathematics. They are willing to solve mathematical problems in different ways and connect their learning with what has been learned. Despite their perception that mathematics is a complicated subject, they are actively engaged in mathematics.

Table 4 also reveals that students had a high engagement in the affective domain. Only one item falls into a slightly high engagement, which is "I often feel frustrated in math class.*" The overall mean for affective engagement is 3.94, indicating that students had a high engagement. Hence, the students displayed comfort during mathematics class. They enjoyed learning and solving mathematics.

**Table 4. Students' engagement in Mathematics before intervention**

| Indicators | Mean | Qualitative Description |
|---|---|---|
| COGNITIVE ENGAGEMENT | | |
| I try to connect what I am learning to things I have learned before. | 4.21 | Agree |
| I try to understand my mistakes when getting something wrong. | 4.21 | Agree |
| I go through the work for math class and make sure that it's right. | 4.15 | Agree |
| I think about different ways to solve a problem. | 4.13 | Agree |
| I would rather be told the answer than have to do the work.* | 3.60 | Agree |
| When work is hard I only study the easy parts.* | 3.42 | Undecided |
| Do just enough to get by.* | 3.40 | Undecided |
| I don't think that hard when I am doing work for class.* | 2.91 | Undecided |
| *Pooled Mean* | *3.75* | *Agree* |
| AFFECTIVE ENGAGEMENT | | |
| I don't care about learning math.* | 4.38 | Agree |
| I want to understand what is learned in math class. | 4.34 | Agree |
| I enjoy learning new things about math. | 4.11 | Agree |
| I look forward to math class. | 4.09 | Agree |
| I don't want to be in math class.* | 4.00 | Agree |
| I get worried when I learn new things about math.* | 4.00 | Agree |
| I think that math class is boring.* | 3.83 | Agree |
| I often feel down when I am in math class.* | 3.81 | Agree |
| I feel good when I am in math class. | 3.74 | Agree |
| I often feel frustrated in math class.* | 3.08 | Undecided |
| *Pooled Mean* | *3.94* | *Agree* |
| BEHAVIORAL ENGAGEMENT | | |
| If I don't understand, I give up right away.* | 4.43 | Agree |
| I keep trying even if something is hard. | 4.42 | Agree |
| I stay focused. | 4.23 | Agree |
| I put effort into learning math. | 4.23 | Agree |
| I complete my homework on time. | 4.11 | Agree |
| I do other things when I am supposed to be paying attention.* | 4.02 | Agree |
| Don't participate in class.* | 4.19 | Agree |
| I talk about math outside of class. | 3.87 | Agree |
| *Pooled Mean* | *4.19* | *Agree* |
| Overall Mean | 3.96 | Agree |

* negative indicators (scoring is reversed)

Legend:

| Scale | Range | Descriptive Rating | Qualitative Interpretation |
|---|---|---|---|
| 5 | 4.51-5.00 | Strong agree | Strongly high engagement |
| 4 | 3.51-4.50 | Agree | High engagement |
| 3 | 2.51-3.50 | Undecided | Slightly high engagement |
| 2 | 1.51-2.50 | Disagree | Low engagement |
| 1 | 1.00-1.50 | Strongly disagree | Very low engagement |

Moreover, in behavioral engagement, all items fall into the high-level engagement. The overall mean for behavioral engagement is 4.19. Thus, it shows that students had high engagement before the intervention. Students do not give up right away, even if they do not understand the topic (4.43). They keep on trying, even if something is hard (4.42). They stay focused and put the effort into learning mathematics (4.23). They complete their homework on time (4.11) and pay attention (4.02) during mathematics class, although they talk less about mathematics outside the class (3.87). The results reveal that students are engaged in learning mathematics in the behavioral sense. It is also evident that students put effort into learning mathematics, despite its complexity.

Finally, the overall mean of engagement based on the three (3) domains is 3.96, indicating that students had a high engagement in mathematics. This implies further that students' engagement in the cognitive, affective, and behavioral domains was high even prior to the intervention. Students were highly engaged and enjoyed learning and solving mathematics.

