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# STUDENTS' CRITICAL THINKING SKILLS AND LEARNING ENGAGEMENT IN MATHEMATICS IN THE MODERN WORLD

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## ABSTRACT

This study examined the levels of critical thinking skills and student engagement in the Mathematics in the Modern World (MMW) course among first-year college students of PLT College, Inc., and determined whether these variables differ when grouped according to course and academic strand. It also investigated the relationship between students' critical thinking skills and their level of engagement. Using a descriptive-correlational research design, data were gathered from students across seven academic programs and ten senior high school strands through validated survey questionnaires. Descriptive statistics, Kruskal–Wallis tests, post hoc analyses, and Pearson correlation were employed to analyze the data. Results revealed that students exhibited moderate to high levels of critical thinking and engagement. A significant difference in critical thinking skills was found across courses ($p = .046$), suggesting that discipline-specific academic demands influence students' cognitive performance. In contrast, no significant difference was observed across academic strands. For student engagement, no significant difference was noted across courses; however, academic strand showed a significant effect ($p = .01$), indicating that students' prior learning backgrounds shape their engagement in MMW. Post hoc analyses showed that these differences were not attributable to any single pair of groups after Bonferroni correction. Furthermore, a strong positive relationship was found between critical thinking skills and student engagement ($r = .542$, $p < .01$), implying that students who are more engaged tend to demonstrate higher levels of critical thinking. These findings underscore the need for differentiated instructional approaches and targeted support to enhance students' learning experiences in MMW.

**Keywords:** *Bonferroni, Classroom Interaction, Cognitive Performance, Discipline-Based Differences, Instructional Strategies, Kruskal-Wallis*

## INTRODUCTION

In the present-day world, which is marked by acute changes and an increase in competition, educational facilities must develop graduates who do not only have good disciplinary knowledge but also the competencies of the 21st century, like critical thinking and active interactions or engagement (Khahro & Javed, 2022). Through critical thinking, information is analyzed, arguments are evaluated and ideas are synthesized thus making the decisions taken to be effective whereas engagement refers to the extent to which the learners are behaviorally, emotionally and cognitively involved in the learning process (Barta et al., 2022; Amerstorfer & Freiin von Münster-Kistner, 2021). These constructs have become generally recognized as key predictors of academic achievement, lifelong learning and professional competence.

Mathematics in the Modern World (MMW) is a course that plays a significant role in developing the quantitative reasoning and problem-solving skills of students (Garcia & Banayo, 2022). Leaving behind traditional mathematics courses, MMW also previews the topical application of mathematical concepts with the use of logical reasoning and analytical thinking, thus making learners ready to cope with modern difficulties in the society (Bangalan & Hipona, 2020). The course is therefore the best environment to develop critical thinking abilities and foster significant student participation.

*Higher Education Skills in Critical Thinking*

Higher education is highly identified as a learning outcome that involves critical thinking. According to Mäkiö & Mäkiö (2023), it can be defined as a purposeful, self-regulated judgment that consists of the interpretation, analysis, evaluation, and synthesis of information consequently allowing the student to process information logically and make sound academic and real-life decisions. Alsaleh (2020) also defines critical thinking as a logical and thoughtful process that aims to decide what to believe or what to do and highlights its importance in the process of self-directed learning and problem-solving.

Critical thinking plays a crucial role in mathematics education as it allows students to learn abstract ideas and use mathematical reasoning to extrapolate them to real-life situations. A study documented the findings that students who have a mathematics experience that is based on problem-based and reasoning-focused activities have high levels of analytical and evaluative thinking (Torres-Peña, 2025). Sulaiman Dzaiy & Abdullah (2024) also added that reflective (and by implication, critical) thought processes are best being exercised in active learning processes and not by rote memorization.

Empirical studies conducted recently suggest that students who have developed well-developed critical thinking abilities have better academic achievement and they are more adaptive to complicated learning activities (Plooy et al., 2024) . According to a study critical thinking has to be incorporated into all learning areas to enable further insights and intellectual training (Li, 2023). These results confirm the hypothesis that MMW as a course oriented towards the application of practical skills in the real world is a suitable site to develop higher-order thinking among college students.

*Student Engagement in Learning*

Student engagement is a complex construct that sums up the quality of involvement of learners during the instructional process. Li and Xue (2023) divided the student engagement into three different areas: behavioral engagement, which is active engagement in academic tasks; emotional engagement, which denotes interest, enjoyment, and affection of learning activities; and cognitive engagement, which involves the level of effort, perseverance, and strategic implementation in learning tasks.

The empirical studies have highlighted student engagement as a powerful indicator of academic achievement. A study recorded that learners who portray high levels of engagement in their studies attain better academic outcomes and show perseverance as well as increased satisfaction with their learning processes (Schnitzler et al., 2021). Engaged learners have higher chances of expressing positive learning behaviors including; prolonged attention, active participation in discussions and completion of tasks (Cents-Boonstra et al., 2021).

In mathematics classroom, participation takes specific importance due to the abstract and challenging nature of the subject. Cognitive engagement is particularly crucial in mathematics as it reflects the willingness by students to devote time to understanding more complex ideas (Gebremeskel et al., 2025), . High emotional and behavioral involvement have also been linked to low mathematics anxiety and increased motivation.

*Correlation between Critical Thinking and Student engagement*

An existing body of literature confirms that there is a close relationship between critical thinking and engagement among students. Students who are emotionally involved tend to use deep order of cognition thus developing critical thinking ability (Palma-Luengo, Martin, & Ossa-Cornejo, 2025). Similar findings were made by a study that concluded that the active learning methods are significantly important in enhancing student engagement and higher-order thinking (Munna & Kalam, 2021).

Further, studies have shown that teaching strategies that encourage team work, problem-solving and inquiry-based learning also encourage critical thinking and participation at the same time. As pointed out by a study, students are in best place to acquire knowledge when they are engaged in the creation of content as opposed to when they receive predetermined information passively (Novalia et al., 2025). Problem-based learning and real-world application in mathematics education was also found to support analytical competence and long term engagement (Boye & Agyei, 2023).

Global studies also indicate that there is a high correlation between critical thinking and engagement. A study has discovered that the college students who displayed high cognitive engagement also scored higher in terms of analytical and evaluative skills

(Fuertes et al., 2023). Likewise, the study by Kong (2021) revealed that the motivational level among the students who engaged in reflective and critical learning activities was high among emotionally engaged students.

This has been supported in local studies conducted in the Philippine context. The critical thinking skills of students in mathematics were significantly affected by the teaching strategies that encourage active learning (Barrios et al., 2022). Similarly, one of the studies by Garcia & Reserva (2025) concluded that students who had higher levels of engagement were more effective in issues that involved judgements and logical judgements.

In spite of these findings, very few researches have specifically addressed the critical thinking skills and student involvement in the Mathematics in the Modern World program when examining the data in terms of course and academic strand. This is the endpoint of a research gap that is set to be filled by the current study, particularly in the context of PLT College, Inc.

In this regard, the proposed study aims at determining the extent of critical thinking abilities and the amount of student engagement in Mathematics in the Modern World by college students at PLT College, Inc. In particular, it can be said that it is supposed to assess the critical thinking of students in terms of analysis, evaluation and synthesis, and their interaction in behavioral, emotional, and cognitive levels. It also aims to identify the presence of important variations in case students are sorted according to academic track and course, and whether there is a significant association in the skills of critical thinking of students and their active participation in the subject.

It is expected that the results of such a study will be useful to students, educators, and administrators because they will provide empirical data that could be used to improve teaching methods, enrich the study experience of students, and support the adoption of the Mathematics in the Modern World curriculum.

## Theoretical Framework

This study is anchored on the Constructivist Learning Theory, Student Engagement Theory, and Critical Thinking Theory, which collectively explain how students' thinking skills and engagement develop in the learning process, particularly in the Mathematics in the Modern World course.

The Constructivist Learning Theory proposed by Jean Piaget and later expanded by Lev Vygotsky posits that learners actively construct knowledge through experience, reflection, and interaction with their environment. Learning is not a passive reception of information but an active process where students build new understanding based on prior knowledge (McLeod, 2025). In the context of Mathematics in the Modern World, this theory explains how students develop analysis, evaluation, and synthesis as they solve real-life mathematical problems, collaborate with peers, and reflect on their learning experiences.

This study is also grounded on the Student Engagement Theory which describes engagement as a multidimensional construct consisting of behavioral, emotional, and cognitive components (O'Regan et al., 2023). Behavioral engagement refers to students' participation in classroom activities; emotional engagement pertains to students' interest, enjoyment, and attitudes toward learning; while cognitive engagement involves the level of effort, persistence, and use of learning strategies. This theory supports the present study's assumption that students who are actively involved in learning activities demonstrate higher academic involvement and deeper learning.

