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MATHEMATICS SELF-EFFICACY AND ENGAGEMENT ON CRITICAL THINKING DISPOSITION (CTD) OF PRE-SERVICE TEACHERS

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ABSTRACT

This study has been conducted to ascertain the level of students' mathematics self-efficacy, engagement in mathematics (emotional, social, and cognitive), and critical thinking disposition or CTD (reflection, attentiveness, open-mindedness, organization, perseverance, and intrinsic goal motivation); and correlate students' CTD with mathematics self-efficacy and engagement. The study employed a descriptive-correlational design to randomly 144 pre-service mathematics teachers from two higher education institutions in Bukidnon, Philippines, using the adopted questionnaires. Results showed that students exhibited a high level of mathematics self-efficacy, emotional and cognitive engagement, and a fair level of social engagement. Further, the respondents displayed a high level of inclination towards reflection and perseverance, a moderate level of organization and intrinsic goal motivation, and a neutral level of open-mindedness, whereas a slightly lower level of attentiveness was reported. As a whole, the results showed a moderate level of CTD among students. Correlational analysis revealed that mathematics self-efficacy and emotional engagement had a very weak positive and non-significant relationship with CTD, whereas social and cognitive engagement were positively and significantly correlated with it. These findings suggest that students who are more socially and cognitively engaged in mathematics tend to exhibit stronger CTD. Hence, teachers are encouraged to provide differentiated learning activities that foster active social engagement and deep intellectual processing, as it is directly related to students' CTD.

Keyword: Reflection, Perseverance, Motivation, Open-Mindedness, Differentiated Learning Activity

1. INTRODUCTION

Mathematics education plays a vital role in developing the critical thinking abilities of students. Both the K to 12 and the revised MATATAG curriculum in the Philippines highlight critical thinking as one of the key competencies in mathematics. Along with this is the need for effective mathematics instruction that fosters critical thinking. The pre-service teachers are central to this educational challenge, whose preparation for professional success is crucial as they hold an important role in enhancing mathematical competence in mathematics education in the future.

Teaching students how to think critically is increasingly recognized as essential in the 21st-century education (Dekker, 2020) and an important indicator of quality of student learning (Alsaleh, 2020). Low critical thinking among Filipino students is one of the reasons why the Philippines continues to perform poorly in mathematics. Studies and assessments such as the National Achievement Test (NAT) and the Program of International Student Assessment or PISA (2022) have consistently shown that Filipino students perform below the global average in areas requiring critical thinking and reasoning abilities. These findings suggest a need to revisit the underlying factors that contribute to fostering critical thinking to achieve educational and professional goals.

According to Nurjanah (2022), as cited by Salviejo (2024), critical thinking is a prerequisite in learning. However, critical thinking does not only involve reasoning skills but also dispositions. Critical thinking has two main components: critical thinking skill and critical thinking

disposition (Quinn, 2022). While critical thinking skill refers to the capacity to think critically, critical thinking disposition indicates the desire and readiness of an individual to think critically. While many studies have been conducted focusing on critical thinking skills, critical thinking disposition is of little (Lopez, 2023). Hence, this study focuses only on the critical thinking disposition of students.

Critical thinking disposition is necessary as it determines whether individuals actually apply their critical thinking skills in real-world situations. While a person may possess the cognitive ability, without the internal motivation or disposition to use those skills, critical thinking is unlikely to occur (Bensley, 2023). In other words, critical thinking disposition has a significant effect on critical thinking skills. In the educational context, enhancing pre-service teachers' critical thinking disposition would allow them to approach the subject with a deeper understanding and commitment to continuous improvement to enhance students' overall mathematics achievement and learning experiences in the future (Salviejo, 2024). On the other hand, a lack of necessary competence will make it hard for them to face challenges in the 21st century.

Research suggests that psychological, motivational, and behavioral factors (Raza et al., 2020), such as self-efficacy and engagement, play an important role to improve students' achievements. And hence, these factors might also have a significant relationship on students' disposition towards critical thinking.

Mathematics self-efficacy is a student's self-evaluation of their belief in their capacity to complete mathematical tasks successfully (Zakariya, 2022). The high level of one's self-efficacy perceptions leads to positive changes in many educational outcomes (Cansoy & Türkoglu, 2017). Self-efficacy has been recognized to have effects on a person's decision-making and thought patterns (Rohaeti et al., 2019), which is significant in developing critical thinking. According to Tus (2021), someone who has high self-efficacy in their abilities is likely to be more successful than those who has low self-efficacy.

Moreover, students' engagement focuses on participation and involvement in learning activities in mathematics. Openness to engage in learning activities offers a promising result to students' overall inclination towards mathematics achievement. In the study of Alvarez-Huerta et al. (2022), it was revealed that students who are engaged in their learning activities will have a positive disposition towards critical thinking and will most likely become successful in their mathematics classes. This signifies the need to provide pre-service teachers with the ground to reflectively engage and participate in their learning process.