The result of this study is supported by a similar study conducted by researchers [38] when they found that students had high engagement levels even before the intervention. However, it contradicts the findings on students having low engagement levels before the intervention [39].

Students' Engagement in Mathematics after the Intervention.

Table 5 presents the mean scores of the students' engagement in Mathematics before the intervention. As shown, among the 26 indicators: the students rated "strongly agree" on the ten (10) items, "agree" on the fourteen (14) items, and "undecided" on the two (2) items.

After the intervention, four items with higher means in the cognitive domain are the following: "I go through the work for math class and make sure that it's right" (4.64), "I try to understand my mistakes when getting something wrong" (4.58). "I think about different ways to solve a problem" (4.57), and "I try to connect what I am learning to things I have learned before" (4.51).

**Table5 4. Students' engagement in Mathematics after intervention**

| Indicators | Mean | Qualitative Description |
|---|---|---|
| COGNITIVE ENGAGEMENT | | |
| I go through the work for math class and make sure that it's right. | 4.64 | Strongly Agree |
| I try to understand my mistakes when get something wrong. | 4.58 | Strongly Agree |
| I think about different ways to solve a problem. | 4.57 | Strongly Agree |
| I try to connect what I am learning to things I have learned before. | 4.51 | Strongly Agree |
| I would rather be told the answer than have to do the work.* | 3.79 | Agree |
| When work is hard I only study the easy parts.* | 3.68 | Agree |
| Do just enough to get by.* | 3.55 | Agree |
| I don't think that hard when I am doing work for class.* | 3.36 | Undecided |
| *Pooled Mean* | *4.08* | *Agree* |
| AFFECTIVE ENGAGEMENT | | |
| I don't care about learning math.* | 4.53 | Strongly Agree |
| I don't want to be in math class.* | 4.42 | Agree |
| I look forward to math class. | 4.34 | Agree |
| I want to understand what is learned in math class. | 4.30 | Agree |
| I enjoy learning new things about math. | 4.23 | Agree |
| I get worried when I learn new things about math.* | 4.13 | Agree |
| I think that math class is boring.* | 4.02 | Agree |
| I feel good when I am in math class. | 3.98 | Agree |
| I often feel down when I am in math class.* | 3.96 | Agree |
| I often feel frustrated in math class.* | 3.40 | Undecided |
| *Pooled Mean* | *4.13* | *Agree* |
| BEHAVIORAL ENGAGEMENT | | |
| I talk about math outside of class. | 4.72 | Strongly Agree |
| If I don't understand, I give up right away.* | 4.57 | Strongly Agree |

| | | |
|---|---|---|
| I stay focused. | 4.53 | Strongly Agree |
| I put effort into learning math. | 4.53 | Strongly Agree |
| I keep trying even if something is hard. | 4.51 | Strongly Agree |
| I do other things when I am supposed to be paying attention.* | 4.32 | Agree |
| Don't participate in class.* | 4.28 | Agree |
| I complete my homework on time. | 4.08 | Agree |
| *Pooled Mean* | *4.44* | *Agree* |
| Overall Mean | 4.21 | Agree |

* negative indicators (scoring is reversed)

Legend:

| Scale | Range | Descriptive Rating | Qualitative Interpretation |
|---|---|---|---|
| 5 | 4.51-5.00 | Strong agree | Strongly high engagement |
| 4 | 3.51-4.50 | Agree | High engagement |
| 3 | 2.51-3.50 | Undecided | Slightly high engagement |
| 2 | 1.51-2.50 | Disagree | Low engagement |
| 1 | 1.00-1.50 | Strongly disagree | Very low engagement |

Students find the CI engaging because they can relate it to real-life situations. They realized that they enjoyed learning Mathematics with this strategy used by the teacher. It is reinforced by the student's responses in the interview as follows:

> *"Chada kaayu atong klase ma'am. Nalingaw ko at the same time naka learn kog daghan. Chada gyud mag tuon nga i-relate sa kinabuhi kay mas dali masabtan. Dali nako ma analyze ang problem if ma relate nako sa kinabuhi" (Our class is very nice, ma'am. I enjoyed it at the same time I learned a lot. It is nice to study if it is related to real life situations because it is easy to understand. I can easily analyze the problem if I can relate it in life.)*
>
> *-Participant 4*
>
> *"Kuan, di man sa ingon nga bright kog math, pero maka ingon ko nga naka tuon gyud ko ma'am ug maka enjoy ang klase kay dili boring. Siguro tungod sa strategy ma'am. Ganahan na kayo ko mag solve ma'am bisan gaka challenge ko pero nalingaw nako mag solve solve ug problems" (I could not say I am intelligent in math but I could say that I have really learned and I enjoyed it because it's not boring. Maybe because of the strategy. I love to solve even if I am challenged but I enjoyed solving problems.)*
>
> *-Participant 5*

Based on the results, students had a higher level of engagement than before the intervention. The overall mean in cognitive engagement is 4.08, indicating that they go deeper to solve the problem. The students challenged themselves to develop the right solution to every problem.

Table 5 also displays that in an affective domain, students have a high level of engagement after their exposure to CI. The overall mean score for affective engagement is 4.13, indicating a high engagement level. This is the same as their level of engagement before the intervention, but the increase in mean score is evident. The only item that is rated "undecided" is "I often feel frustrated in math class" (3.40). It indicates that students are confused if they are frustrated in math class.

Additionally, in the behavioral domain, students showed high engagement in mathematics. The overall mean in behavioral engagement is 4.44, indicating a high engagement level. This implies that students do not give up right away; even if they do not understand the topic, they keep trying. Even if something is hard, they stay focused and put effort into learning mathematics and other subjects.

Finally, the overall mean of the three domains is 4.21, indicating a high engagement level after the intervention. Behavioral engagement has a higher mean than cognitive and affective domains. Students were more likely to be engaged in the behavioral sense.

This confirms that mean scores of the students on engagement increased after the intervention [38] and students had positive engagement after the intervention [36].

The paired t-test between the Pretest and Posttest Scores of Students Problem-Solving Skills

The result of the paired t-test between the pretest and posttest scores of students in problem-solving skills, when exposed to contextualized instruction, is shown in Table 6.

**Table 6. Comparison of students' problem-solving skills between pretest and posttest**

| Group | | N | Mean | SD | t-value | Sig. |
|---|---|---|---|---|---|---|
| Problem Solving Skills | Pretest | 53 | 20.75 | 9.403 | 18.742 | 0.000** |
| | Posttest | 53 | 45.26 | 3.181 | | |

**p-value highly significant at 0.05 level

Table 6 reveals that the t-value is 18.742 with the probability value of 0.000 ($p<0.05$), indicating a highly significant difference. Thus, the null hypothesis, which states that "there is no significant difference in the students' problem-solving skills when exposed to CI," is rejected. This means that the students have improved their problem-solving skills in the posttest compared to the pretest after exposure to CI. This also implies that CI has improved the problem-solving skills of students.

As reflected in the table, the pretest scores have a higher SD (9.403), indicating a higher deviation of scores, while in the posttest, it lowers down to 3.181. This indicates that scores of the students are now closer to the mean and are less spread than the pretest scores. This is supported by the interview answer, demonstrating that the students were able to have a deeper understanding of polynomials and rational algebraic expressions, which contributed to students' high posttest scores.

> *"Nakasabot rajud ko sa algebraic expressions ma'am. Maglisud ko ug sabot sa una, pero karun murag nahayagan na akong huna huna ani nga topic. Naka tuon pud ko sa polynomials ma'am bisan karun pako ka encounter ana" (I finally understood algebraic expressions, ma'am. I have difficulty understanding before but now it seems clear about this topic. I also learned polynomials even if I just encountered it.)*
>
> *-Participant 5*

It is supported that a significant difference exists in the students' problem-solving skills when exposed to treatment in the posttest [40]. Similar findings [33] was observed that a significant difference existed in the students' problem-solving skills between the pretest and posttest. This finding confirms the potential of CI to enhance the problem-solving skills of students.