Furthermore, the study is anchored on the Critical Thinking Theory of Peter Facione (2013), which defines critical thinking as a purposeful, self-regulated judgment involving analysis, evaluation, and synthesis. According to this theory, these skills enable learners to interpret information, assess arguments, and draw logical conclusions. This framework supports the measurement of students' critical thinking skills in the present study using the same three dimensions.

The relationship between student engagement and critical thinking is further supported by the Active Learning Theory of Bonwell & Eison (1991), which emphasizes that students learn best when they actively participate in the learning process. Active learning strategies encourage students to think critically while increasing their behavioral, emotional, and cognitive engagement. This suggests that higher engagement in Mathematics in the Modern World leads to stronger critical thinking skills.

Guided by these theories, the present study assumes that students' level of engagement significantly influences the development of their critical thinking skills. Likewise, students who possess strong critical thinking abilities are more likely to become actively engaged in learning tasks. Thus, these theories provide a strong foundation for examining the levels, differences, and relationship between critical thinking skills and student engagement among college students of PLT College, Inc..

## Conceptual Framework

The conceptual framework of the proposed investigation is based on the assumption that the background traits of students, especially their chosen academic strand and the course that they are enrolled in, can have some sort of effect on the development of the key 21st-century competencies, including critical thinking and student engagement. The competencies are hypothesized as critical predictors of educational success in the academic domain, especially in the fields that require analytical thinking, which is the case with the Mathematics in the Modern World (MMW) curriculum.

In the study, the operationalization of critical thinking skills is based on the analysis, evaluation, and synthesis dimensions, and relies on the available literature of scholarly explanations of critical thinking as a self-regulated, deliberate, and reflective process. These abilities enable learners to handle information, make a sound judgment, and apply a logical inference skills, skills that are considered to be invaluable in understanding the real world use of mathematics as noted in MMW.

The student engagement is explored as a three dimensional construct which entails behavioral, emotional and cognitive engagement. The construct reflects the level of involvement, engagement, self-drive, and intellectual capital of students towards their academic activities.

The model postulates the correlation between critical thinking and student engagement. Empirical data proposes that a high degree of engagement predicts better a student to defend themselves by more advanced thinking strategies that enhance their critical thinking and instructional practices that promote higher-order thinking stimulate engagement as well. This back and forth exchange is especially relevant in the field of mathematics education in which real life problem solving, reasoning, and activities of inquiry are the keystones to learning success.

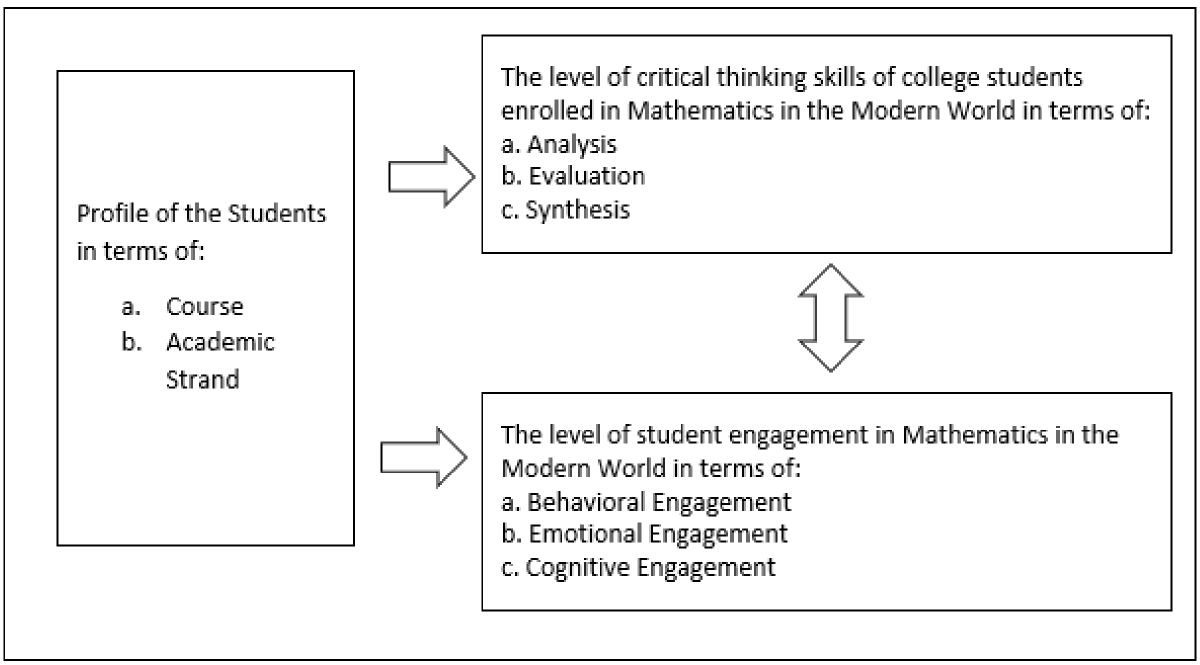


**Figure 1. Research Paradigm of the Study**

Figure 1 shows the research paradigm of the study, which depicts the correlation between profile of students, the level of critical-thinking skills as well as levels of student engagement in Mathematics in Modern World. The framework consists of three main elements, namely, the profile of students, critical-thinking skills, and student engagement.

The profiles of students such as course and academic strand are thought to be grouping/moderating variables in the study. These profiles are hypothesized to produce and describe the difference in the degrees of critical-thinking skills as well as student interest that is experienced among the participants.

The operationalization of the level of critical thinking skills demonstrated by college students in Mathematics in the Modern World is operationalized by the measures of analysis, evaluation, and synthesis. These dimensions reflect the advanced cognition skills, which form the basis of effective problem solving and decision making in the field.

Student engagement in Mathematics in the Modern World is characterized in terms of behavioral engagement, emotional engagement and cognitive engagement. These variables are a generalization of the involvement, affective interest, motivation, and mental effort of the students of the learning process.

The framework of the current study is based on the fact that, the academic strands and courses of students could have an impact on their critical-thinking and their participation in Mathematics in the Modern World. Based on this, the research will focus on evaluating critical thinking through analysis, evaluation and synthesis, and assessing engagement, in terms of behavioral, emotional, and cognitive aspects.

It also recognizes that the two constructs are interdependent on each other; students that are involved in critical thinking are more likely to have a high level of engagement in the learning process and strongly engaged learners are likely to possess stronger higher-order thinking abilities. Under this framework, the research aims at establishing the degree of critical thinking and engagement, differences across the academic backgrounds of students, as well as the relationship that exists between the two key learning outcomes.

## Research Questions

This study aimed to determine the level of critical thinking skills and the level of student engagement in Mathematics in the Modern World among college students of PLT College, Inc. Specifically, it seeked to answer the following questions:

1. What is the level of critical thinking skills of college students enrolled in Mathematics in the Modern World in terms of:
    a. Analysis
    b. Evaluation
    c. Synthesis
2. What is the level of student engagement in Mathematics in the Modern World in terms of:
    a. Behavioral Engagement
    b. Emotional Engagement
    c. Cognitive Engagement
3. Is there a significant difference in the level of critical thinking skills when grouped according to their academic strand and course?
4. Is there a significant difference in the level of student engagement when grouped according to academic strand and course?
5. Is there a significant relationship between students’ level of critical thinking skills and their level of engagement in Mathematics in the Modern World?

## METHODOLOGY

### Research Design

The research design used in this study was a descriptive -correlational research design to examine the critical-thinking competences and student engagement of college students undertaking Mathematics in the Modern World at PLT college, Inc. The descriptive dimension has been applied to outline and measure the degrees of critical-thinking skills of students, namely, analysis, evaluation, and synthesis, and their involvement on behavioral, emotional, and cognitive levels.

The correlational aspect was used to determine the existence of a statistically significant correlation between the critically-thinking abilities of the students and the level of interest they show in the topic. This is a relevant design as it allows the researcher to quantify the extent of relationship between variables without interfering with experimental conditions.

Moreover, the study also applied a comparative approach to examine possible differences in the skills of critical-thinking and student engagement in cases when students are stratified in terms of academic strand and course.

The descriptive-correlational design would be appropriate to this investigation since it will allow the researcher to describe the levels of the variables, compare the demographic groups, and discuss inter-variable relationships that are needed to understand the learning behaviors and higher-order thinking in Mathematics in the Modern World among students.

### Research Environment

The study was undertaken at PLT College, Inc. which is a privately-owned institution of postsecondary with its location at Bayombong, Nueva Vizcaya. The institution also has a variety of undergraduate programs in education, business, criminology, health sciences, hospitality management and information technology, hence students of all academic backgrounds and strands are attracted.

