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The Association Between Recreational Mathematics Learning on the Students' Engagement and Higher-Order Thinking Skills

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Abstract*—This study aimed to determine the association between Recreational Mathematics Learning on the Students' Engagement, and Higher-Order Thinking Skills among selected Grade 11 Senior High School. Specifically, it sought to identify the level of Recreational Mathematics Learning, the level of students' engagement on the level of students' higher-order thinking skills. A descriptive-correlational research design was used with 80 Grade 11 students from three schools during the School Year 2025–2026, selected through a purposive sampling. Data were collected using a 5-point Likert scale questionnaire and analyzed using weighted mean, standard deviation, and Pearson Product-Moment Correlation Coefficient. Findings revealed that the levels of Recreational Mathematics Learning, Students' Engagement and Higher-Order Thinking Skills in all variables were rated high, indicating that students generally experience Recreational Mathematics Learning are engaged while also demonstrating strong higher-order thinking skills. Findings revealed significant associations between Recreational Mathematics Learning on the Students' Engagement and Higher-Order Thinking Skills. The study concludes that Recreational Mathematics Learning was significantly associated with students' engagement and higher-order thinking skills. As a result, the null hypotheses were rejected. Overall, the results emphasized that integrating recreational mathematics into instruction enhances students' active participation, motivation, and cognitive development, leading to more meaningful and effective learning experiences. It is therefore recommended that teachers may include recreational mathematics, higher-order thinking tasks, and problem-solving activities in their lessons to make learning more engaging and to help develop students' thinking skills. Students are encouraged to take part in these activities more actively so they can improve their critical thinking and problem-solving skills even outside the classroom. Future researchers are also encouraged to explore this topic further using larger groups of participants and stronger research designs.*

***Keywords*—** *Recreational mathematics learning, students' engagement, higher-order thinking skills.*

I. INTRODUCTION

In today's classrooms, there is a growing need for teaching methods that go beyond simply passing information to students and instead encourage active participation and deeper thinking. Approaches that rely heavily on memorization often do not lead to meaningful understanding or long-term learning. Students are more likely to learn effectively when they are engaged in the process, encouraged to be curious, to ask questions, to explore concepts, and to reflect on their own thinking.

As noted by Zelbo (2019), recreational mathematics and mathematical connections have been studied to improve student learning. When learners take a more active role in their education, they tend to become more motivated, independent, and confident in applying their knowledge to new situations. This kind of learning environment also helps build critical thinking skills and supports lifelong learning beyond the classroom.

One approach with strong potential is recreational mathematics learning, which includes fun, interactive activities such as puzzles, games, and brain teasers. Anggraeni & Budiharti (2021) emphasized that employing recreational math in the classroom is a sure way to increase student achievement and motivation. All these activities and exercises are meant to make students familiar with mathematical concepts and to develop their confidence and curiosity in low-stress conditions.

These activities make math more enjoyable and less intimidating, helping reduce anxiety and build a more positive attitude toward the subject. More importantly, they challenge students to think logically, recognize patterns, and test different strategies. Instead of simply following procedures, students are encouraged to explore and discover solutions on their own. This process naturally develops higher-order thinking skills such as analyzing, evaluating, and creating, which are key levels in Bloom's Taxonomy.

This study examines the association among recreational mathematics learning, student engagement, and higher-order thinking skills. It seeks to find out whether the use of recreational mathematics activities in lessons can enhance students' participation, interest, and overall learning experience. By exploring these relationships, the study aims to offer practical insights for teachers who want to make their instruction more engaging and effective. The results may help improve teaching strategies, support better student outcomes, and contribute to the ongoing development of educational practices that encourage deeper and more meaningful learning.

1.1 Statement of the Problem

Problem/s which were addressed by the research

This study aimed to determine the association between recreational mathematics learning on the students' engagement and higher-order thinking skills.

Specifically, it sought answers to the following questions:

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1. What is the level of recreational mathematics learning in terms of:
   1.1. Focus on Enjoyment,
   1.2. Accessibility,
   1.3. Element of Surprise,
   1.4. Didactive Value, and
   1.5. Interdisciplinary Connection?
2. What is the level of students' engagement in terms of:
   2.1. Academic,
   2.2. Emotional,
   2.3. Social; and
   2.4. Personal?
3. What is the level of students' higher-order thinking skills in terms of:
   3.1. Critical Thinking,
   3.2. Creative Thinking,
   3.3. Analysis,
   3.4. Metacognition, and
   3.5. Synthesizing?
4. Does recreational mathematics learning significantly relate to students' engagement in selected Grade 11 senior high schools?
5. Does the recreational mathematics learning significantly relate to the students' higher-order thinking skills of selected Grade 11 Senior High School?