**The paired t-test between the Pretest and Retention Test Scores of Students Problem-Solving Skills**

Table 7 displays the result of the paired t-test of the pretest and retention test scores of students' problem-solving skills when exposed to contextualized instruction.

**Table 7. Comparison of students' problem-solving skills between pretest and retention test**

| Group | | N | Mean | SD | t-value | Sig. |
|---|---|---|---|---|---|---|
| Problem Solving Skills | Pretest | 53 | 20.75 | 9.403 | 18.862 | 0.000** |
| | Retention | 53 | 45.23 | 3.055 | | |

**p-value highly significant at 0.05 level

As shown in the table, the t-value is 18.862 with a probability value of 0.000 ($p<0.05$), indicating a highly significant difference. Thus, the null hypothesis, which states that "there is no significant difference in the students' problem-solving skills when exposed to contextualized instruction," is rejected. This means that the students enhanced their problem-solving skills in the retention test when compared to the pretest. Students' understanding of mathematics problems was evident as they enhanced their understanding after the intervention.

The above findings are supported by related studies on getting significant differences in the problem-solving skills of the students exposed to treatment in terms of retention tests as well as the retention scores [33]. This can be attributed to the strategy in which students developed their problem-solving skills.

**The paired t-test between the Pretest and Posttest Scores of Students' Engagement in Mathematics**

Table 8 presents the comparison of the pretest and posttest scores of students' engagement in mathematics when exposed to contextualized instruction. The mean score before the intervention is 3.96 and the mean score after the intervention is 4.21. The t-value is 4.66 with a probability value of 0.000 ($p<0.05$) indicating a significant difference between the pretest and posttest scores on students' engagement in mathematics when exposed to CI. Hence, the null hypothesis stating "there is no significant difference between the pretest and posttest on students' engagement in mathematics when exposed to CI" is rejected.

**Table 8. Comparison of students' mathematics engagement before and after intervention**

| Group | | N | Mean | SD | t-value | Sig. |
|---|---|---|---|---|---|---|
| Mathematics engagement | Pretest | 53 | 3.96 | 0.3076 | 4.66 | 0.000** |
| | Posttest | 53 | 4.21 | 0.4586 | | |

**p-value highly significant at 0.05 level

Increased students' engagement in learning mathematics is caused by CI as supported by a similar study [40] that tested CI can improve students' academic performance and self-efficacy beliefs. The responses of the students confirm this result during the interview as follows:

*"Kanang kuan ma'am, ganahan na kaayo ko mag klase ta ma'am. Sauna mahadlok ko mag sulod sa math nga klase kay boringan ko sa math. Pero pag klase na nato, nawala akong kahadlok ug dili nako boringan" (I like our class ma'am. I am afraid to join math class before because it was boring. But now, my fears are gone and I am no longer bored in the class.)*

*-Participant 3*

*….pero maka ingon ko nga naka tuon gyud ko ma'am ug maka enjoy ang klase kay dili boring. Siguro tungod sa strategy ma'am. Ganahan na kayo ko mag solve ma'am bisan gaka challenge ko pero nalingaw nako mag solve solve ug problems" (... but I could say that I have really learned and I enjoyed the class because it's not boring. Maybe because of the strategy. I love to solve even if I am challenged but I enjoyed solving problems.)*

*-Participant 5*

The use of CI in the teaching of polynomials and rational algebraic expressions has shown a potential effect on student engagement. Students enjoyed the class, even though it was challenging, and they did not find the mathematics class boring anymore. More so, Participant 3 claimed that he/she did not fear the subject any longer.