Mathematics in the Modern World (MMW) is a compulsory general-education course in a variety of programs at the college, and it makes PLT College an excellent location to study the critical-thinking skills and active involvement of the students in the subject. The learning environment received by the students in the institution gives them a chance to experience real world application of mathematics, classroom discussions, and performance-based activities that are in tandem with the goal of the study.

The research involved a sample of chosen college students taking Mathematics in the Modern World in the ongoing academic semester, as representative of different academic strands and courses at PLT College, Inc.

## Respondents of the Study

The participants of this research were first-year undergraduates taking the Mathematics in the Modern World (MMW) course at PLT college, Inc. in this academic term. They were sampled out of seven programs of various degree programs namely, BS Accountancy, BS Biology, BS Medical Technologist, BS Nursing, BS Pharmacy, BS Radiologic Technology, and Bachelor in Elementary Education. These programs were specifically selected to get a wide range of student profiles at the institution.

Further to add depth in the analysis, the research was also mindful of the high school tracks or strands of the respondents. Students were drawn out of various academic backgrounds, such as ABM, GAS, HUMSS, STEM, and the Pre-Baccalaureate Health and Science strand. Also, some Technical-Vocational-Livelihood (TVL) strands which included Home Economics, ICT, Agri-Fishery Arts and Industrial Arts were represented. Any students who did not declare their affiliation with a particular strand or whose particular strand was not relevant were also represented so as to have a complete representation of the MMW student representation.

**Table 1. Demographic Profile of the Respondents**

| Course | | |
|---|---|---|
| | F | % |
| BSA | 10 | 4.0 |
| BSBIO | 1 | .4 |
| BSMT | 11 | 4.4 |
| BSN | 180 | 72.6 |
| BSP | 13 | 5.2 |
| BSRT | 22 | 8.9 |
| BEED | 11 | 4.4 |
| Total | 248 | 100.0 |
| Strand | | |
| | F | % |
| ABM | 27 | 10.9 |
| GAS | 29 | 11.7 |
| HUMMS | 65 | 26.2 |
| STEM | 98 | 39.5 |
| PBHS | 6 | 2.4 |
| HOME ECONOMICS | 13 | 5.2 |
| ICT | 2 | .8 |
| AGRIFISHERY ARTS | 1 | .4 |
| INDUSTRIAL ARTS | 2 | .8 |
| NO STRAND | 5 | 2.0 |
| Total | 248 | 100.0 |

As shown in Table 1, the largest group of respondents came from the Bachelor of Science in Nursing (BSN) program, comprising 72.6% (f = 180) of the total population, followed by BSRT (8.9%), BSP (5.2%), and BSMT and BEED (both at 4.4%). Smaller proportions were contributed by BSA (4.0%) and BSBIO (0.4%). The inclusion of these programs was intentional, allowing the study to capture a broad spectrum of student backgrounds and academic orientations across the institution. Students came from diverse educational pathways, including STEM (39.5%), HUMSS (26.2%), GAS (11.7%), and ABM (10.9%), as well as specialized strands such as Pre-Baccalaureate Health and Science (2.4%). Several Technical-Vocational-Livelihood (TVL) strands were also represented, such as Home Economics (5.2%), ICT (0.8%), Agri-Fishery Arts (0.4%), and Industrial Arts (0.8%). Additionally, 2.0% of the respondents were categorized under “No Strand,” which included students whose SHS track was unspecified or not applicable.

This heterogeneous mix of respondents provided a comprehensive basis for examining variations in critical thinking skills and student engagement across different academic pathways and prior learning experiences. A purposive sampling technique was employed to include only students officially enrolled in MMW classes, ensuring that all participants had direct, consistent, and recent exposure to the course content and classroom activities relevant to the variables investigated in the study.

## Instrumentation

This study used an adopted questionnaire to gather the data. The material consisted of 3 parts. The first part included the respondents' demographic profile, including course, gender, age and senior high school track. The second part included the questionnaire to measure the level of critical thinking of students and the third part is the student’s engagement in Mathematics in the Modern World.

### *Critical Thinking Measurement*

The Critical Thinking Measurement created by Abdulah and Wangid is a measure of three basic dimensions of critical thinking, namely, analysis, evaluation, and synthesis, which are identified with different levels of higher-order cognitive processes. The dimension of analysis measures the ability of students to analyze and interpret the information in a systematic manner. Specifically, this dimension evaluates the skills of students to suggest solutions to everyday issues, identify similarities and differences between different information sources, and evaluate the accuracy and relevance of information supported by different resources.

The dimension of evaluation evaluates the quality of students in their critical judgment and assessment of information, issues, and arguments. It involves the use of critical thinking towards real-life issues, flexibility to new and existing situations, multidimensional assessment of problems, detection of inaccurate perspectives and resolution of the conflicting information of various sources.

On the other hand, the synthesis dimension is the measure of the skills of students to combine the information and draw conclusions that are well-founded and supported. This dimension assesses the development of individual verdicts out of heterogeneous materials, justification of stands with sound evidence, syntheses of different informational bits, inference of findings out of varied materials and generation of alternative solutions to problems.

The instrument also was subjected to a thorough psychometric examination in order to determine its validity and reliability. Validity of the items was tested with Pearson product-moment correlations. Results also showed that out of a pilot-tested group of 20 items, 13 were found to be valid and used in the final instrument. A Cronbachs alpha of 0.966 was obtained in the reliability analysis indicating excellent internal consistency. The construct validity of the questionnaire was further supported by the use of an exploratory factor analysis (EFA) that was done on the 13 items that were validated. The findings provided a Kaiser-Meyer-Olkin (KMO) Measure of Adequacy of Sampling 0.889 which indicated very appropriate data to perform a factor analysis and ensured that the instrument used was statistically sound in measuring the critical thinking ability of students.

*Students Engagement Measurement*

The Student Engagement Measurement in Mathematics in the Modern World assesses three major areas of engagement, including behavioral, emotional, and cognitive, which are diverse aspects of engagement among students in learning. Behavioral engagement dimension is the aspect of observable involvement and effort in mathematics teaching. In particular, this dimension measures the attentiveness of students to the instructor, class discussion, perseverance in doing mathematical tasks, effort in corrections, adherence to instructions, help-seeking behavior as well as the use of home study. It also takes into account the negative behaviors like prone to distraction, evading difficult questions, pretending to study and dropping challenging problems which are reverse coded measures.

Emotional engagement dimension assesses the affective reactions, interests of the students towards mathematics learning and their emotion absorption. This dimension measures the level of interest in the new mathematical conceptions, pleasure in mathematics learning and enjoyment in attending the classes, the feeling of immersion in time when solving the challenging tasks, and readiness to spend more time on the mathematics activities. Reverse -coded items include negative emotional reactions, such as boredom, disliking mathematics classes, and liking other subjects.

The dimension of cognitive engagement, in its turn, is used to evaluate the intellectual effort, motivation, and application of the learning strategies by the students who study mathematics. This dimension measures the desire of the students to strive to achieve the high grades, the way they use the self-questioning in order to check the understanding, the possibility to contextualize mathematics in the real life situations, the usage of various strategies to solve the problems, the ability to set the goals, to persevere in changing the strategies in case of meeting with some difficult problems, focus during studying, reflection about the lessons learnt at home, and memorizing of the important ideas. It also takes into account such tendencies as guessing without equal care and mental distraction during studying, which are reverse-coded indicators.

## Data Gathering Procedure

Once the researcher received permission to conduct the study, he liaised with the Mathematics in the Modern World instructors to come up with an adequate schedule within which the questionnaires would be administered. All the documentation was ready before the survey administration wherein the informed consent form was given which clearly indicated the objective of the study, the voluntary nature of the exercise and the rights of the respondents on privacy and confidentiality.

The questionnaires were filled using Google Forms in the free time of the students or after classes to ensure that as many people possible participated and do not disrupt the normal classes. When all the questionnaires were retrieved, the responses were sorted properly, coded and ready to be analyzed statistically. The researcher was able to maintain the quality, integrity and accuracy of the data that was gathered through systematic arrangement and data management.

The best ethical standards were observed during the data collection process. The rights of the respondents were given full respect, their involvement was on their own free will and they were not to face any repercussion at any time provided they wanted to pull out of the study. There was high confidentiality on all the information that was collected. Not only did this ethical practice safeguard the wellbeing of the respondents, it also increased the study reliability and validity.

## Treatment of Data

This paper used quantitative research method to conduct an analysis on the data collected using two instruments that are validated. All answers were properly coded and analysed with the help of Microsoft Excel and Statistical Package of the Social Sciences (SPSS). It was decided to treat data in such a manner that it would directly answer each of the research questions, as it would trace the levels of critical thinking and engagement of the students in the Mathematics in the Modern World course and establish whether there were differences and relationships depending on academic strand and course.