II. Methodology

A descriptive-correlational research design was used with 80 Grade 11 students from three schools during the School Year 2025–2026, selected through a purposive sampling. Data were collected using a 5-point Likert scale questionnaire and analyzed using weighted mean, standard deviation, and Pearson Product-Moment Correlation Coefficient.

III. Results and Discussion

This chapter presents, analyzes, and interprets the data collected that showed a significant relationship between the Recreational Mathematics Learning and Students' Engagement, as well as Students' Higher-Order Thinking Skills in a selected Grade 11 Senior High School.

Recreational Mathematics Learning

This study involved mathematical problems, puzzles, games, and activities designed primarily for amusement and mental stimulation, often encouraging problem-solving outside traditional classroom settings.

Recreational Mathematics Learning provides students with opportunities to develop critical thinking skills as they work through challenges. It promotes collaboration when activities are done in groups. To interpret the data, statistical tools such as the mean and standard deviation were used. The mean was applied to determine the average level of students' responses for each indicator, providing an overall picture of their experiences. On the other hand, the standard deviation was used to assess the variation in responses among students, indicating whether their perceptions were similar or varied. These statistical measures help provide a clearer, more reliable interpretation of how respondents experience recreational mathematics learning.

Table 1 presents the level of recreational mathematics learning, as perceived by students, in terms of focus on enjoyment. The table shows several indicators, along with their corresponding means, standard deviations, and verbal remarks.

Table 1. Level of Recreational Mathematics Learning in Terms of Focus on Enjoyment

Statements As a student I…	Mean	SD	Remarks
…participate willingly in math activities because they are fun and exciting.	3.79	0.96	Often
…show interest by paying attention and joining activities during enjoyable math lessons.	4.10	0.88	Often
…demonstrate appreciation for math lessons that incorporate games, puzzles, and fun activities.	4.06	0.93	Often
…express positive feelings, such as happiness or excitement, during math games.	4.11	0.93	Often
…value learning mathematics more when lessons are enjoyable and playful.	4.19	0.76	Often
Weighted Mean	4.05		
SD	0.90		
Verbal Interpretation	High		

Table 1 shows that students are likely to take part in enjoyable activities, participate in lessons with enthusiasm, and enjoy playing games and puzzles while engaged in mathematics. All respondents showed a high level of agreement, as evidenced by an aggregate weighted mean of 4.05 and a standard deviation of 0.90, both indicating that student responses are fairly similar. These results also support the conclusion that the vast majority of students believe they enjoy recreational mathematics and experience it as a positive emotion.

As a result, incorporating elements of enjoyment, fun, and playfulness into math instruction will foster positive emotions and motivate students to participate actively in math and develop a greater appreciation for the subject. Similarly, creating opportunities for students to enjoy their math learning experience will help facilitate greater participation in mathematics by providing positive experiences and meaningful learning.

Table 2 indicates the level of recreational mathematics learning in terms of accessibility, as perceived by the students. The table shows several indicators, along with their corresponding means, standard deviations, and verbal remarks.

Table 2. Level of Recreational Mathematics Learning in Terms of Accessibility

Statements As a student I…	Mean	SD	Remarks
…recall math concepts more easily after learning them through fun and interactive activities.	3.83	0.96	Often
…identify important math concepts while participating in recreational math activities.	3.81	0.93	Often
…understand math lessons better when teachers use games and recreational tasks.	3.99	0.82	Often
…explain math concepts clearly after learning them through fun classroom activities.	4.06	0.86	Often
…describe how recreational math activities help make lessons easier to understand.	3.90	0.89	Often
Weighted Mean	3.92		
SD	0.89		
Verbal Interpretation	High		

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Table 2 shows a high degree of consistency in the responses, as reflected in a weighted mean of 3.92 and a standard deviation of 0.89. These values suggest that students share similar perceptions regarding the accessibility of recreational mathematics. Overall, the findings suggest that students commonly experience greater understanding and clarity when engaged in enjoyable, interactive math activities.