Although the concepts of mathematics self-efficacy and engagement have been studied and explored vastly in the academe, there have been only a few studies that reveal their interrelationships and mutual functioning mechanisms with critical thinking disposition, particularly in the context of pre-service mathematics teachers who are responsible for fostering critical thinking in mathematics education in the future.

Thus, this study investigated the influence of mathematics self-efficacy and engagement on the critical thinking disposition of BSE Mathematics students of Central Mindanao University and Don Carlos Polytechnic College for SY 2025-2026.

2. STATEMENT OF THE PROBLEM

The study aimed to investigate the influence of mathematics self-efficacy and engagement on critical thinking disposition among BSE Mathematics students of Central Mindanao University and Don Carlos Polytechnic College for SY 2025-2026.

Specifically, it sought to answer the following questions:

1. What is the level of students' mathematics self-efficacy?
2. What is the level of students' engagement in mathematics in terms of:
   a. Emotional engagement;
   b. Social engagement; and
   c. Cognitive Engagement?
3. What is the level of students' critical thinking disposition in terms of:
   a. Reflection;
   b. Attentiveness;
   c. Open-mindedness;
   d. Organization;
   e. Perseverance; and
   f. Intrinsic goal motivation?

4. Is there a significant relationship between students' critical thinking disposition and:
   a. Self-efficacy; and
   b. Engagement?

3. METHODOLOGY

3.1 Research Design

This study used a descriptive-correlational type of research design. The descriptive method was used to describe the level of mathematics self-efficacy, engagement, and critical thinking disposition of pre-service mathematics teachers. In addition, a correlation design was applied to determine the relationship between self-efficacy and engagement with the critical thinking disposition of the pre-service teachers.

3.2 Locale of the Study

The research was conducted in two of the higher education institutions located in the province of Bukidnon, Philippines, specifically, Central Mindanao University and Don Carlos Polytechnic College. These institutions offer a Bachelor of Secondary Education major in Mathematics program, which provided the researcher with relevant data from the pre-service mathematics teachers for the study.

3.3 Respondents and Sampling

The study employed purposive sampling since it focuses on the first-year to fourth-year pre-service mathematics teachers who are enrolled from the two selected higher education institutions in Bukidnon for the school year 2025-2026. The questionnaires were disseminated through Google Forms and through face-to-face to all qualified participants; however, only those who were available were included. Leaving a total of 144 respondents, eighty (80) from Central Mindanao University and sixty-four (64) from Don Carlos Polytechnic College. This group was appropriate for the study since they represent future mathematics educators.

3.4 Research Instrument

The variables of the study were measured through adopted questionnaires. Three instruments were employed in collecting the data.

The first part was the Mathematics Self-Efficacy and Anxiety Questionnaire (MSEAQ) developed by May (2009), which was adopted and localized by Riboroso et al. (2018). This instrument was used to determine the mathematics self-efficacy and anxiety of students. It consists of 29 statements, wherein 14 statements are for self-efficacy and 15 statements are for self-anxiety, but the researcher utilized the mathematics self-efficacy questionnaire only for this study. Each indicator was rated through a five-point Likert scale. The following table was used to interpret the data.

Scale	Range	Description	Interpretation
5	4.21-5.00	Strongly Agree	Very High
4	3.41-4.20	Agree	High
3	2.61-3.40	Neutral	Average
2	1.81-2.60	Disagree	Low
1	1.00-1.80	Strongly Disagree	Very Low

The second part was the Students' Engagement in Mathematics Questionnaire adopted from Leis et al. (2015), which was localized by Gutierrez and Doronio (2024). It has three sub-dimensions, namely: emotional engagement, social engagement, and cognitive engagement, which have a total of 13 indicators. A five-point Likert scale was used to analyze the engagement level of students in mathematics.

Scale	Range	Description	Interpretation
5	4.21-5.00	Strongly Agree	Highly Positive
4	3.41-4.20	Agree	Positive
3	2.61-3.40	Neutral	Fair
2	1.81-2.60	Disagree	Negative
1	1.00-1.80	Strongly Disagree	Highly Negative

The last part was the Student-Educator Critical Thinking Disposition Scale (SENCTDS), which was localized and adopted by Salviejo et al. (2024) from Quinn et al. (2022). It is composed of 6 sub-scales (reflection, attentiveness, open-mindedness, organization, perseverance, and intrinsic goal motivation) with 21 indicators. A 7-point Likert scale was used to analyze the level of students' critical thinking disposition.