To calculate the level of critical thinking and involvement of the students, descriptive statistics including means, median, standard deviations, frequency counts, and percentages were calculated on each element of critical thinking (analysis, evaluation, and synthesis) and student engagement (behavioral, emotional, and cognitive). These descriptive indicators were used to give a clear picture of general perceptions, abilities and engagement behaviors of the students towards the subject.

**Table 2. Likert scale interpretation.**

| Likert Scale | Description | Value Allocation | Qualitative Description |
|---|---|---|---|
| 1 | Strongly Disagree | 1.00-1.49 | The respondent does not demonstrate the behavior, attitude, or skill described in the statement. |
| 2 | Disagree | 1.50-2.49 | The respondent inconsistently demonstrates the behavior, attitude, or skill; it is shown only at times or with minimal effort. |
| 3 | Agree | 2.50-3.49 | The respondent generally demonstrates the behavior, attitude, or skill described and applies it in most situations. |
| 4 | Strongly Agree | 3.50-4.00 | The respondent consistently demonstrates the behavior, attitude, or skill described, showing strong competence or engagement. |

Inferential statistical tests were performed to investigate the presence of considerable differences in the critical thinking skills and student engagement between the groups organized based on academic strand and course. Kruskal-Wallis Test was applied to establish the significant differences because a group of sample has n=1. Post hoc tests like Dunn Bonferonni Test were used when Kruskal-Wallis Test results indicated significant differences so as to determine which of the specific groups differed with each other. Lastly, in order to check the existence of a significant relationship between the critical thinking skills and the student engagement, Pearson r Correlation was calculated to enable the study to establish the strength and direction of relationship between the two variables. Any inferential analysis performed was interpreted with a level of significance of 0.05, which provides accuracy and reliability to the statistical analysis. In this calculated and strict approach to data treatment, the study has given valuable information on the level of critical thinking and the level of engagement of students and the interaction of these two most important variables in education.

## RESULTS AND DISCUSSION

### Section 1. The level of critical thinking skills of college students enrolled in Mathematics in the Modern World (MMW)

This section provides the level of critical thinking skills of the students in MMW in terms of Analysis, Evaluation and Synthesis. Table 3 presents their level of critical thinking in terms of Analysis.

**Table 3. Mean and Standard Deviation for Each Item of Critical Thinking in terms of Analysis**

| Analysis | Mean | SD | Description |
|---|---|---|---|
| I can make a recommendation about daily life's problems happened. | 2.95 | 0.45 | Agree |

| | | | |
|---|---|---|---|
| I can compare the similarity and difference of many varieties of information sources I obtain. | 2.91 | 0.46 | Agree |
| I can assess information from many various of resources. | 2.88 | 0.50 | Agree |
| Overall | 2.91 | 0.36 | Agree |

**Note: 1-1.49=Strongly Disagree, 1.50-2.49=Disagree, 2.50-3.49= Agree, 3.50-4= Strongly Agree*

The general average of 2.91 (SD 0.36) is an indicator that students, on the one hand, agree that they have analytical skills. The item with the greatest mean was received on the indicator of the ability to make a recommendation about the problems encountered in everyday life (M = 2.95, SD = 0.45) which means that students are confident in their ability to use analytical thinking in the context of real-life situations. This observation means that they can process information, evaluate alternatives and create a rational solution to their daily challenges.

The questions “I can compare the similarity and difference of numerous types of the information resources I receive” (M=2.91, SD=.46) and “I can evaluate information of various types” (M=2.88, SD=.50) also achieved the mean scores in the Agree category, meaning that students consider themselves able to evaluate and differentiate information sources of several types, which is a critical quality in academic achievement, being digital-literate, and making informed decisions. The standard deviations were relatively constant and hence the responses were quite similar among the students.

These findings are consistent with past studies that indicate that students generally portray moderate and high scores in self-perceived analytical thinking especially in areas that involve comparison, classification, and assessment of information (Yan et al., 2023). The results also highlight how the students would perform better in the aspects of critical thinking involving analysis when the tasks were familiar or related to real-life experiences, which would support the conclusion of this research that shows that respondents had a functional level of analytical ability and it could give them a strong basis of complex critical thinking approaches like evaluation and synthesis.

Table 4 presents the students level of critical thinking in mathematics in the modern world in terms of Evaluation.

**Table 4. Mean and Standard Deviation for Each Item of Critical Thinking in terms of Evaluation**

| Evaluation | Mean | SD | Description |
|---|---|---|---|
| I can use the ability of critical thinking to evaluate many various of issues in daily life. | 3.04 | 0.47 | Agree |
| I can adapt to many existing and new issues. | 2.92 | 0.58 | Agree |
| I can compare problems in many kinds of perspectives and evaluate its truth | 2.95 | 0.49 | Agree |

| | | | |
|---|---|---|---|
| I can understand how opinion is incorrect. | 2.95 | 0.57 | Agree |
| I can accomplish many varieties of opinion/ information resources contradicting. | 2.79 | 0.52 | Agree |
| Overall | 2.93 | 0.37 | Agree |

**Note: 1-1.49=Strongly Disagree, 1.50-2.49=Disagree, 2.50-3.49= Agree, 3.50-4= Strongly Agree*

The mean of 2.93 (SD 0.37) shows that the students, overall, believe that they have evaluation thinking abilities. This indicates that the learners think they are able to assess the validity of information, compare alternative opinions and evaluate the validity of arguments. The greatest mean was taken as the statement of “I can apply the ability of critical thinking to assess a number of various problems in my daily life” (M = 3.04, SD = 0.47) that shows the confidence of the students in the application of the skills of evaluating the problems outside of the academic activities to the real practical situations in life. Such perceived competence presupposes the possibility of the learners critically analyzing the issues and making justified conclusions based on the evidence at their disposal.

Likewise, students also said that they are capable of comparing problems in various types of perspectives and judging its correctness (M = 2.95, SD = 0.49) and grasping how opinion is wrong (M = 2.95, SD = 0.57). These products accentuate their perceived power to identify bias, spot inaccuracies and examine alternative perspectives-skills that are believed to be critical to academic success and responsible citizenship in a digital and informational society. The highest mean score, even in the category of Agree was reported to the statement “I can accomplish many varieties of opinion/ information resources contradicting.” (M 2.79, SD 0.52). This can suggest that although students are able to analyze specific items of information, there is a minor amount of confusion when it comes to negotiating between opposing sources or integrating differing opinions, a problem that many first-year students still face since they do not know how to engage in higher-order reasoning.

These results mirror Golden (2023), who highlighted that assessment, especially that of identifying discrepancies and making a rational decision, is not necessarily well-evolved among early college students. Another research also discovered that students tend to perform better in appraisal tasks that are related to real-life situations and tend to be comatose when working with conflicting information (Stanton et al., 2021). These findings can be used to support the current research as it is possible to state that respondents have the basic evaluative skills, but instructional approaches helping them to overcome the complex or conflicting information could be used.

Table 5 presents the students level of critical thinking in mathematics in the modern world in terms of Synthesis.

**Table 5. Mean and Standard Deviation for Each Item of Critical Thinking in terms of Synthesis**

| Synthesis | Mean | SD | Description |
|---|---|---|---|
| I can formulate my opinion from many varieties of resources | 2.95 | 0.40 | Agree |
| I can defend my opinion with various supporting strong evidence | 2.96 | 0.51 | Agree |
| I can combine many varieties of information I obtain | 2.91 | 0.46 | Agree |
| I can make a conclusion from many varieties of information resources I obtain. | 2.86 | 0.50 | Agree |
| I can give other alternatives toward solving problems | 2.84 | 0.53 | Agree |
| Overall | 2.90 | 0.35 | Agree |

**Note: 1-1.49=Strongly Disagree, 1.50-2.49=Disagree, 2.50-3.49= Agree, 3.50-4= Strongly Agree*

The overall average score of 2.90 (SD 0.35) shows that there was an overall agreement level, which implies that the participants generally view themselves as people who can take the information and build arguments and find solutions based on various sources. The implication of this trend is that first-year college students are learning to synthesize information and come up with well-supported arguments- a necessary part of higher-order thinking.

Among the separate items, the highest mean (M = 2.96, SD = 0.51) was attained by the statement that said: I can defend my opinion with different strong evidence. This finding implies that the students believe that they can defend their opinions with the help of appropriate data or sources, which is the basic skill in academic writing, research assignments and problem-solving processes that demand the use of evidence-based arguments.

Other statements that were supported by the respondents include: I can make an opinion based on varied resources (M mean = 2.95 SD=.40), and I can put together varied information (M=2.91 SD=.46). These results indicate an emergent skill in idea combination, and show a transition between easy understanding to creative and analytical combination.