In summary, the use of recreational mathematics enhances learning accessibility by making concepts easier to understand, recall, and communicate. Providing engaging and interactive activities supports students in developing clearer comprehension and promotes more effective participation in mathematics.

Table 3 indicates the level of recreational mathematics learning in terms of the element of surprise, as perceived by the students. The table shows several indicators, along with their corresponding means, standard deviations, and verbal remarks.

Table 3. Level of Recreational Mathematics Learning in Terms of Element of Surprise

Statements As a student I…	Mean	SD	Remarks
…notice new and interesting math ideas when activities include surprises.	4.10	0.84	Often
…participate more actively when math lessons include unexpected challenges.	3.95	0.83	Often
…apply math skills to solve problems that are presented in surprising ways.	3.85	0.87	Often
…explore different methods to solve fun math puzzles and surprise problems.	3.88	0.91	Often
…show curiosity by asking questions during surprising math activities.	4.00	0.87	Often
Weighted Mean	3.96		
SD	0.86		
Verbal Interpretation	High		

Table 3 shows that students perceive surprise as an important factor in enhancing their learning of mathematics. Students reported noticing new and interesting math ideas, participating more actively, and showing curiosity when activities involved surprises. They also indicated that they can apply math skills and explore different problem-solving methods when tasks are presented in creative and unexpected ways, highlighting the role of surprise in stimulating interest and deeper thinking. The responses showed high consistency among respondents, as reflected in a weighted mean of 3.96 and a standard deviation of 0.86. These values suggest that students share similar perceptions regarding the use of surprise in recreational mathematics.

In summary, integrating elements of surprise into mathematics instruction enhances student participation, curiosity, and problem-solving skills. Providing unexpected, stimulating activities encourages learners to explore new ideas and fosters a more engaging, meaningful mathematics learning experience. Overall, the findings suggest that incorporating unexpected challenges and novel activities positively affects students' engagement and curiosity in learning mathematics.

Table 4 indicates the level of recreational mathematics learning in terms of didactic value, as perceived by the students. The table shows indicators along with their corresponding mean, standard deviation, and verbal remarks.

Table 4 shows that students perceive recreational mathematics as having strong instructional or didactic value in supporting their learning. The responses were highly consistent, as reflected in the weighted mean of 3.87 and a standard deviation of 0.88. These values suggest that students share similar perceptions regarding the instructional value of recreational mathematics.

Overall, the findings suggest that engaging in fun and meaningful math activities improves understanding, application, and performance in mathematics.

Table 4. Level of Recreational Mathematics Learning in Terms of Didactive value

Statements As a student I…	Mean	SD	Remarks
…explain what math lessons I learn from games and recreational activities.	3.81	0.86	Often
…apply math concepts learned from fun activities to regular classwork.	3.86	0.88	Often
…use skills learned in recreational math activities during quizzes and tests.	3.86	0.87	Often
…show understanding by correctly answering questions after fun lessons.	3.86	0.91	Often
…show improvement in math skills after participating in recreational activities.	3.95	0.88	Often
Weighted Mean	3.87		
SD	0.88		
Verbal Interpretation	High		

In summary, the integration of recreational mathematics in instruction enhances its didactic value by promoting the application of concepts, strengthening skills, and improving student performance. Providing opportunities for interactive and enjoyable learning experiences.

Table 5 indicates the level of recreational mathematics learning in terms of interdisciplinary connection, as perceived by the students. The table shows several indicators, along with their corresponding means, standard deviations, and verbal remarks.

Table 5. Level of Recreational Mathematics Learning in Terms of Interdisciplinary Connection

Statements As a student I…	Mean	SD	Remarks
…stay attentive throughout math lessons that include recreational activities.	3.90	1.03	Often
…participate actively by answering questions and joining math activities.	3.94	0.99	Often
…contribute ideas during group math discussions.	3.91	0.94	Often
…analyze math problems carefully during fun classroom activities.	3.88	0.91	Often
…show active involvement during recreational math tasks.	3.90	0.87	Often
Weighted Mean	3.91		
SD	0.87		
Verbal Interpretation	High		

Table 5 shows that students perceive recreational mathematics as promoting interdisciplinary connections through active engagement. The respondents were very similar, as reflected in a weighted mean of 3.91 and a standard

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deviation of 0.87. These values suggest that students share similar perceptions regarding the interdisciplinary benefits of recreational mathematics

In summary, incorporating recreational mathematics into instruction enhances interdisciplinary connections by encouraging active participation, collaboration, and critical thinking. Providing engaging and interactive learning experiences helps students make meaningful connections and promotes a more participatory mathematics learning environment.