A significant difference in students' engagement in Mathematics when exposed to engaging teaching pedagogy was also found by a related study [41]. However, the result of this study indicating sustained high engagement of students in pretest and posttest contradicts researchers' findings that students before the intervention had low engagement levels and only became highly engaged after the intervention [39].

## 4. CONCLUSIONS AND RECOMMENDATIONS

Based on the results, the following conclusions are drawn:

The level of students' problem-solving skills during the pretest is very low and high in both the posttest and retention tests. The group has improved based on the mean scores in the pretest, posttest, and retention tests.

Students have a high engagement level in cognitive, affective, and behavioral domains before and after exposure to contextualized instruction (CI). However, the mean scores increased in all domains after the intervention.

There is a significant difference in students' problem-solving skills after the intervention. The students' problem-solving skills are statistically significant in the posttest and retention tests. CI helps students build and improve their skills as they become invigorated and fearless enough to respond to every given problem.

There is a significant difference in all domains of students' engagement in Mathematics when exposed to CI. Students are cognitively, affectively, and behaviorally engaged in mathematics learning.

Based on the findings and conclusions of the study, the following recommendations are given:

Parents and teachers are encouraged to provide students with the opportunities and experiences to develop their problem-solving skills, even if it is not a mathematics class. They may allow their children or students to solve real-life problems at any point in their life.

Mathematics teachers may venture into potential teaching pedagogies that capture students' interest in being engaged in learning Mathematics.

Mathematics educators and curriculum makers might consider using CI as it aids in students' learning by positively affecting students' understanding of problem-solving. It helps them visualize and solve problems. It can assist students to apply these ideas to an assortment of challenging word problems. Furthermore, it helps make the learning of mathematics more significant and simpler.

To keep students highly engaged, it is recommended for mathematics educators to use contextualized instruction in teaching mathematics as the strategy provides engaging and purposeful experiences throughout the learning process. It is also suggested that parents guide and help the students engage in Mathematics learning and monitor their learning to promote higher engagement.

Mathematics educators, school administrators, and curriculum makers might consider the students' problem-solving skills in the class. The use of contextualized instruction in delivering lessons is beneficial for improving the students' problem-solving skills. The utilization of contextualized instruction could help the students conquer their abhorrence towards mathematics.

Finally, future researchers may find other teaching strategies to improve students' problem-solving skills and engagement. The implementation of this study is highly significant, and the use of this method is highly encouraged.

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## 6. REFERENCES:

[1] Trends in International Mathematics and Science Study TIMSS (2019) https://timssandpirls.bc.edu/timss2019/

[2] Santos, M. L. K. P., Diaz, R. V., & Belecina, R. R. (2015). Mathematical modeling: effects on problem-solving performance and math anxiety of students. International Letters of Social and Humanistic Sciences, 65, 103-115. https://doi.org/10.18052/www.scipress.com/ILSHS.65.103

[3] Phonapichat, P., Wongwanich, S. & Sujiva, S. (2014). An Analysis of Elementary School Students' Difficulties in Mathematical Problem Solving. *Procedia - Social and Behavioral Sciences, 116*(2014), 3169–317. https://doi.org/10.1016/j.sbspro.2014.01.728

[4] Alvi, E. & Nausheen, M. (2014). Examining Grade 9 Students' Engagement in Mathematical Problem-Solving (MPS) When Working as Individuals and in a Small Group Settings. *Bulletin of Education and Research*. https://files.eric.ed.gov/fulltext/EJ1217919.pdf

[5] Duque, C. & Tan, D. (2018). Students' Mathematics Attitudes and Metacognitive Processes in Mathematical Problem Solving. *European Journal of Education Studies*, 4(11), 1-25.

[6] Tan, D.A. (2018). Mathematical Problem-Solving Heuristics and Solution Strategies of Senior High School Students, *International Journal of English and Education*, 7(3), July 2018, 1-17.

[7] Tan, D.A. & Limjap, A.C. (2018). "Filipino students' use of metacognitive skills in mathematical problem solving: An emergent model", *International Journal of Development Research*, 8, (05), 20430-20439.