Scale	Range	Description	Interpretation
7	6.18-7.00	Strongly Agree	Very High
6	5.31-6.17	Agree	High
5	4.44-5.30	Somewhat Agree	Moderate
4	3.57-4.44	Neither Disagree nor Agree	Neutral
3	2.70-3.56	Somewhat Disagree	Slightly Low
2	1.83-2.69	Disagree	Low
1	1.00-1.82	Strongly Disagree	Very Low

3.5 Data Gathering Procedure

Prior to data gathering, the researcher wrote a request letter noted by the faculty of the college and the Dean of the College of Education of Central Mindanao University, and the President of Don

Carlos Polytechnic College, to secure permission to conduct the research study. The letter indicated that the students' participation in this study was voluntary and that their responses would remain confidential and would be used for research purposes only. Prior to the administration of the questionnaire together with the letter of request, a consent form was secured from the first-year to fourth-year students of BSE Mathematics for their voluntary participation. The researcher used both Google Forms and printed forms in administering the questionnaires and personally retrieved them from the respondents to immediately tally, tabulate, and analyze the data to obtain relevant information for the study.

3.6 Statistical Techniques

The following statistical techniques were used to answer the research problems.

To determine the levels of students' self-efficacy, engagement, and critical thinking disposition, a descriptive statistic such as the mean was used. Pearson's r correlation was applied to determine the relationship between independent (self-efficacy and engagement) and dependent (critical thinking disposition) variables at a 0.05 significance level.

4. RESULTS AND DISCUSSION

This chapter presents the analysis and interpretation of data gathered from the respondents. It focuses on the levels and the relationships among students' mathematics self-efficacy and engagement on critical thinking disposition. The order of presentation follows the arrangement of the problems in the study.

4.1 Level of Students' Mathematics Self-Efficacy

Table 1 presents the level of students' mathematics self-efficacy. The table also displays the mathematics self-efficacy's mean score with qualitative interpretations.

Table 1. Level of Students' Mathematics Self-Efficacy

Indicators	Mean	Interpretation
1. I feel confident enough to ask questions in my mathematics class.	3.41	High
2. I believe I can do well on a mathematics test.	3.29	Average
3. I believe I can complete all the assignments in a mathematics course.	3.76	High
4. I believe I am the kind of person who is good at mathematics.	3.05	Average
5. I believe I will be able to use mathematics in my future career when needed.	4.22	Very High
6. I believe I can understand the content in a mathematics course.	3.51	High
7. I believe I can get an "A" when I am in a mathematics course.	3.04	Average
8. I believe I can learn well in a mathematics course.	3.69	High
9. I feel confident when taking a mathematics test.	3.24	Average
10. I believe I am the type of person who can do mathematics.	3.47	High
11. I feel that I will be able to do well in future mathematics courses.	3.52	High
12. I believe I can do the mathematics in a mathematics course.	3.47	High
13. I believe I can think like a mathematician.	2.76	Average
14. I feel confident when using mathematics outside of school.	3.33	Average
Overall	3.41	High

The results in Table 1 showed that the overall mean score for mathematics self-efficacy is 3.41, which means that the pre-service mathematics teachers' level of mathematics self-efficacy is high. This implies that the pre-service mathematics teachers have developed a reasonably high belief in their ability to complete mathematical tasks, learn mathematical content, and apply skills in the real world. The result is in line with Dua et al. (2022) study, who revealed that pre-service mathematics teachers have high mathematics self-efficacy, which indicates to have high confidence in their ability to do mathematics and can help their future students who may struggle in mathematics courses. Also, Zuya et al. (2016) reported that pre-service teachers have above average confidence levels in mathematics self-efficacy, while Hendricks et al. (2024) and R. Giles et al. (2016) both found a positive self-perception

in mathematics teaching efficacy among pre-service teachers. The evidence spans diverse contexts, suggesting a consistent pattern of high mathematics self-efficacy among pre-service teachers.

As observed in table 1, the highest mean scores among the indicators were the statement "I believe I will be able to use mathematics in my future career when needed." with a mean score of 4.22, which is interpreted as "very high" level and the statement "I believe I can complete all the assignments in a mathematics course." with a mean of 3.76 indicating a high level of mathematics self-efficacy. These suggest that most pre-service mathematics teachers have a very high confidence and awareness of the relevance and importance of mathematics in the real world, which can also be expanded to have a high ability to complete mathematical tasks and include their effectiveness in instructing mathematics (Zuya et al., 2016). Furthermore, the study of Orongan et al. (2024) showed pre-service teachers with high self-efficacy in teaching and learning, specifically in lesson preparation.

On the other hand, among the indicators being measured, the pre-service mathematics teachers had the least belief in "I believe I can get an "A" when I am in a mathematics course," with a mean score of 3.04 and interpreted as an average level of mathematics self-efficacy. Following this is the item "I believe I can think like a mathematician." which had a mean score of 2.76, indicating an average level of mathematics self-efficacy. The findings indicate that although pre-service mathematics teachers had high belief in completing their math tasks, it does not guarantee that it will have high belief in their performance in math. Further, they have an average level of confidence in their ability to approach problems and think critically in a manner consistent with a mathematician.