Students' Engagement

In this study, this refers to the level of interest, motivation, and active participation that students exhibit toward their learning and school environment. It's a key factor in academic success and personal development. The levels of students' academic, emotional, social, and personal engagement were analyzed statistically using means and standard deviations.

Table 6 presents the level of students' academic engagement. The table shows several indicators, along with their corresponding means, standard deviations, and verbal remarks.

Table 6. Level of Students' Engagement in Terms of Academic Engagement

Statements As a student I…	Mean	SD	Remarks
…practice math skills by actively participating in fun math activities.	3.95	0.88	Often
…put effort into solving math problems during games or activities.	3.86	0.81	Often
…stay focused on task during math lessons.	3.95	0.74	Often
…complete math tasks on time during recreational lessons.	3.84	0.74	Often
…work carefully on math activities to produce correct answers.	3.99	0.74	Often
Weighted Mean	3.92		
SD	0.78		
Verbal Interpretation	High		

Table 6 shows that the responses were largely consistent, showing similar patterns across participants, as reflected in the weighted mean of 3.92 and a standard deviation of 0.78. These values suggest that students share similar perceptions of their academic engagement.

In summary, the use of recreational mathematics enhances students' academic engagement by promoting active participation. Providing enjoyable learning experiences encourages students to invest effort and take responsibility for their learning, leading to more effective academic outcomes.

Table 7 presents the level of students' emotional engagement. The table shows several indicators, along with their corresponding means, standard deviations, and verbal remarks.

Table 7 shows that students demonstrate a high level of emotional engagement when participating in recreational mathematics activities. The responses showed strong consistency across all participants, as reflected in a weighted mean of 4.08 and a standard deviation of 0.88. These values suggest that students share similar perceptions regarding their emotional engagement.

In summary, integrating recreational mathematics into instruction enhances students' emotional engagement. Providing a more positive attitude toward mathematics encourages greater involvement in learning.

Table 7. Level of Students' Engagement in Terms of Emotional Engagement

Statements As a student I…	Mean	SD	Remarks
…feel excited during fun and interactive math lessons.	4.10	0.94	Often
…feel motivated to learn math during enjoyable lessons.	4.10	0.87	Often
…enjoy participating in math games or puzzles.	4.09	0.94	Often
…develop positive feelings toward mathematics through recreational activities.	4.01	0.85	Often
…appreciate mathematics more when lessons include fun activities.	4.09	0.83	Often
Weighted Mean	4.08		
SD	0.88		
Verbal Interpretation	High		

Table 8 presents the level of students' social engagement. The table shows indicators along with their corresponding mean, standard deviation, and verbal remarks.

Table 8. Level of Students' Engagement in Terms of Social Engagement

Statements As a student I…	Mean	SD	Remarks
…work cooperatively with classmates during math group activities.	4.13	0.82	Often
…share ideas and answers with classmates during discussions.	4.10	0.76	Often
…explain my math thinking to others during group work.	3.98	0.87	Often
…compare my ideas with classmates' ideas during activities.	3.81	0.93	Often
…support classmates while solving math problems together.	4.34	0.79	Always
Weighted Mean	4.07		
SD	0.83		
Verbal Interpretation	High		

Table 8 shows that students demonstrate a high level of social engagement when participating in recreational mathematics activities. Most respondents gave very similar answers, with a clear consistency reflected in the weighted mean of 4.07 and a standard deviation of 0.83. These values suggest that students share perceptions regarding their level of social engagement.

In summary, integrating recreational mathematics into instruction enhances students' social engagement. Providing opportunities for group interaction and collaborative problem-solving fosters a more interactive and supportive learning environment.

Table 9 presents the level of students' personal engagement. The table shows several indicators, along with their corresponding means, standard deviations, and verbal remarks.