[8] Gayeta, N.E. & Caballes, D. G. (2017). Measuring conceptual change on stoichiometry using mental models and ill-structured problems in a flipped classroom environment. *Asia Pacific Journal of Multidisciplinary Research*, *5*(2), 104-113.

[9] Andamon J. & Tan, D.A. (2018). Conceptual Understanding, Attitude and Performance in Mathematics of Grade 7 Students, *International Journal of Scientific & Technology Research*, 7(8), August 2018, 96-105.

[10] Caballes, D. G., & Tiria, R. A. (2020). The digital skills of secondary school teachers in Manila. *CiiT International Journal of Software Engineering and Technology, 12*(3), 33-37.

[11] Caballes, D. G., & Doblada, J. C. L. (2021). Relationship of teachers' technology skills and selected profile: basis for redesigning training for online distance learning modality. *Instabright International Journal of Multidisciplinary Research, 3*(1), 17-22.

[12] Caballes, D. G., & Dapitan, D. A. (2019). Determining the level of ICT skills of junior high school faculty of Tagumpay National High School. *CiiT International Journal of Wireless Communication, 11*(5), 80-85.

[13] Caballes, D. G., Panol, R. F., Vasquez, A. G., & Valdez, M. R. (2021). Competency level of science teachers in teaching evolution: basis for training design. *Global Journal of Advanced Research, 8*(8), 235-243.

[14] Caballes, D. G., & Narca, M. L. (2020). Philosophical bases of pedagogy in teaching knowledge, skills, attitudes of Sebastinian graduates. *CiiT International Journal of Digital Image and Processing, 12*(3), 49-52.

[15] Caballes, D. G., & Belen, J. L. (2020). The beginning teachers' challenges in an inquiry-based approach to teaching science: provision for a special science research elective course. *CiiT International Journal of Software Engineering and Technology, 12*(3), 38-44.

[16] Caballes, D. G., & Capinig, R. A. V. (2020). DepEd commons: sustaining students' learning in physical science. *CiiT International Journal of Data Mining and Knowledge Engineering*, *12*(3), 55-60.

[17] Galarosa, K.J.D., & Tan, D.A. (2021). Students' academic performance and motivation in Physics using Microlearning via Cybergogy. Unpublished Thesis. Central Mindanao University.

[18] Hinampas, R.T., Murillo, C.R., Tan, D.A., & Layosa, R.U., (2018). Blended Learning Approach: Effect on Students' Academic Achievement and Practical Skills in Science Laboratories. *International Journal of Scientific and Technology Researches*, 7(11), 63-69, November 2018.

[19] Ciubal-Fulgencio, N., & Tan, D. (2018). Effects of mathematics communication strategies on attitude and performance of grade 8 students, *Asian Academic Research Journal of Multi-disciplinary*, Volume 5, Issue 2, February 2018.

[20] Aguanta, E. & Tan, D.A. (2018). Effects of Dyad Cooperative Learning Strategy on Mathematics Performance and Attitude of Students Towards Mathematics, *International Journal of English and Education*, 7(3), 303-313.

[21] Coronel, C. & Tan, D.A. (2019). Twenty-First (21st) Century Skills and Student Mathematics Performance in Self-Blend Approach, *International Journal of English and Education*, 8(2), 342-357, April 2019.

[22] Saligumba, I.P., & Tan, D. (2018). Gradual Release of Responsibility Instructional Model: Its Effects on Students' Mathematics Performance and Self-Efficacy. *International Journal of Scientific & Technology Research.* Volume 7, Issue 8. 276-291.

[23] Salingay, N., & Tan, D. (2018). Concrete-Pictorial-Abstract Approach on Students' Attitude And Performance In Mathematics, *International Journal of Scientific & Technology Research*, Volume 7, Issue 5, May 2018.

[24] Segumpan, L., & Tan, D. (2018). Mathematics performance and anxiety of junior high school students in a flipped

classroom, *European Journal of Education Studies*, Volume 4, Issue 12.