4.2 Level of Students' Engagement in Mathematics

The following tables show the level of students' engagement in mathematics with its subcategories (emotional, social, and cognitive engagement). Each table also displays the mean score of each indicator with qualitative interpretations.

Table 2. Level of Students' Engagement in terms of Emotional Engagement in Mathematics

Indicators	Mean	Interpretation
1. Math class was fun today.	3.46	Positive
2. Today I felt bored in math class. *	3.43	Positive
3. I enjoyed thinking about math today.	3.23	Fair
4. Learning math was interesting to me today.	3.58	Positive
5. I liked the feeling of solving problems in math today.	3.44	Positive
Overall	3.43	Positive

* Negative indicator (scoring is reversed)

The data presented in Table 2 illustrates the level of students' engagement in mathematics in terms of emotional engagement. The findings indicate that the respondents demonstrate a fair to positive level of emotional engagement as observed in the mean scores across indicators. The highest mean score was observed in the statement "Learning math was interesting to me today." with a mean of 3.58, which can be interpreted as "Positive" level of engagement. This implies that most pre-service mathematics teachers show strong interest and emotional involvement in learning mathematics. This is followed by the statement "Math class was fun today." as the second highest mean, 3.46, indicating a positive engagement. This suggests that the teacher was effective in creating a pleasant and engaging classroom environment, making the students enjoy the learning experiences in mathematics class.

On the other hand, the lowest mean score was observed in the statement "Today I felt bored in math class. *" with a mean of 3.43, interpreted as a positive level of emotional engagement. This suggests that the pre-service mathematics teachers may not feel bored during mathematics class, hence the learning activities and discussion in mathematics may have caught their interest and attention. This is followed by the statement "I enjoyed thinking about math today." who received the least mean score of 3.23, which falls under a fair level of emotional engagement. This implies that the respondents had an average level of enjoyment when it came to learning and thinking mathematical concepts. Hence, mathematical activities in class may need to be more engaging and meaningful to spark some enjoyment of mathematical concepts.

The overall mean for the emotional domain is 3.43, which can be described as having a positive level of emotional engagement in mathematics courses. The pre-service mathematics teachers showed a positive level of enjoyment and feeling emotionally connected to their mathematics learning experiences. This involves emotional satisfaction from learning and solving mathematics problems. This finding is consistent with the study of Ji et al. (2022) and Edo et al. (2024) that pre-service teachers had a moderate to high level of emotional engagement during their teacher education trainings.

Table 3. Level of Students' Engagement in terms of Social Engagement in Mathematics

Indicators	Mean	Interpretation
6. Today I talked about math to other students in class.	3.19	Fair
7. Today I helped other students with math when they didn't know what to do.	3.05	Fair
8. Students in my math class helped each other learn today.	3.72	Positive
9. Today I shared ideas and materials with other students in math class.	3.33	Fair
Overall	3.32	Fair

Table 3 presents the level of engagement in terms of social engagement in mathematics. The results reveal that the respondents generally exhibit a fair to positive levels of engagement, with most mean scores falling under the category of "Fair". Among the indicators, the highest mean score was observed in the item " Students in my math class helped each other learn today." with a mean score of 3.72, interpreted as "Positive" level of engagement. This means that pre-service mathematics teachers observed a highly supportive learning environment in their mathematics class where their classmates help and assist one another. Following this, the statement "Today I shared ideas and materials with other students in math class." obtained a mean score of 3.33 and can be interpreted as "Fair" level of engagement. This suggests that sharing of mathematical ideas and materials with peers was fairly or moderately observed in mathematics class.

However, the lowest mean score falls under the statements "Today I talked about math to other students in class." with a mean of 3.19 and "Today I helped other students with math when they didn't know what to do." with a mean score of 3.05, both interpreted as "Fair" level of social engagement. This means that pre-service teachers may feel more comfortable discussing mathematics with peers occasionally, but less frequently for providing peer assistance. This is reflected in the study of Roscoe and Chi (2007), as cited by Gimarangan et al. (2025), who pinpoints that peer discussion is better in fostering collaborative learning rather than peer assistance, which focuses on direct help or guidance.

As a whole, the findings indicated a fair level of social engagement among pre-service mathematics teachers during their mathematics class with an overall mean score of 3.32. This means that there is a fair or occasional collaboration and interaction among students within the classroom environment. The study of Agbozo et al. (2024) highlights that pre-service mathematics teachers find enjoyment in mathematics if it were delivered in manner that their voices be heard and in a more interactive approach. This suggests a fair level of social engagement characterized by meaningful interactions integrated into mathematics class.