Table 9 shows that students demonstrate a high level of personal engagement when participating in recreational mathematics activities. The responses showed high consistency, as reflected in a weighted mean of 3.91 and a standard deviation of 0.89. These values suggest that students share similar perceptions of their personal engagement. Overall, the findings imply that recreational mathematics

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supports students in being responsible, reflective, and persistent in their learning.

Table 9. Level of Students' Engagement in Terms of Personal Engagement

Statements As a student I…	Mean	SD	Remarks
…monitor my effort and participation during math activities.	4.00	0.84	Often
…continue solving math problems even when they are difficult.	3.76	0.93	Often
…evaluate my performance after completing math tasks.	3.90	0.92	Often
…take responsibility for finishing my math work properly.	3.96	0.93	Often
…reflect on what I learned after each math activity.	3.94	0.83	Often
Weighted Mean	3.91		
SD	0.89		
Verbal Interpretation	High		

In summary, integrating recreational mathematics into instruction enhances students' personal engagement by fostering self-monitoring, reflection, and accountability. Providing interactive and enjoyable learning experiences encourages learners to take ownership of their learning and persist in solving problems, leading to more meaningful and effective mathematics outcomes.

Students' Higher-Order Thinking Skills

In this study, these are cognitive processes that involve critical thinking, creative thinking, analysis, metacognition, and synthesizing beyond basic memorization or recall. These skills enable learners to analyze, evaluate, and create new knowledge, thereby solving complex problems. The development of these higher-order thinking skills fosters independent learning and enhances students' ability to make informed decisions.

The level of students' higher-order thinking skills in terms of critical thinking, creative thinking, analysis, metacognition, and synthesizing was treated statistically using mean and standard deviation.

Table 10 presents the level of students' higher-order thinking skills in critical thinking. The table shows several indicators, along with their corresponding means, standard deviations, and verbal remarks.

Table 10. Level of Students' Higher-Order Thinking Skills in Terms of Critical Thinking

Statements As a student I…	Mean	SD	Remarks
…analyze different strategies used to solve math problems.	4.13	0.74	Often
…check whether math answers are correct or incorrect.	3.94	0.95	Often
…justify answers by explaining my reasoning clearly.	3.73	0.84	Often
…evaluate which problem-solving method works best.	3.88	0.92	Often
…choose the most effective solution for a math problem.	4.01	0.89	Often
Weighted Mean	3.94		
SD	0.87		
Verbal Interpretation	High		

Table 10 shows that students demonstrate a high level of critical thinking when engaged in recreational mathematics activities. There was a high level of consistency in the responses, as shown by the weighted mean of 3.94 and a standard deviation of 0.87. These values emphasized that students share similar perceptions regarding their critical thinking skills.

In summary, incorporating recreational mathematics into instruction enhances students' critical thinking by encouraging careful analysis allowing students to explore multiple strategies and make informed decisions, promoting higher-order cognitive skills in mathematics learning.

Table 11 presents the level of students' higher-order thinking skills in creative thinking. The table shows several indicators, along with their corresponding means, standard deviations, and verbal remarks.

Table 11 shows that students demonstrate a high level of creative thinking when participating in recreational mathematics activities. There is a high degree of consistency among the responses, as reflected in the weighted mean of 3.75 and a standard deviation of 0.96. These values suggest that students share similar perceptions regarding their creative thinking skills. Overall, the findings imply that recreational mathematics explore multiple approaches, think innovatively, and develop original solutions to mathematical challenges.

Table 11. Level of Students' Higher-Order Thinking Skills in Terms of Creative Thinking

Statements As a student I…	Mean	SD	Remarks
…try new strategies when solving math tasks.	4.00	0.93	Often
…develop original solutions for math challenges.	3.76	0.92	Often
…create new ways to solve math problems during activities.	3.69	1.03	Often
…generate more than one answer to a math problem.	3.59	0.96	Often
…produce creative ideas during recreational math activities.	3.71	0.96	Often
Weighted Mean	3.75		
SD	0.96		
Verbal Interpretation	High		

In summary, incorporating recreational mathematics into instruction enhances students' creative thinking by promoting flexibility, and idea generation. Providing engaging and interactive activities encourages learners to approach problems from different perspectives and apply inventive strategies, supporting the development of higher-order thinking skills in mathematics.

Table 12 shows the level of students' higher-order thinking skills in analysis. The table shows several indicators, along with their corresponding means, standard deviations, and verbal remarks.