[25] Tan-Ucang, J. & Tan, D.A. (2013). Students' Beliefs and Mathematics Performance in a Process-Oriented Guided-Inquiry Learning (POGIL) Environment. *CMU Journal of Science.* 17 (2013), 141-157.

[26] Balasico, C.L., & Tan, D.A., (2020). Predictors of Performance of Central Mindanao University Laboratory High School Students, *PEOPLE: International Journal of Social Sciences*, 6(2), 1-21.

[27] Cordova, C., & Tan, DA. (2018). Mathematics Proficiency, Attitude and Performance of Grade 9 Students in Private High School in Bukidnon, Philippines‖. *Asian Academic Research Journal of Social Sciences and Humanities*, vol. 5, issue 2, pp. 103-116, February 2018.

[28] Cordova, C., Pagtulon-an, EA., & Tan, DA. (2018). No Assignment Policy: A Boon or A Bane?‖. *International Journal of English and Education*, 8(1), 144-160, January 2019.

[29] Cordova C., Tan D. and Ucang J. (2018). Take-Home Assignment and Performance of Grade 11 Students. *International Journal of Scientific and Technology Researches*, 7(12), 57-61, December 2018.

[30] NCTM. (2000). *Principles and Standards for School Mathematics*. Reston, VA: National Council of Teachers of Mathematics (NCTM). https://www.nctm.org/standards/

[31] Caballes, D. G., & Belen, J. L. (2020). Contextualization of activities in selected topics in molecular biology. *CiiT International Journal of Biometrics and Bioinformatics, 12*(1), 6-10.

[32] Osman et. al (2018). Enhancing Students' Mathematical Problem-Solving Skills through Bar Model Visualisation Technique. *International Electronic Journal of Mathematics Education*, https://doi.org/10.12973/iejme/3919

[33] Asparin, A. A. & Tan, D. A. (2018). Students' Problem-Solving Skills in Enhanced Gradual Release of Responsibility Instruction Model. Asian *Academic Research Journal of Multidisciplinary, 5*(3), 121-128.

[34] Al-Khateeb, M.A. (2018). The Effect of Teaching Mathematical Problems Solving Through Using Mobile Learning on the Seventh Grade Students' Ability to Solve them in Jordan. *International Journal of Interactive Mobile Technologies*, https://doi.org/10.3991/ijim.v12i3.8713

[35] Santhalia, PW. et al (2020). Building students' problem-solving skill in the concept of temperature and expansion through phenomenon-based experiential learning. *Journal of Physics,* 1422 (2020), 012021 https://doi.org/10.1088/1742-6596/1422/1/012021

[36] Antipuesto, J.L., & Tan, D.A. (2020). Enhancing Student Performance and Engagement in Mathematics Via Peeragogy, Science International (Lahore), 32(2), 159-164.

[37] Wang, M., Fredricks, J., Ye, F., Hofkens, T., and Linn, J.C. (2016). The Math and Science Engagement Scales: Scale development, validation, and psychometric properties. Learning and Instruction. https://doi.org/10.1016/j.learninstruc.2016.01.008

[38] Murillo, J. A. & Tan, D. A. (2019). Students' Mathematics Performance and Engagement in an Inquiry-Based Learning Approach. *International Journal of English and Education, 8*(3), 64-74.

[39] Cevikbas, M. & Kaiser, G. (2021) Student Engagement in a Flipped Secondary Mathematics Classroom. *International Journal of Science and Math Educ*. https://doi.org/10.1007/s10763-021-10213-x

[40] Cainoy, J. & Tan, D. (2020). Students' Academic Performance and Self-Efficacy Beliefs in a Contextualized Instruction. *Science International 32*(06) https://www.researchgate.net/publication/347827039

[41] Gumban, RJ. B. & Tan, D.A. (2019). Students' Mathematics Performance, Engagement and Information and Communication Technology Competencies in a Flipped Classroom Environment, , International Journal of English and Education, 8(3), 186-200.