Table 4. Level of Students' Engagement in terms of Cognitive Engagement in Mathematics

Indicators	Mean	Interpretation
10. Today in math class I worked as hard as I could.	3.82	Positive
11. Today it was important to me that I understood the math really well.	3.76	Positive
12. I tried to learn as much as I could in math class today.	3.94	Positive
13. I did a lot of thinking in my class today.	3.82	Positive
Overall	3.84	Positive

Table 4 presents the level of students' engagement in terms of cognitive engagement in mathematics. All the indicators were described as "Positive" level of engagement in mathematics. Among the indicators being measured, it was found out that the highest mean score was observed in the item "I tried to learn as much as I could in math class today." with a mean score of 3.94 and the statement "Today in math class I worked as hard as I could." and "I did a lot of thinking in my class today." both had a mean score of 3.82 still indicating a positive level of

engagement. This means that most pre-service teachers showed persistence and eagerness to learn and understand mathematical concepts.

On the other hand, the least mean score was observed in the statement "Today it was important to me that I understood the math really well." with a mean score of 3.76, still indicating a "Positive" level of engagement in mathematics. This means that most pre-service teachers really value the importance of understanding mathematical concepts considering that they will be teaching mathematics in the future.

As a whole, the level of cognitive engagement among the respondents can be categorized as "Positive" with an overall mean of 3.84. This result suggests that the pre-service mathematics teachers were actively engaged in mental processes and effort during their mathematics class. This in line in the study conducted by Weingarden (2025) who reported that pre-service mathematics teachers showed positive mental engagement in their learning process through reflection and active participation in problem solving.

Table 5. Summary of the Level of Students' Engagement in Mathematics

Domain	Mean	Interpretation
Emotional Engagement	3.43	Positive
Social Engagement	3.32	Fair
Cognitive Engagement	3.84	Positive
Overall	3.53	Positive

The overall mean for students' engagement in mathematics is 3.53 which can be interpreted as "Positive" engagement in mathematics. The given metrics concur with research indicating that pre-service teachers are capable of substantive mathematical involvement, particularly in cognitive domains. ElSayary et al. (2022) supports this by pointing out the interconnected nature of social/emotional, behavioral, and cognitive engagements in the development of teacher.

Further, there are several studies that support this pattern of engagement. Fabregas et al. (2025) found a positive relationship between emotional intelligence and mathematics resilience among pre-service teachers, which suggest a vigorous potential of engagement. However, Balacuit et al. (2025) contradict the claim that among the dimensions, cognitive engagement is higher among mathematics students.

4.3 Level of Students' Critical Thinking Disposition

The following tables present the level of students' critical thinking disposition in terms of reflection, attentiveness, open-mindedness, organization, perseverance, and intrinsic goal motivation. Each table also displays the mean score of each indicator with qualitative interpretations.

Table 6. Level of Students' Critical Thinking Disposition in terms of Reflection

Indicators	Mean	Interpretation
1. When a theory, interpretation, or conclusion is presented to me, I try to decide if there is good supporting evidence.	5.03	Moderate
2. When faced with a decision, I seek as much information as possible.	5.63	High
3. I try to gather as much information about a topic before I draw a conclusion about it.	5.62	High
Overall	5.43	High

Table 6 presents the level of students' CTD in terms of reflection. Based on the data presented, the level of students' inclination towards reflective thinking ranges from moderate to high level. Among the indicators, it has been shown that the greatest mean score was observed in the statement "When faced with a decision, I seek as much information as possible." with a mean score of 5.63, indicating a high level of inclination towards reflection. This means that most pre-service mathematics teachers are highly inclined into reflective activity before coming up with a conclusion when faced with decision making.

On the other hand, the least mean score was observed in the item "When a theory, interpretation, or conclusion is presented to me, I try to decide if there is good supporting evidence." with a mean score of 5.03, interpreted as moderate level of disposition. This means that pre-service mathematics teachers demonstrate a reasonable inclination towards evaluating the credibility and evidence of information that is presented to them but may not consistently apply it.

As a whole, the level of students' inclination towards reflection is considered "High" having a mean score of 5.43. This reflects an openness to value evidence-based reasoning rather than

drawing out impulsive conclusions. In the study of Ozturk (2022), it was revealed that the pre-service mathematics teachers scored above average on CTD, including reflection. In the Philippines, it was supported by Salviejo et al. (2024) who noted that pre-service mathematics teachers demonstrate a moderate to high critical thinking disposition, including reflection being significant in their learning approach.

Table 7. Level of Students' Critical Thinking Disposition in terms of Attentiveness

Indicators	Mean	Interpretation
4. I find that I'm easily distracted when thinking about a task.*	3.00	Slightly Low
5. I find it hard to concentrate when thinking about problems.*	2.81	Slightly Low
6. I often miss out on important information because I'm thinking of other things.*	3.08	Slightly Low
7. I often daydream when learning a new topic.*	3.39	Slightly Low
Overall	3.07	Slightly Low

* Negative indicator (scoring is reversed)

Table 7 presents the level of students' CTD in terms of attentiveness. Based on the findings, it indicates that the respondents demonstrate a slightly low level of disposition towards reflection as supported by the mean scores across all indicators. The highest mean score was observed in item "I often daydream when learning a new topic. *" with a mean of 3.39, interpreted as "slightly low" level. This implies that pre-service teachers often daydream when they encounter new materials or topics leading to a slightly below average level of attentiveness.