Table 12 shows that students demonstrate a high level of analytical thinking when engaged in recreational mathematics activities. The responses were quite consistent overall, with most respondents giving similar answers as reflected in the weighted mean of 3.78 and a standard deviation of 0.97. These values suggest that students share similar perceptions regarding their analytical skills.

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Table 12. Level of Students' Higher-Order Thinking Skills in Terms of Analysis

Statements As a student I…	Mean	SD	Remarks
…analyze patterns and relationships in math problems.	3.80	1.04	Often
…break down difficult math problems into simpler parts.	3.69	0.98	Often
…compare different methods used to solve problems.	3.73	0.98	Often
…examine how numbers and ideas are connected.	3.84	0.91	Often
….organize information carefully to solve math tasks.	3.85	0.94	Often
Weighted Mean	3.78		
SD	0.97		
Verbal Interpretation	High		

In summary, incorporating recreational mathematics into instruction enhances students' analytical thinking by promoting careful examination. Providing interactive, challenging activities encourages learners to approach problems methodically and to develop higher-order cognitive skills.

Table 13 presents the level of students' higher-order thinking skills in metacognition. The table shows several indicators, along with their corresponding means, standard deviations, and verbal remarks.

Table 13. Level of Students' Higher-Order Thinking Skills in Terms of Metacognition

Statements As a student I…	Mean	SD	Remarks
…identify my strengths and weaknesses in mathematics.	4.15	0.87	Often
…monitor my understanding during math activities.	3.96	0.89	Often
…adjust my strategy when I do not understand a problem.	3.93	0.82	Often
…evaluate how well my solution works.	3.86	0.91	Often
…reflect on my thinking while solving math problems.	4.01	0.95	Often
Weighted Mean	3.98		
SD	0.89		
Verbal Interpretation	High		

Table 13 shows that students demonstrate a high level of metacognitive skills when participating in recreational mathematics activities. There is a high degree of consistency among the responses, as reflected in the weighted mean of 3.98 and a standard deviation of 0.89. These values suggest that students share similar perceptions regarding their metacognitive skills.

In summary, incorporating recreational mathematics into instruction enhances students' metacognitive abilities. Providing engaging, interactive activities helps learners become more aware of their thinking processes.

Table 14 indicates the level of students' higher-order thinking skills in terms of synthesizing. The table shows several indicators along with their corresponding mean, standard deviation, and verbal remarks.

Table 14 shows that students demonstrate a high level of synthesizing skills when engaged in recreational mathematics activities. There is a high degree of consistency among the responses, as reflected in the weighted mean of 3.82 and a standard deviation of 0.88. These values suggest that students share similar perceptions regarding their synthesizing skills. Overall, the findings imply that recreational mathematics supports students in combining prior knowledge with new information, constructing coherent solutions, and drawing meaningful conclusions.

Table 14. Level of Students' Higher-Order Thinking Skills in Terms of Synthesizing

Statements As a student I…	Mean	SD	Remarks
…combine ideas from different math lessons to solve problems.	3.99	0.82	Often
…construct solutions using ideas from different topics.	3.81	0.94	Often
…integrate what I learned before with new math concepts.	3.83	0.82	Often
…summarize key ideas learned after math activities.	3.71	0.93	Often
…formulate conclusions based on completed math tasks.	3.76	0.89	Often
Weighted Mean	3.82		
SD	0.88		
Verbal Interpretation	High		

In summary, incorporating recreational mathematics into instruction enhances students' synthesizing abilities by promoting integration, organization, and application of ideas. Providing engaging and interactive activities encourages learners to make connections across concepts, summarize understanding, and construct well-founded conclusions.

Test of Significant Association between Recreational Mathematics Learning and Students' Engagement

To test the significant association between recreational mathematics learning and students' engagement in terms of the academic engagement, emotional engagement, social engagement, and personal engagement, the data were statistically analyzed using Jamovi 2.3.28 using the Pearson correlation coefficient.

Table 15 shows a significant association between recreational mathematics learning and students' academic, emotional, social, and personal engagement, as measured by the Pearson correlation coefficient.

