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Integrating Traditional Games (TG) in Mathematics to Enhance Students' Conceptual Understanding, Social Skills, and Attitudes

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Integrating traditional games into the classroom enriches educational experiences, promoting cultural preservation and active learning. This quasi-experimental study examined the effects of integrating TG into mathematics lessons on Grade 8 students' conceptual understanding, social skills, and attitudes toward mathematics. Forty-two students from a public secondary high school in the Philippines were selected through purposive sampling based on specific criteria. The study employed t-tests for both dependent and independent samples to analyze the effect of integrating TG in mathematics lessons as activities to students' learning, using data from researcher-made pre-tests and post-tests, along with

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open-ended survey questions assessing social skills and attitudes toward mathematics. Clarke and Braun's thematic analysis was applied to qualitative data to support the study's findings further. Nine traditional games were integrated into the mathematics lessons. The results demonstrated significant improvements in students' post-test scores, enhanced conceptual understanding of mathematics, developed social skills, and positive attitudes toward mathematics. The study recommends that teachers integrate Traditional Games (TG) into mathematics instruction to enhance student engagement, deepen conceptual understanding of mathematics, and develop students' social skills. Curriculum and textbook developers may consider incorporating TG-based activities to promote engaging and meaningful learning. Future researchers could further explore the integration of TG in mathematics instruction to gain deeper insights and provide additional support for the findings of this study.

Introduction

The development of mathematical study has progressed alongside the advancement of civilization and educational curricula. Recognizing its significance in improving quality of life, mathematics teachers hold a unique and relevant position within the educational system. However, many students perceive mathematics as uninteresting and difficult to understand, leading to a negative attitude toward the subject (Aguilar, 2021; Estonanto & Dio, 2019).

One of the modern trends in 21st-century education to maintain students' interest and ensure continuous improvement in their mathematical abilities is game-based learning (GBL). Vankúš (2021) found that 84% of the 57 journal articles listed in Scopus and Web of Science (WOS) in 2021 reported positive effects of GBL on students' learning, including their interest, engagement, and attitudes. Additionally, in 2023, 28 open-access journal articles demonstrated a favorable effect on students' cognitive domain, while 20 articles showed a positive impact on students' affective domain, particularly in terms of engagement, involvement, and interest. Furthermore, only 18% of the studies used non-digital game-based learning (Hui & Mahmud, 2023).

In the context of the Philippines, where preserving cultural heritage is vital, integrating traditional games into the curriculum offers a balanced approach to education. This method not only leverages the benefits of game-based learning on students' cognitive and affective domains, as well as their social skills and attitudes, but also helps mitigate the potentially harmful effects of excessive digital device use—such as distractions, decreased well-being, heightened attention-deficit symptoms, impaired emotional and social intelligence, technology addiction, social isolation, and disrupted sleep (Dienlin & Johannes, 2022; OECD, 2024b; Small et al., 2020).

This strategy aligns with the United Nations Educational, Scientific and Cultural Organization's [UNESCO] (2017) explanation of Sustainable Development Goal (SDG) number 4, which emphasizes that quality education is most effective when it is responsive to the cultural context and the particularities of a place and community. By incorporating traditional games, educators can not only enhance students' social skills and attitudes but also promote an appreciation of culture and its contribution to sustainable development, thereby creating a more holistic and culturally relevant learning environment. Kamid et al. (2022) state that traditional games create a positive and relaxed learning environment that enhances

students' mathematics learning.

The studies of Carmen (2015) and Morales (2017) designed activities in Physics that used traditional games or Laro ng Lahi. The developed activities helped the teachers provide a new pedagogical approach to the cultural context, enhancing students' critical thinking abilities and conceptual understanding of physics, as well as increasing students' motivation to study. This approach is aligned with the 1987 Philippine Constitution Article XIV, Section 14 (n.d.), which emphasizes that the government must support the preservation, enrichment, and dynamic development of national culture. Hence, integrating TG into mathematics education aligns with the government's objective of preserving national culture and improving students' motivation and learning. In addition, playing TG using locally made or indigenous materials complies with the government's objective to promote the use of educational resources that students are more familiar with and have experience with.

The related literature and studies highlight the significant contribution of game-based learning in helping students develop both cognitive and affective skills, supporting the feasibility of integrating TG into mathematics lessons and activities. Many studies published in Scopus and WOS have incorporated both digital (82%) and non-digital games (18%) into their lessons (Vankúš, 2021). However, very few studies have integrated national or traditional (non-digital) games into mathematics education in the Philippines. The objective of integrating TG into mathematics lessons is to create activities that use TG to help students appreciate and engage with the lessons through active participation and game analysis, thereby relating the activities of the TG to mathematical concepts. Hence, this study explored the influence of integrating traditional games into mathematics lessons on students' conceptual understanding, social skills, and attitudes toward mathematics. Specifically, this study answered the following questions:

(1) What lessons and activities in mathematics may be developed integrating the TG?
(2) How effective are the developed lessons integrating TG in enhancing students' conceptual understanding, social skills, and attitude toward mathematics?
(3) What are the challenges and learning experiences of the students in learning the developed lessons?