The item with the lowest mean score (M=2.84, SD=0.53) was linked to the item *I can offer alternative solutions towards problem solving. Despite the fact that this item is also a pointer of agreement, it implies a relatively less confidence in the production of new or alternative solutions. Typically, it involves more knowledge and practice of concepts to synthesize, and this can be the reason why learners in the introductory college level have moderate level of development in this area.

The findings are consistent with the data provided in a recent study, which has found that synthesis-related skills including the creation of solutions, the construction of arguments, and the integration of information are likely to emerge gradually and need to be explicitly taught (Tong et al., 2022). That study shows that students usually exhibit a low level of ability to put together information but fail to come up with new or alternative solutions without being practiced. These current results are in line with this literature, meaning that, although there are foundational skills in synthesis, there is a possibility of improvement in developing creativity and flexibility in problem-solving.

**Section 2. The Level Of Student Engagement In Mathematics In The Modern World (MMW)**

This section provides is the level of student engagement in Mathematics in the Modern World in terms of behavioral, emotional and cognitive engagement. Table 6 presents their level of engagement in terms of behavioral engagement.

**Table 6. Mean and Standard Deviation for Each Item of Students Engagement in Terms of Behavioral Engagement.**

| Behavioral Engagement | Mean | SD | Description |
|---|---|---|---|
| I listen to my teacher in my math class. | 3.33 | 0.53 | Agree |
| I participate in the discussion in math class | 3.24 | 0.54 | Agree |
| I get easily distracted in math class [R] | 2.55 | 0.68 | Agree |
| I work hard in math class | 3.19 | 0.56 | Agree |
| At home I review math problems that I did not understand in school | 3.00 | 0.59 | Agree |
| When I see difficult math problems, I stop working on them. [R] | 3.02 | 0.60 | Agree |
| Sometimes I skip difficult math questions[R] | 2.59 | 0.68 | Agree |
| When I make mistakes in math, I work until I correct them. | 3.10 | 0.58 | Agree |
| I follow my teacher's directions in math class. | 3.31 | 0.55 | Agree |
| I sometimes act out as if I am studying in math class. [R] | 3.20 | 0.57 | Agree |
| I ask my friends or teachers for a help when I can't solve math problems. | 3.38 | 0.60 | Agree |
| Overall | 3.08 | 0.38 | Agree |

**Note: 1-1.49=Strongly Disagree, 1.50-2.49=Disagree, 2.50-3.49= Agree, 3.50-4= Strongly Agree*

Behavioral engagement of students in mathematics yielded high mean and standard deviation with an overall mean of 3.08 (SD = 0.38), which was interpreted as Agree, denoting that students are predominantly behaviorally engaged in their math classes. Listening to the teacher (M = 3.33), participation in class discussions (M = 3.24), hard work in math class (M = 3.19), and following the teacher's directions (M = 3.31) were all mentioned as high activities contributing to overall engagement. Students also displayed positive learning behaviors even beyond the classroom, as their responses indicated that they review math problems at home (M = 3.00) and keep working until they correct their mistakes (M = 3.10)—traits of persistence and responsible learning. Moreover, the highest mean was reached in asking friends or teachers for help when unable to solve math problems (M = 3.38)—indicating a strong help-seeking behavior, which is a mark of active engagement.

Nonetheless, the reverse-coded items revealed that there are still some unwanted behaviors among students. The students stated that they sometimes get easily distracted (M = 2.55), sometimes stop working on difficult problems (M = 3.02), skip difficult questions (M = 2.59), and sometimes only pretend to be studying (M = 3.20). The analysis statistically reversed these items, so higher scores still indicate positive engagement, but their means suggest that the problems of distractions, avoidance of tasks, and surface engagement still exist. The results show that the students' behavioral engagement in mathematics is of satisfactory quality, yet there is still a need for persistence, focus, and genuine involvement in tasks, especially when they are difficult.

The results of the current research are in line with the previous one which pointed out that the behavioral engagement, shown through attention, effort, persistence, participation, and help-seeking, is one of the major factors for academic success, especially in mathematics, and that the students who regularly exhibit all these behaviors, are the ones who reach the best learning outcomes (Saracostti et al., 2025).

Table 7 presents their level of engagement in terms of emotional engagement.

**Table 7. Mean and Standard Deviation for Each Item of Students Engagement in Terms of Emotional Engagement.**

| Emotional Engagement | Mean | SD | Description |
|---|---|---|---|
| I am interested in learning new things in math. | 3.18 | 0.56 | Agree |
| I do not like attending math classes. [R] | 3.10 | 0.59 | Agree |
| Learning math is fun. | 2.98 | 0.70 | Agree |
| I feel excited when I study in math class. | 2.79 | 0.68 | Agree |
| I feel bored when I study in math. [R] | 2.84 | 0.67 | Agree |
| I am excited about solving difficult math problems. | 2.54 | 0.72 | Agree |
| I like to study other subject s rather than math. [R] | 2.42 | 0.73 | Disagree |
| Time passes very quickly when I study math. | 2.88 | 0.65 | Agree |
| I forget where I am when I study math | 2.58 | 0.77 | Agree |
| I want to spend more time solving math problems. | 2.56 | 0.76 | Agree |
| Overall | 2.79 | 0.49 | Agree |

**Note: 1-1.49=Strongly Disagree, 1.50-2.49=Disagree, 2.50-3.49= Agree, 3.50-4= Strongly Agree*

Students' emotional engagement with mathematics led to an overall average of 2.79 (SD = 0.49), which was interpreted as Agree and it was a general indication that the students showed good emotional responses to learning math. The most ranked item was, “I am interested in learning new things in math” (M = 3.18), which demonstrated students’ curiosity and their readiness to learn the math concepts. Among the items presenting enjoyment and interest, “Learning math is fun” (M = 2.98) and “I feel excited when I study in math class” (M = 2.79)*, the existence of moderate positive emotional engagement was further indicated. Students voiced their concurring opinions that “Time passes very fast when I study math” (M = 2.88), which hints at absorption and concentration during the whole learning process.

Interestingly, some of the phrases were coded inversely, the following being “I do not like attending math classes,” “I feel bored when I study math,” and “I like to study other subjects rather than math.” Despite these items being negative in their phrasing, to be in favor of them means to opposite interpretation. For instance, the mean scores of 3.10 and 2.84 for the two reverse-coded items, when reversed, imply that students are generally happy with the attending of math classes and that they are not bored during the math lesson very often. The statement “I like to study other subjects rather than math” got a mean of 2.42 (Disagree), which after reverse coding means that students are likely to prefer, or at least not be pushed away from, mathematics compared to other subjects.

Even when emotional engagement in general is rated positively, the lower averages for “I am excited about solving difficult math problems” (M = 2.54) and “I want to spend more time solving math problems” (M = 2.56) imply that students may still show less enthusiasm or less confidence when taxing math problems are presented to them. A study has found similar results and pointed out that emotional engagement is a mix of students' affective reactions such as interest, enjoyment and less negative emotions which all play a significant role in the students' persistence and academic motivation (Acosta-Gonzaga, 2023; Qi et al., 2025). Positive emotions and reduced boredom, comparable with the opposite interpretations of the reverse-coded items, are among the factors that result in better engagement and making the learning process more profound.

Table 8 presents their level of engagement in terms of cognitive engagement.

**Table 8. Mean and Standard Deviation for Each Item of Students Engagement in Terms of Cognitive Engagement.**

| Cognitive Engagement | Mean | SD | Description |
|---|---|---|---|
| I want to get good grade in math class. | 3.58 | 0.61 | Strongly Agree |
| Sometimes I follow my best guess when I do not the answer [R] | 3.10 | 0.59 | Agree |
| When I study math, I ask myself questions to make sure I understand it correctly | 3.23 | 0.55 | Agree |
| I try to connect math to real life situations. | 2.97 | 0.62 | Agree |

| | | | |
|---|---|---|---|
| I try to think different ways to solve math problems. | 3.17 | 0.53 | Agree |
| I try to develop my own strategy when I solve math problems | 3.06 | 0.57 | Agree |
| I set goal for myself when I study math. | 3.00 | 0.53 | Agree |
| When I can't solve a math problem, I try to change my strategy. | 3.06 | 0.52 | Agree |
| I often think about something else when I study math. [R] | 2.90 | 0.59 | Agree |
| At home I think about what I learned in math class. | 2.82 | 0.63 | Agree |
| I am focused when I study math. | 2.92 | 0.67 | Agree |
| I memorize important facts to understand math better. | 3.09 | 0.56 | Agree |
| Overall | 3.08 | 0.36 | Agree |

**Note: 1-1.49=Strongly Disagree, 1.50-2.49=Disagree, 2.50-3.49= Agree, 3.50-4= Strongly Agree*

The analysis of data indicates that the students' cognitive engagement in mathematics was very positive on the whole, as an overall mean of 3.08 (SD = 0.36) has been interpreted as Agree. The item "I wish to get good grades in math class" (M = 3.58) scored the highest among all which expressed a very strong personal wish for academic success. The students reported the frequent use of cognitive strategies such as self-questioning ("I ask myself questions to make sure I understand it correctly," M = 3.23), exploring multiple solution approaches ("I try to think of different ways to solve math problems," M = 3.17), and developing personal strategies for problem solving (M = 3.06). These findings are suggestive of students being involved in activities that demonstrate profound thinking and self-regulatory learning.