Whereas the lowest mean among the indicators was observed in the item "I find it hard to concentrate when thinking about problems. *" with a mean of 2.81 suggesting a slightly lower level of CTD. This means that most pre-service teachers are somewhat prone to distractions when faced with problems or tasks.

Attentiveness domain displayed a 3.07 mean, the least among the domains of CTD, and can be interpreted as slightly low. This suggests that the respondents are somewhat less attentive but mostly struggle to sustain their focus and attention when engaging in cognitive tasks. They often daydream and are somewhat prone to distractions. This implies that instructors may encourage students to practice self-regulation to maintain focus (Webb et al., 2017). However, the result is contrary to the study of Yorganci (2016) who found that pre-service math teachers demonstrated a moderate level of being attentive and focused when given with tasks.

Table 8. Level of Students' Critical Thinking Disposition in terms of Open-Mindedness

Indicators	Mean	Interpretation
8. Thinking is not about being flexible, it's about being right.*	3.44	Slightly Low
9. Being open-minded about different worldviews is less important than people think.*	4.15	Neutral
10. When attempting to solve complex problems, it's better to give up fast if you cannot reach a solution.*	5.04	Moderate
11. I know what I think and believe so it's not important to dwell on it any further.*	4.19	Neutral
Overall	4.21	Neutral

* Negative indicator (scoring is reversed)

Table 8 presents the level of CTD in terms of open-mindedness. The results reveal that respondents exhibit a slightly low to moderate level of disposition towards open-mindedness as supported by the mean scores across indicators. The highest mean score was observed in the item "When attempting to solve complex problems, it's better to give up fast if you cannot reach a solution.* with a mean of 5.04, interpreted as "Moderate" level of disposition. This suggests that pre-service mathematics teachers had an above average level of inclination towards not giving up easily when faced with problems.

On the other hand, the least mean score was observed in the item "Thinking is not about being flexible, it's about being right.*" with a mean of 3.44, indicating a slightly low level of disposition towards open-mindedness. This suggests that pre-service mathematics teachers had below average inclination of being flexible in thoughts and being open to different ideas.

As a whole, the level of students' disposition towards open-mindedness is average, with a mean of 4.21 indicating a neutral level of disposition towards open-mindedness. This neutrality indicates that the respondents are neither rigid

nor highly receptive to the different viewpoints, however, they could be enhanced by providing them more exposure to diverse perspectives that broaden their cognitive flexibility and viewpoint. This is in line with Maltepe (2016) and Yorganci (2016) who found that pre-service teachers have a medium level of open-mindedness as reflected in their level of CTD.

Table 9. Level of Students' Critical Thinking Disposition in terms of Organization

Indicators	Mean	Interpretation
12. I like to make lists of things I need to do and thoughts I may have.	5.26	Moderate
13. I take notes so I can organize my thoughts.	5.56	High
14. I make simple charts, diagrams or tables to help me organize large amounts of information.	5.08	Moderate
Overall	5.30	Moderate

Table 9 presents the level of CTD in terms of organization. The data revealed that respondents displayed a moderate to high level of disposition towards organization. The highest mean score was observed in the item "I take notes so I can organize my thoughts." with a mean of 5.56 indicating a high level of disposition towards organization. This suggests that most pre-service teachers used notes to organize their thoughts and ideas.

On the other hand, the lowest mean score was observed in the item "I make simple charts, diagrams or tables to help me organize large amounts of information." with a mean of 5.08, indicating a moderate level of disposition towards order. This means that most pre-service teachers had a moderate level of being orderly such as making charts and diagrams to organize ideas.

As a whole, respondents showed a fairly good disposition towards organization habit with a mean of 5.30 which corresponds to its qualitative interpretation as 'moderate'. This implies that they often inclined to make lists, take notes, and use tools like charts and diagrams to structure their thoughts. This is in line with Salviejo (2024) who reported that pre-service mathematics teachers had a moderate level of tendency towards being orderly and systematic when working a task.

Table 10. Level of Students' Critical Thinking Disposition in terms of Perseverance

Indicators	Mean	Interpretation
15. I persevere with a task even when it is very difficult.	5.22	Moderate
16. Frustration does not stop me from finishing what needs to be done.	5.46	High
17. I find it desirable to keep going even if it is sometimes hard.	5.57	High
Overall	5.42	High

Table 10 presents the level of students' CTD in terms of perseverance. As observed in the data presented, the respondents displayed a moderate to high level of disposition towards perseverance. The highest mean was observed in the item "I find it desirable to keep going even if it is sometimes hard." with a mean of 5.57, indicating a high level of inclination towards perseverance. This suggests that pre-service mathematics teachers tend to persevere and are less likely to give up even when the situation seems difficult.