Table 15 shows that recreational mathematics learning is associated with students' engagement across all aspects. There were no negative associations from any component of recreational mathematics learning, such as focus on enjoyment, accessibility, element of surprise, didactic value, or interdisciplinary approach, and, therefore, the increase in recreational mathematics learning corresponds with the increase in students' engagement. This implies that students become more motivated and actively involved in classroom activities when recreational mathematics strategies are integrated into instruction.

The results revealed that focus on enjoyment has a moderate positive association with all types of student engagement: Cognitive; emotional; social; and personal. This means that students who perceive mathematics as enjoyable are more likely to be cognitively, emotionally, and socially

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engaged, and to be personally invested in their mathematics learning.

Table 15. Recreational Mathematics Learning and Students' Engagement

Recreational Mathematics Learning		Students' Engagement			
		Academic	Emotional	Social	Personal
Focus on Enjoyment	Pearson Correlation	0.63***	0.62***	0.44***	0.46***
	Significance (2-Tailed)	<.001	<.001	<.001	<.001
	N	80	80	80	80
Accessibility	Pearson Correlation	0.69***	0.68***	0.65***	0.74***
	Significance (2-Tailed)	<.001	<.001	<.001	<.001
	N	80	80	80	80
Element of Surprise	Pearson Correlation	0.63***	0.63***	0.54***	0.67***
	Significance (2-Tailed)	<.001	<.001	<.001	<.001
	N	80	80	80	80
Didactive Value	Pearson Correlation	0.72***	0.67***	0.57***	0.60***
	Significance (2-Tailed)	<.001	<.001	<.001	<.001
	N	80	80	80	80
Interdisciplinary Connection	Pearson Correlation	0.71***	0.71***	0.70***	0.60***
	Significance (2-Tailed)	<.001	<.001	<.001	<.001
	N	80	80	80	80

Note: *p<.05, ** p<.01, ***p<.001

Accessibility has a strong positive correlation to all types of engagement. This means that when students can easily understand and access mathematical activities and resources, they will generally become more actively engaged, feel positively towards them, work collaboratively with other students, and take personal responsibility for their mathematics learning.

The element of surprise exhibits a moderate positive association with all types of engagement. This supports that by creating unexpected and/or new experiences in math instruction, students are more likely to show interest; increase their emotional involvement, increase their likelihood of social interactions, and become personally engaged.

Similarly, didactic value exhibits moderate to strong positive association with students' engagement. This indicates that if students view math activities as meaningful and educational, they will typically be more engaged with academic tasks, experience positive emotions and social interactions with peers, and develop a sense of commitment to their learning from math.

In addition, the interdisciplinary approach exhibits a strong positive association with academic engagement, emotional engagement, and social engagement, along with a moderate correlation with personal engagement. This emphasized that when math is viewed as being integrated with other disciplines, students will understand math concepts better, be more interested in mathematics, work collaboratively with other students, and be more personally involved in their own learning.

In summary, this implies that students' engagement with recreational mathematics learning is strongly and positively association across all areas of engagement. Most of the associations were found to have moderate to strong positive association. Fostering greater enjoyment, accessibility, creativity, instructional values and inter-disciplinary connections in mathematics allows for greater improvements in students' academic involvement, emotional bonds with mathematics, social interactions with others while learning mathematics and personal commitment to the study of mathematics.

Test of Significant Association between Recreational Mathematics Learning and Students' Higher-Order Thinking Skills

To test the significant association between recreational mathematics learning and students' higher-order thinking skills in terms of the academic engagement, emotional engagement, social engagement and personal engagement, was treated statistically using Jamovi 2.3.28 using the Pearson correlation coefficient.

Table 16 indicates the association between recreational mathematics learning and students' higher-order thinking skills in terms of critical thinking, creative thinking, analysis, metacognition, and synthesis using the Pearson correlation coefficient.

Table 16 shows a significant association between recreational mathematics learning and all elements of students' higher-order thinking skills. The five components of recreational mathematics all showed upward momentum in each student's higher-order thinking abilities. Thus, as students participated in more recreational mathematics, they were able to develop more and better higher-order thinking skills. This indicates that recreational mathematics activities help students enhance their abilities.

The results revealed that focus on enjoyment demonstrated a moderate positive association with each of the higher-order thinking skills, which implies that if a student enjoys working with mathematics, they will be able to critically evaluate, create original ideas, analyze problem solutions, reflect on the way they think, and bring together many concepts into one idea.