Among the items included in the scale, there were some which were reverse-scored; for example, "Sometimes I follow my best guess when I do not know the answer" and "I often think about something else when I study math." The items are negatively worded, yet their mean scores are 3.10 and 2.90, respectively, which when reversed indicate that students mostly do not guess and that they are not very likely to be unfocused when doing math. This gives further evidence of the cognitive loading of the respondents. In addition, students expressed that they try to connect mathematics with their everyday lives (M = 2.97), that they achieve math skills (M = 3.00), and that they adapt their methods to solve problems as they experience them (M = 3.06). All these factors indicate a high level of cognitive involvement.

The results of this study support the findings of a previous study, which indicated that students who engage cognitively in the learning process utilize self-regulation, elaboration, and strategic problem-solving strategies to increase their level of understanding and performance (Alam and Mohanty, 2023). Students with a higher level of motivation (consistent with a strong desire to achieve high grades) are more likely to exert the necessary effort to employ deep-processing and adaptive learning strategies (Davidovitch and Dorot, 2023). These theoretical perspectives suggest that the participants in the present study demonstrate cognitive behaviors that are associated with productive learning and achievement within the area of mathematics.

## Section 3. Significant Difference In The Level Of Critical Thinking Skills When Grouped According To Their Academic Strand And Course

Table 9 presents which profile of the students in terms of course have a significant difference in the level of their critical thinking skills.

**Table 9. Significant Difference In The Level Of Critical Thinking Skills When Grouped According To Their Course and Academic Strand**

| Profile | f | df | p-value | Decision |
|---|---|---|---|---|
| Course | 12.80 | 6 | 0.046 | Reject Ho |
| Academic Strand | 16.33 | 9 | 0.06 | Accept Ho |

**Ho= There is no significant difference in any profile variable on the level of critical thinking skills and their level of engagement in Mathematics in the Modern World*

The analysis shows that the course of students affects the critical thinking skills of students because they are different or better able to score higher on critical thinking. The F value calculated from the study was 12.80 with degrees of freedom (df) = 6, which indicates a significant difference and provides strong evidence to reject the null hypothesis of no difference between student critical thinking levels across groupings. Critical thinking skills appear to differ based on a student's program of academic study due to differences between individual programs' curricula, differences in cognitive demands on each major, and the types of mathematical and/or analytical training provided in the respective programs. However, when classified according to academic strand during senior high school, no significant difference exists in a student's critical thinking skills in the Mathematics in the Modern World course. An F-value of 16.33 (df = 9) with a p-value of 0.06 (greater than .05) results in acceptance of the null hypothesis. Thus, prior academic strands appear to have little if any impact on a student's critical thinking skills during their college experience. Following the transition from SHS to college, critical thinking skills become less influenced by the student's SHS background in comparison to the demands placed on the student by their degree program.

The results confirm previous findings by Prabhakar et al. (2023), which highlighted that critical thinking is developed through discipline-based hands on practice experiences combined with the cognitive complexity required to successfully complete an academic program. The types of degree programs that have a greater emphasis on analytical, or problem-solving skills can be expected to better promote the development of critical thinking in their students than degree programs types that have a relatively small or no emphasis on analytical or problem-solving skills. Therefore, based on the data examined in this study, there is additional support for the idea that differences in critical thinking by degree type result from variations in emphasis placed on analytical or problem-solving skills in degree programs.

Table 10 presents the post hoc pairwise comparison using the Dunn-Bonferroni Test of the course profile of the respondents.

**Table 10. Pairwise Comparison Across Courses of the Respondents**

| Sample 1-Sample 2 | Test Statistic | Std. Error | Std. Test Statistic | Sig. | Adj. Sig.[a] |
|---|---|---|---|---|---|
| BEED-BSBIO | 6.682 | 74.326 | .090 | .928 | 1.000 |
| BEED-BSP | 15.413 | 29.153 | .529 | .597 | 1.000 |
| BEED-BSN | 37.065 | 22.102 | 1.677 | .094 | 1.000 |
| BEED-BSRT | 52.932 | 26.278 | 2.014 | .044 | .924 |
| BEED-BSA | 77.782 | 31.093 | 2.502 | .012 | .260 |
| BEED-BSMT | 81.455 | 30.344 | 2.684 | .007 | .153 |
| BSBIO-BSP | -8.731 | 73.848 | -.118 | .906 | 1.000 |
| BSBIO-BSN | -30.383 | 71.360 | -.426 | .670 | 1.000 |
| BSBIO-BSRT | -46.250 | 72.761 | -.636 | .525 | 1.000 |
| BSBIO-BSA | 71.100 | 74.635 | .953 | .341 | 1.000 |
| BSBIO-BSMT | -74.773 | 74.326 | -1.006 | .314 | 1.000 |
| BSP-BSN | 21.653 | 20.437 | 1.059 | .289 | 1.000 |
| BSP-BSRT | -37.519 | 24.894 | -1.507 | .132 | 1.000 |
| BSP-BSA | 62.369 | 29.932 | 2.084 | .037 | .781 |
| BSP-BSMT | 66.042 | 29.153 | 2.265 | .023 | .493 |
| BSN-BSRT | -15.867 | 16.072 | -.987 | .324 | 1.000 |
| BSN-BSA | 40.717 | 23.120 | 1.761 | .078 | 1.000 |
| BSN-BSMT | 44.389 | 22.102 | 2.008 | .045 | .937 |
| BSRT-BSA | 24.850 | 27.140 | .916 | .360 | 1.000 |
| BSRT-BSMT | 28.523 | 26.278 | 1.085 | .278 | 1.000 |
| BSA-BSMT | -3.673 | 31.093 | -.118 | .906 | 1.000 |

*Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.*
*Asymptotic significances (2-sided tests) are displayed. The significance level is .050.*
*a. Significance values have been adjusted by the Bonferroni correction for multiple tests.*

The results of our analysis of the pairwise comparisons using Bonferroni-adjusted critical values show that after adjustment none of the comparisons between the various programs reached statistical significance at the 0.05 alpha level. Unadjusted (raw) significance levels of the pairwise comparisons were below the 0.05 alpha level on a number of occasions. Some examples include: BEED vs. BSRT (p = .044), BEED vs. BSA (p = .012), BEED vs. BSMT (p = .007), BSP vs. BSA (p = .037), BSP vs. BSMT (p = .023), and BSN vs. BSMT (p = .045). However, when adjusted with the Bonferroni correction, all of these comparisons were still greater than the 0.05 alpha level, thus indicating that the differences observed in unadjusted p-values are not statistically significant when comparing between different programs after controlling for multiple comparisons.

Although the results of the Kruskal–Wallis analysis indicated that a statistically significant difference existed among the course means, the results of the post hoc analysis indicate that no individual program is statistically different from another program with regard to critical thinking skills when applying the conservative Bonferroni correction. Therefore, while the omnibus F test demonstrates a significant amount of variability among groups, it does not indicate large differences between particular programs.

The incidence of finding no statistical differences among the various degree programs is frequently seen when the number of groups becomes large and the Bonferroni method is applied, therefore significantly decreasing the chances of making a Type I error. However, as noted by Sauro and Lewis (2012), a large number of comparisons using the Bonferroni method also has an increased chance of making a Type II error. This occurs particularly with studies that include multiple group comparisons and can hide genuine but small differences that exist between groups (i.e., true differences exist but are not detected due to the statistical correction).

Students' analytical critical thinking was statistically different across courses, indicating differences exist in students' ability to critically think based on their degree program. However, no significant differences were observed among different academic strands, indicating that the previous senior high school background of students had minimal effect once they entered college. This is supported by the findings of Prabhakar, et al.(2023), who found that discipline-specific experiences and cognitive demands of academic programs have more impact on the development of students' analytical critical thinking skills than the educational experiences of students prior to entering college.

Post hoc pairwise comparisons conducted using Bonferroni adjustments revealed that there were no such pairs of courses that had statistically significant differences since the adjusted p-values were all greater than 0.05. However, several of the unadjusted p-values suggested differences among course pairs (e.g., BEED vs. BSMT, BEED vs. BSA), but when p-values were corrected for multiple comparisons, these differences were no longer statistically significant.