On the other hand, the lowest mean score was observed in the item "I persevere with a task even when it is very difficult." with a mean of 5.22 indicating a moderate level of disposition. This implies that pre-service teachers demonstrate an above average, level of inclination towards persistence, they mostly persevere by keeping in mind to keep working even when the tasks challenge them.

As a whole, respondents demonstrated a high level of disposition towards perseverance in the face of difficulty, with a mean score of 5.42. This suggests that pre-service mathematics teachers are inclined to persist, endure, and focus on their goals despite difficult or stressful situations. However, the findings of Salviejo (2024) revealed that pre-service mathematics teachers had a moderate level of CTD including perseverance.

Table 11. Level of Students' Critical Thinking Disposition in terms of Intrinsic Goal Motivation

Indicators	Mean	Interpretation
18. I enjoy information that challenges me to think.	5.22	Moderate
19. I look forward to learning challenging things.	5.53	High
20. Completing difficult tasks is fun for me.	5.20	Moderate
21. Even if material is difficult to comprehend, I enjoy dealing with information that arouses my curiosity.	5.22	Moderate
Overall	5.29	Moderate

Table 11 presents the level of CTD in terms of intrinsic goal motivation. Based on the results, the respondents generally demonstrated a moderate to high level of disposition towards intrinsic goal motivation. The highest mean score was observed in the item "I look forward to learning challenging things." with a mean of 5.53, indicating a high level of disposition. This suggests that pre-service mathematics teachers are inclined to have a positive attitude when dealing with challenging tasks. They tend to enjoy learning, especially when the task seems challenging to them.

On the other hand, the lowest mean was observed in the item "Completing difficult tasks is fun for me." with a mean of 5.20, indicating a moderate level of disposition. This means that pre-service teachers had an above average level of inclination towards enjoyment of completing difficult tasks. They develop intrinsic satisfaction, though not always, in dealing with difficult tasks. Overcoming difficulty is rewarding for them.

As a whole, students' disposition towards intrinsic-goal motivation is moderate, with a mean score of 5.29. This suggests that respondents show a moderate level of enjoyment and curiosity of challenging tasks, however, it may be present, but it does not guarantee consistency. The result is in line with the result found by Lestari and Arfiandhani (2019) who pointed out that pre-service teachers were dominantly motivated by intrinsic and altruistic motives.

Table 12. Summary of the Level of Students' Critical Thinking Disposition

Domain	Mean	Interpretation
Reflection	5.43	High
Attentiveness	3.07	Slightly Low
Open-Mindedness	4.21	Neutral
Organization	5.30	Moderate
Perseverance	5.42	High
Intrinsic Goal Motivation	5.29	Moderate
Overall	4.79	Moderate

Table 12 showed that the pre-service mathematics teachers had a moderate level of critical thinking disposition (overall mean=4.79). This suggests that students had limited or above average inclination to think critically. This is in line with the earlier study which reported pre-service mathematics teachers showing a moderate level of CTD (Yorganci, 2016; Palavan, 2020; Salviejo et al., 2024). However, studies conducted by Kuşcu and Erdoğan (2024), Akgul and Izmirli (2021) and Karakuş (2024) reported that university students had above average to a high level of critical thinking disposition. This discrepancy suggests that teacher education programs may need to strengthen varied teaching strategies that foster critical thinking habits and dispositions among pre-service mathematics teachers. Since CTD is crucial for pre-service teachers to perform successfully in both their academic and future endeavors (Kurniati et al.,2015; Pu et al., 2019; Edo et al., 2024; Salviejo, 2024).

4.4 Correlational Analysis of the Variables

Table 13 presents the correlation between mathematics self-efficacy and engagement with critical thinking disposition of pre-service mathematics teachers. Pearson's r correlation was used to measure the strength and direction of the relationship between mathematics self-efficacy and engagement with critical thinking disposition.

Table 13. Correlation Analysis Between Mathematics Self-efficacy and Engagement in Critical Thinking Disposition

Independent Variables	Pearson Correlation (r)	Probability (p)
Mathematics Self-Efficacy	0.157	.061
Engagement		
Emotional	0.147	0.079
Social	0.263**	0.001
Cognitive	0.351***	<0.001

*** Correlation is significant at the * p < .05, ** p < .01, *** p < .001*

The correlation analysis illustrated in Table 13 for mathematics self-efficacy and CTD indicates a very

weak and not statistically significant at the 0.05 level (r=0.157, p=0.061). This means that respondents' belief in their ability to succeed in mathematics is not significantly related to their critical thinking disposition. This finding contradicts the earlier study by Gürler and Kaplan (2023) who reported that higher levels of self-efficacy among students tend to show stronger critical thinking disposition. This discrepancy may be due to the difference in scope between the two constructs: Gürler and Kaplan (2023) investigated the self-efficacy for STEM practices, which reflects a broad confidence in one's ability to handle diverse academic tasks, whereas the present study examined subject-specific self-efficacy in mathematics.