Accessibility had a moderate to strong positive association with all higher-order thinking skills, indicating that when the concepts in mathematics are made clear to the student, adding an element of fun, they will be engaged in thinking about what they are learning to a greater degree, thus being able to engage in a deeper level of analysis when evaluating their learning outcomes and process of thought.

Likewise, the element of surprise had a moderate to strong positive association with all higher-order thinking skills, indicating that when a student encounters something new and unexpected while learning, it prompts deeper thought, creating an opportunity to display higher-order thinking.

The didactic value of recreational mathematics appears to have a positive association with each dimension of higher-

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order thinking skill. This implies that when students view mathematical activities as meaningful and purposeful, they are more inclined to engage in critical analysis, creative exploration, and metacognitive reflection.

Table 16. Recreational Mathematics Learning and Students' Higher-Order Thinking Skills

Recreational Mathematics Learning		Students' Higher-Order Thinking Skills				
		Critical Thinking	Creative Thinking	Analysis	Metacognition	Synthesizing
Focus on Enjoyment	Pearson Correlation	0.49***	0.49***	0.48***	0.59***	0.54***
	Significance (2-Tailed)	<.001	<.001	<.001	<.001	<.001
	N	80	80	80	80	80
Accessibility	Pearson Correlation	0.66***	0.56***	0.70***	0.67***	0.65***
	Significance (2-Tailed)	<.001	<.001	<.001	<.001	<.001
	N	80	80	80	80	80
Element of Surprise	Pearson Correlation	0.64***	0.50***	0.66***	0.70***	0.64***
	Significance (2-Tailed)	<.001	<.001	<.001	<.001	<.001
	N	80	80	80	80	80
Didactive Value	Pearson Correlation	0.66***	0.65***	0.71***	0.68***	0.68***
	Significance (2-Tailed)	<.001	<.001	<.001	<.001	<.001
	N	80	80	80	80	80
Interdisciplinary Connection	Pearson Correlation	0.68***	0.65***	0.71***	0.67***	0.70***
	Significance (2-Tailed)	<.001	<.001	<.001	<.001	<.001
	N	80	80	80	80	80

Note: *p<.05, ** p<.01, ***p<.001

Additionally, there is a significant positive association across all higher-order thinking skills when using an interdisciplinary approach to learning. This indicates that when mathematics is integrated with other subjects, students will be able to utilize higher-order thinking processes, including connecting concepts, thinking more broadly and using higher cognitive processes, such as analysis.

In summary, the data implies that students' higher-order thinking skills are associated positively and substantially through recreational mathematics. That is, most of the associations show moderate to strong positive association; therefore, engaging students in meaningful, accessible, and interdisciplinary experiences in mathematics will greatly contribute to their critical thinking, creativity, analytical and metacognitive abilities, and their ability to synthesize information into new contexts.

IV. Conclusion and Recommendations

There is a significant association between Recreational Mathematics Learning and the students' engagement in terms of academic, emotional, social, and personal aspects. Therefore, the null hypothesis is rejected. This means that recreational mathematics learning positively influences students' overall engagement by encouraging active participation, improving interest in learning, strengthening social interaction, and increasing students' confidence and motivation in mathematics.

There is a significant association between Recreational Mathematics Learning and the students' higher-order thinking skills in terms of critical thinking, creative thinking, analysis, metacognition, and synthesizing. Therefore, the null hypothesis is rejected. This implies that recreational mathematics learning helps students develop deeper thinking skills by encouraging them to analyze problems carefully, generate creative ideas, reflect on their own thinking processes, and connect concepts to form meaningful solutions.

Based on the conclusions drawn from the study, and in consideration of the significant positive effects of recreational mathematics learning on both students' engagement and higher-order thinking skills, the following recommendations are advised:

School administrators may continue to support the integration of recreational mathematics learning by providing resources, training, and opportunities such as math clubs and competitions.

Teachers may incorporate recreational mathematics into their lessons to increase student engagement and promote higher-order thinking skills. They may encourage students to actively engage in recreational mathematics learning activities such as puzzles and games.

Future researchers may be encouraged to explore the long-term and broader effects of recreational mathematics across different contexts and variables. Further studies may focus on specific strategies and use mixed-method approaches to gain a more comprehensive understanding of its impact.

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