The results of Kruskal-Wallis suggest there are significant differences and variability across courses due to the nature of the omnibus results and randomly assigning students to courses through a lottery system. Sauro and Lewis (2012) state that Bonferroni correction may help control for the possibility of Type I error, however, it can mask the detectability of small differences in means, therefore explaining the difference observed in these two statistical assessments. In general, students' level of critical thinking will generally be related to their current program of study, however, there is insufficient statistical power. It is not possible to determine statistically significant pairwise differences between specific courses, based on the results of the Kruskal-Wallis and post hoc tests.

Table 10 indicates that the significant difference observed at the Kruskal-Wallis level (Table 9) is not attributable to any single pair of courses, but rather to the collective variation across all course groups.

## Section 4. Significant Difference In The Level Of Students' Engagement When Grouped According To Their Academic Strand And Course

Table 11 presents which profile of the students in terms of course have a significant difference in the level of their engagement.

**Table 11. Significant Difference In The Level Of Students Engagement When Grouped According To Their Course and Academic Strand**

| Profile | f | df | p-value | Decision |
|---|---|---|---|---|
| Course | 9.28 | 6 | 0.16 | Accept Ho |
| Academic Strand | 20.64 | 9 | 0.01 | Reject Ho |

**Ho= There is no significant difference in any profile variable on the level of critical thinking skills and their level of engagement in Mathematics in the Modern World*

The study results indicated that there is no significant difference in the students' level of engagement in Mathematics in the Modern World according to their current college course (f = 9.28, p = 0.16). That is to say, they all participated, paid attention, and got involved in the subject matter to a similar extent irrespective of whether they were taking up BSA, BSN, BSP, BEED, BSRT, BSMT, or BSBIO programs. This points to the conclusion that the engagement in MMW is determined more by the subject matter and the teaching approach than the academic program the student has chosen.

On the other hand, the engagement level of students was significantly different when they were classified according to their academic strand in senior high school (f = 20.64, p = 0.01). In another words, students' prior academic preparation and learning experiences in SHS, such as those coming from STEM, ABM, HUMSS, TVL, or other strands, have a statistically significant influence on the extent of their engagement in college mathematics. The students from the strands with more math exposure may feel more confident and motivated, while those who come from the strands with less math foundation may experience lower engagement because of anxiety or unfamiliarity with the quantitative concepts.

The study supports the idea that the educational background of students has a significant impact on their readiness, motivation, and participation in college general education courses (Del Rosario et al., 2024). Qian (2025) mentions that different learning environments provide varying amounts of confidence and interest to the students, which consequently control their involvement in mathematics-related areas. The findings indicate that even if the students' major does not cause a marked difference in participation, the academic track in secondary education does, so it is very important to prepare students with strong math skills and positive learning attitudes before they start their higher education journey.

Table 12 presents the post hoc pairwise comparison using the Dunn-Bonferroni Test of the academic strand profile of the respondents.

**Table 12. Pairwise Comparison Across Academic Strand of the Respondents**

| Sample 1-Sample 2 | Test Statistic | Std. Error | Std. Test Statistic | Sig. | Adj. Sig.[a] |
|---|---|---|---|---|---|
| PBHS-AGRIFISHERY ARTS | -5.083 | 77.481 | -.066 | .948 | 1.000 |
| PBHS-HOME ECONOMICS | -20.814 | 35.404 | -.588 | .557 | 1.000 |
| PBHS-NO STRAND | -26.383 | 43.437 | -.607 | .544 | 1.000 |
| PBHS-HUMMS | 41.729 | 30.607 | 1.363 | .173 | 1.000 |
| PBHS-ABM | 45.231 | 32.376 | 1.397 | .162 | 1.000 |
| PBHS-GAS | 49.842 | 32.172 | 1.549 | .121 | 1.000 |
| PBHS-ICT | -57.083 | 58.570 | -.975 | .330 | 1.000 |
| PBHS-INDUSTRIAL ARTS | -63.583 | 58.570 | -1.086 | .278 | 1.000 |
| PBHS-STEM | 77.884 | 30.168 | 2.582 | .010 | .442 |
| AGRIFISHERY ARTS-HOME ECONOMICS | 15.731 | 74.441 | .211 | .833 | 1.000 |
| AGRIFISHERY ARTS-NO STRAND | -21.300 | 78.580 | -.271 | .786 | 1.000 |
| AGRIFISHERY ARTS-HUMMS | 36.646 | 72.283 | .507 | .612 | 1.000 |
| AGRIFISHERY ARTS-ABM | 40.148 | 73.049 | .550 | .583 | 1.000 |
| AGRIFISHERY ARTS-GAS | 44.759 | 72.959 | .613 | .540 | 1.000 |
| AGRIFISHERY ARTS-ICT | 52.000 | 87.855 | .592 | .554 | 1.000 |
| AGRIFISHERY ARTS-INDUSTRIAL ARTS | -58.500 | 87.855 | -.666 | .505 | 1.000 |
| AGRIFISHERY ARTS-STEM | 72.801 | 72.098 | 1.010 | .313 | 1.000 |
| HOME ECONOMICS-NO STRAND | -5.569 | 37.748 | -.148 | .883 | 1.000 |
| HOME ECONOMICS-HUMMS | 20.915 | 21.794 | .960 | .337 | 1.000 |
| HOME ECONOMICS-ABM | 24.417 | 24.216 | 1.008 | .313 | 1.000 |
| HOME ECONOMICS-GAS | 29.028 | 23.943 | 1.212 | .225 | 1.000 |

| | | | | | |
|---|---|---|---|---|---|
| HOME ECONOMICS-ICT | -36.269 | 54.485 | -.666 | .506 | 1.000 |
| HOME ECONOMICS-INDUSTRIAL ARTS | -42.769 | 54.485 | -.785 | .432 | 1.000 |
| HOME ECONOMICS-STEM | 57.070 | 21.174 | 2.695 | .007 | .316 |
| NO STRAND-HUMMS | 15.346 | 33.291 | .461 | .645 | 1.000 |
| NO STRAND-ABM | 18.848 | 34.924 | .540 | .589 | 1.000 |
| NO STRAND-GAS | 23.459 | 34.736 | .675 | .499 | 1.000 |
| NO STRAND-ICT | 30.700 | 60.016 | .512 | .609 | 1.000 |
| NO STRAND-INDUSTRIAL ARTS | 37.200 | 60.016 | .620 | .535 | 1.000 |
| NO STRAND-STEM | 51.501 | 32.888 | 1.566 | .117 | 1.000 |
| HUMMS-ABM | 3.502 | 16.424 | .213 | .831 | 1.000 |
| HUMMS-GAS | 8.112 | 16.019 | .506 | .613 | 1.000 |
| HUMMS-ICT | -15.354 | 51.497 | -.298 | .766 | 1.000 |
| HUMMS-INDUSTRIAL ARTS | -21.854 | 51.497 | -.424 | .671 | 1.000 |
| HUMMS-STEM | -36.155 | 11.475 | -3.151 | .002 | .073 |
| ABM-GAS | -4.610 | 19.184 | -.240 | .810 | 1.000 |
| ABM-ICT | -11.852 | 52.568 | -.225 | .822 | 1.000 |
| ABM-INDUSTRIAL ARTS | -18.352 | 52.568 | -.349 | .727 | 1.000 |
| ABM-STEM | -32.653 | 15.591 | -2.094 | .036 | 1.000 |
| GAS-ICT | -7.241 | 52.443 | -.138 | .890 | 1.000 |
| GAS-INDUSTRIAL ARTS | -13.741 | 52.443 | -.262 | .793 | 1.000 |
| GAS-STEM | -28.042 | 15.164 | -1.849 | .064 | 1.000 |
| ICT-INDUSTRIAL ARTS | -6.500 | 71.733 | -.091 | .928 | 1.000 |
| ICT-STEM | 20.801 | 51.238 | .406 | .685 | 1.000 |
| INDUSTRIAL ARTS-STEM | 14.301 | 51.238 | .279 | .780 | 1.000 |

*Each row tests the null hypothesis that the Sample 1 and Sample 2 distributions are the same.*
*Asymptotic significances (2-sided tests) are displayed. The significance level is .050.*
*a. Significance values have been adjusted by the Bonferroni correction for multiple tests.*

The outcome of the pairwise comparison indicates that nearly all the different academic strands are alike in the level of their students' engagement to Mathematics in the Modern World. Only after the Bonferroni adjustment was made did the researchers observe that all the comparisons were yielding the Adjusted Sig. values, which were all taller than the critical value of 0.05, implying that no strand pairs are different from one another statistically.

The only pair that did not get adjusted but was still significant was PBHS–STEM (p = .010) and HOME ECONOMICS–STEM (p = .007); however, once they corrected for the multiple comparisons, both became non-significant (Adj. Sig. = .442 and .316, respectively). The same case goes for HUMSS–STEM and ABM–STEM as they were both having low p-values in the raw test, but the corrected values were still above the threshold.