In terms of engagement, emotional engagement also showed a very weak positive and non-significant relationship with CTD (r=0.147, p=0.079). This indicates that although pre-service mathematics teachers who show positive emotional engagement tend to have slightly higher CTD, this relationship is not statistically significant. Conversely, social engagement displayed a significant and a considerable weak positive relationship with CTD (r=0.263**, p=0.001). This implies that pre-service teachers who actively interact with their peers, cooperate and engage socially in mathematics class tend to have slightly higher CTD. This is in line with the study made by Ullyott (2022) who revealed that interaction among diverse peers, encouraging multiple perspectives, respecting for diverse opinions, and encouraging students' passion are all beneficial in improving CTD of students.

Moreover, the findings revealed that there is a moderate positive and significant relationship between cognitive engagement and CTD among pre-service mathematics teachers (r=0.351***, p=<0.001). This suggests that respondents who showed mental engagement and persistence in learning and understanding mathematics tend to have higher CTD.

All variables are positively related to CTD however, while mathematics self-efficacy and emotional engagement showed non-significant correlation with CTD, social and cognitive engagement play a crucial role in developing high CTD among pre-service mathematics teachers. While self-efficacy is crucial for academic success and engagement, its relationship with CTD is either indirect or mediated by other factors (Han et al., 2024; Orakcı & Khalili., 2024). Conversely, the weak, positive relationship between social and cognitive engagement with CTD highlights the importance of active social interaction and intellectual participation in mathematics class. This is in line with findings which reported that cognitive engagement is linked to higher-order thinking skills and problem solving (Chen et al., 2024) and that social interaction promotes deeper engagement (Chen et al., 2024; Zhu et al., 2024). It suggests that fostering an interactive learning environment and deep cognitive processing in mathematics could promote students' critical thinking disposition. With this, it is important for educational sectors to design effective pedagogical strategies and curricula that promote both content mastery and professional competencies.

5. CONCLUSION

Based on the results, the following conclusions were drawn.

1. The level of mathematics self-efficacy among pre-service mathematics teachers is high. This means that they are confident in their ability to understand mathematical concepts and perform mathematical tasks.
2. Pre-service mathematics teachers also showed a positive level of emotional and cognitive engagement while exhibiting a fair level of social engagement in mathematics class. This revealed that they demonstrate strong individual engagement with mathematics content but less consistently with peers.
3. However, in terms of critical thinking disposition, pre-service teachers showed a high level of reflection and perseverance; a moderate level for organization and intrinsic goal motivation; while they displayed neutrality in terms of being inclined to open-mindedness; and a slightly lower level for being inclined to attentiveness. Overall, pre-service mathematics teachers displayed a moderate level of critical thinking disposition.
4. The findings of this research also revealed a very weak positive and non-significant relationship exists between mathematics self-efficacy and emotional engagement to the critical thinking disposition. Meanwhile, both social and cognitive

engagement displayed a positive correlation with CTD. This implies that critical thinking disposition is positively linked to how students interact with their peers and intellectually engage in mathematics content, but not to how confident they feel nor their emotional concerns about mathematics. As the level of students' social and cognitive engagement in mathematics increases, their critical thinking disposition tends to increase also, and vice versa.

6. RECOMMENDATION

Based on the findings and conclusions, the following recommendations were established.

1. Teacher Education institutions may incorporate implementing training programs and designing curricula to develop and sustain the math self-efficacy of pre-service teachers. This includes providing them with authentic mathematical problem-solving, varying teaching strategies, and providing support for struggling students.
2. Instructors or facilitators are encouraged to promote interactive learning activities that require pre-service mathematics teachers to collaborate with their peers while learning mathematics to further their social engagement. Also, provide them with flexible teaching strategies that accommodate their individual learning styles to foster and sustain their emotional and cognitive engagement.
3. Policy makers may incorporate the promotion of critical thinking disposition into the standards and assessment of national teacher education. Providing them with resources and programs that enhance critical thinking in teacher education. Students may also actively engage in several key practices and good study habits. Also, for future researchers to consider a mixed research design to determine the factors and reasons behind the moderate level of CTD among pre-service mathematics teachers.
4. Lastly, teacher educators may promote social interactions and more intellectual activities in class to challenge students' higher-order thinking skills. And for future researchers to include respondents from other institutions or fields not solely focused on pre-service teachers who are mathematics majors, to enable comparative analysis and generalizations of findings.

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