This implies that under strict statistical controls, no particular SHS strand was statistically differentiated in terms of students' engagement from any other strand either way; in other words, the engagement of students in mathematics was across the board uniform in all the different strands regardless of their different prior academic preparations.

Even though the Kruskal-Wallis test (Table 11) indicated that the strands differ significantly, the pairwise comparisons indicated that no pair of strands is responsible for this difference after corrections for errors are made. The implication is that the strand influence might be widespread but not limited to certain pairs. The results are consistent with Istijanto & Nathalie (2024), who found that student engagement in academic tasks is primarily influenced by intrinsic factors like motivation, metacognition, and learning strategies, rather than by extrinsic background factors like academic track or previous curriculum. This provides a rationale for different strands of students eventually exhibiting the same levels of engagement in college mathematics.

**Section 5. Significant Relationship In The Level Of Critical Thinking Skills and Students Engagement in Mathematics in the Modern World**

Table 13 presents the significant relationship between the respondents critical thinking skills and engagement in mathematics in the modern world.
Table 13. Significant Relationship Between Students Critical Thinking Skills and Engagement in Mathematics in the Modern World.

**Table 13.** Significant Relationship Between The Respondents Critical Thinking Skills And Engagement

| | | Engagement |
|---|---|---|
| Critical | Pearson Correlation | .542** |
| | Sig. (2-tailed) | .000 |
| | Decision | Reject Ho |

** Correlation is significant at the 0.01 level (2-tailed).*
**Ho= There is no significant difference in any profile variable on the level of critical thinking skills and their level of engagement in Mathematics in the Modern World*

According to Table 13, a positive correlation was found among the students' critical thinking skills, and their engagement in the Mathematics in the Modern World course with the Pearson correlation coefficient of r = .542. It means that students' critical thinking skills are likely to develop together with the increase in their engagement, and this applies in reverse too.

The correlation is confirmed to be significant statistically at the 0.01 level (p = .000), which is way below the cutoff point of 0.05. Therefore, the null hypothesis claiming that there is no significant relationship is rejected. This means that students who are more engaged—participating actively, paying attention, exerting effort, and involving themselves cognitively and behaviorally—also tend to demonstrate higher levels of analysis, evaluation, and synthesis, which form the core of critical thinking skills.

Engagement in the subject matter, particularly mathematics, is a clear reflection of the degree to which the students are paying attention, exerting effort, and being persistent during the learning process. The students' active participation in the process through asking questions, solving problems, and reflecting on solutions is a good example of their critical thinking abilities being naturally exercised and even strengthened. Hence, engagement serves as both a precondition and a reinforcer of critical thinking development.

This result is consistent with the findings of a study that found that higher levels of student engagement significantly predict stronger critical thinking performance and overall cognitive development (Singh et al., 2022; Johar et al., 2023). Their study emphasized that active and meaningful involvement in academic tasks creates learning conditions that promote reasoning, analysis, and higher-order thinking—mirroring the relationship observed in your research.

## Conclusions

The study concerning the critical thinking capabilities of students in Mathematics in the Modern World shows that the students of the first year of college, in general, reveal Agree level of analytical, evaluative, and synthetic thinking. The students' evaluation ability was emphasized in their recommendations and comparing the information from different sources, which is proof of their capacity to handle and knock-down real-life problems through logical reasoning. The students' evaluative ability was, however, moderate as they mentioned being sure of their ability to evaluate problems, determine the validity of the information, and spot the biases, but having some difficulty with the case of the sources being conflicting or having opposite claims. The students' synthesis abilities, though still in the Agree range, were less developed in the area of offering alternative solutions which is caused by the need for more practice in the area of coming up with new ideas and integrating different sources together. The overall picture painted by the results of the study is that, although students have the basic critical thinking skills, these are just budding and hence the need for instructional support that is specific to their development to move on to the higher-order competencies.

The findings related to student engagement indicate that the learners' engagement was almost uniformly positive across the behavior, emotions, and cognitive aspects in the course of Modern Mathematics. In terms of behavioral aspect, playing the role of students, strong involvement, readiness to seek help, and perseverance are the main traits, however, they still get distracted occasionally and tend to put off the hard tasks. Emotional aspect is also good with students showing interest and having fun in learning math but the enthusiasm goes down pretty much when the problem is tough—this indicates that the students may have negative feelings or lack of self-confidence due to the hardest questions. On the cognitive level, students are eager to get good grades and apply the right strategies for understanding, problem-solving, and reflecting on learning; however, their ability to make connections between mathematics and real-life situations and to keep their focus outside the classroom is only moderate. In conclusion, these results suggest that above all, students are to some extent engaged in all areas; however, teaching them how to cope with tough tasks and increasing their cognitive involvement in mathematics are to be done more effectively.

The study result has shown that there are different levels of students' critical thinking skills according to the course they are taught, but if they are grouped by academic strand, the difference does not come out as significant. This implies that the acquisition of critical thinking skills is different for different degree programs, possibly the reason being differences in the administration of the curriculum, teaching methods and the cognitive level each course demands. On the other hand, the previous academic strands of the students did not seem to be the reason for the differences in their critical thinking level, which indicates that in college, learning experiences specific to the course have a more significant impact than that of the senior high school background. The outcome of the research highlights the necessity of teaching methods based on the course in the development of students' higher-order thinking skills.

The results indicated that there is no considerable difference in student engagement throughout the different courses which implies that Mathematics in the Modern World is still alike in terms of engagement levels through different degree programs. However, a notable difference was found when students were grouped by academic strand indicating that students' engagement is influenced by their senior high school preparation, prior mathematical experiences, and academic rigor with which they are familiar. For instance, STEM students might show higher commitment as a result of the rigorous mathematics they were exposed to, while the opposite could be true for non-STEM students who might be more anxious or less confident. Previous academic experiences and students' backgrounds are critical factors that might affect their participation/defaults (be it behavioral, emotional, or cognitive) in a particular subject. Thus, deployment of different teaching methods based on academic readiness of students may be a means to promote engagement in MMW.

The study revealed a positive and notable relationship between critical thinking skills of students and their participation in Mathematics in the Modern World as strong as ($r = .542$, $p < .001$). This means that the students who participated more—behaviorally, emotionally, and cognitively—are also the ones more likely to show high-level thinking in terms of analysis, evaluation, and synthesis. Engagement is an indicator of success in overcoming the challenges of the subject, reflecting on the matter, and being open to the different ways of solving problems.

## Recommendations

Based on the findings of the study, here are the recommendations of the study:

*For Teachers* - Adapt teaching strategies based on the course and academic strand of students. Use activities that develop both engagement and critical thinking. Provide additional support to students from strands with lower engagement levels. Enhance classroom interactions to strengthen student engagement.

*For Students* - Actively participate in class activities to improve both engagement and critical thinking skills. Seek academic assistance when needed. Develop positive study habits and reduce reliance on memorization.

*For Program Heads* - Assist teachers in designing contextualized learning materials appropriate to the needs of different courses and strands. Encourage faculty mentoring and sharing of best practices. Monitor the progress of students across strands and courses.

*For Future Researchers* - Investigate other variables that may influence engagement and critical thinking, such as motivation, learning environment, teaching styles, or digital literacy. Use qualitative or mixed-methods approaches to better understand why specific strands show differences in engagement. Include larger and more diverse samples to compare results across institutions and year levels. Examine intervention programs and test their effectiveness in improving critical thinking and engagement over time.

**Compliance with Ethical Standards**

This study was conducted in strict adherence to established ethical research protocols to ensure the protection of all participants and the integrity of the scientific process. Prior to data collection, the researcher obtained formal permission from the administration of PLT College, Inc. and collaborated with Mathematics in the Modern World (MMW) instructors to ensure a non-disruptive gathering process. Informed consent was obtained from all student respondents, who were explicitly briefed on the study's objectives and their right to voluntary participation, including the freedom to withdraw at any stage without repercussion.

To uphold the highest standards of Data Privacy, all responses collected via Google Forms were anonymized, ensuring that the identity of the students remained confidential and that no personal data could be traced back to individuals. The researcher maintained the well-being of respondents by ensuring the survey did not interfere with their regular academic schedule. Furthermore, no conflicts of interest were present in the conduct of this study, and plagiarism was strictly avoided through the diligent citation of all referenced literature.

The interpretation of the Kruskal-Wallis, post hoc, and Pearson correlation results was performed objectively and transparently, ensuring that the reported levels of critical thinking and engagement were not subject to researcher bias. The data generated were utilized solely for academic purposes to contribute to the pedagogical understanding of mathematics education. Artificial intelligence tools were utilized exclusively for language refinement and structural guidance; however, the researcher maintains full responsibility for the scientific accuracy and original content of the final manuscript.

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