The study's results can benefit students, teachers, textbook writers, curriculum writers, educational leaders, and future researchers. The students can benefit from the activities that are designed to help them relate mathematical concepts, which can lead to higher retention of learning. The teachers can also be guided by the results and design lessons and activities in mathematics that use TG to promote active participation and preservation of the culture. The results of the study can also inspire textbook and curriculum writers to integrate traditional games in designing mathematics curricula or lessons to comply with the Department of Education's contextualization (DepEd, 2021). Educational leaders and researchers can be informed of the results of the present study and further investigate its effectiveness.

Theoretical Framework

This study is grounded in Socio-Cultural Theory, supported by Multiple Intelligences Theory. These two theories underpin the integration of traditional games (TG) in teaching and learning mathematics.

The Socio-Cultural Theory of Learning, developed by Russian psychologist Lev Vygotsky in 1968, emphasizes the importance of social interaction, culture, and language in the learning

process. Central to Vygotsky's theory is the concept of the Zone of Proximal Development (ZPD), where learning occurs as a learner engages in tasks just beyond their independent capability, with support from a more knowledgeable individual. Cultural context significantly influences learning, with cultural norms shaping thinking and learning processes. Vygotsky's impact on education, particularly in instructional design and collaborative learning, underscores the vital role of social interactions and cultural context in cognitive development.

In this study, traditional games, deeply rooted in the country's culture and history, are integrated into mathematics lessons to provide a culturally relevant learning context. These games promote teamwork, communication, and collaboration, thereby enhancing students' understanding of mathematical concepts. Socio-cultural theory highlights the role of social interaction in learning, with games often involving the ZPD. By using traditional games, educators can guide students through mathematical concepts while fostering a sense of community, cultural identity, and motivation.

Howard Gardner, a psychologist and professor at Harvard University, developed the Multiple Intelligences (MI) theory in the early 1980s. This theory challenges the traditional view of intelligence as a single, fixed capacity measured by IQ tests. Gardner (2022) proposed that there are multiple distinct types of intelligences, each representing different ways individuals excel in learning, problem-solving, and performing various tasks. For instance, in the context of Bodily-Kinesthetic Intelligence, traditional games (TG) often involve physical activities that engage this type of intelligence. Games such as "Patintero" or "Piko" require movement and coordination, providing hands-on experiences that appeal to learners strong in this area. Similarly, Logical-Mathematical Intelligence is engaged when TGs are strategically chosen to integrate logical and mathematical thinking. Many games involve strategic planning, counting, and problem-solving, catering to students with strengths in logical-mathematical reasoning.

Spatial Intelligence is another domain where TG like "Tumbang Lata" or "Holen" are beneficial. These games require spatial awareness and planning, engaging players to navigate spaces, estimate distances, and visualize patterns. In terms of Intrapersonal and Interpersonal Intelligence, many TG involve social interaction, fostering collaboration, communication, and relationship-building—key aspects of these intelligences. Naturalistic Intelligence is engaged when games are played outdoors, often involving elements of nature. For example, "Luksong Tinik" or "Sipa" are typically played in open spaces, connecting learners with their environment and nature.

Linguistic intelligence is engaged when students discuss strategies, articulate rules, and communicate their thoughts about the mathematical concepts embedded in the games. While traditional games may not directly involve music, educators can enhance learning for students with Musical Intelligence by incorporating rhythmic elements or chants related to the mathematical content. Finally, Existential Intelligence is connected through the cultural significance of TG, which often reflects students' identity and heritage. This engagement with cultural elements aligns with Gardner's notion of existential intelligence, which involves contemplating deep questions about existence and meaning.

The integration of traditional games in mathematics lessons aligns with Gardner’s Multiple Intelligences Theory. By incorporating diverse activities that appeal to various intelligences, students can engage with mathematical concepts through different cognitive pathways, enhancing comprehension and retention while honoring the cultural context of learning.

Method

This study's approach includes the research design, participants, application process and data collection tools.

Research Design

This study utilized a quasi-experimental research design involving two experimental groups - the implementation group and the comparison group (Creswell & Creswell, 2018). This design allows for the observation of two groups to assess the effect of integrating TG in mathematics lessons and answer the research questions. The descriptive method was used to describe the student's learning experiences and challenges in participating in the implementation of the treatment. The descriptive method is a scientific method that entails observing and describing the behavior of a subject without influencing it in any way (Shuttleworth, 2008).

Participants

The study participants were determined through a selection process using a multi-stage approach. First, eligible criteria were established. The two groups should have the same performance and were lower than the other groups. The two groups should be Grade 8 students and were purposively selected to participate in the study to satisfy the assumption of normality. Subsequently, students who were repeaters and had at least one absence during the research implementation were not included in the final participants reported in the study. Finally, the study participants were 42 Eighth-grade students from one of the public secondary high schools in the Philippines – 22 students in the comparison group and 20 students in the experimental group. Eight-grade students were selected because they are the next students to take the Program for International Students Assessment (PISA) when they turn 15 years old (OECD, 2024a).

Application Process & Data Collection Tools

The study followed all ethical conditions and protocols in data collection. Before the study was conducted, permission was sought from the School Division Superintendent (SDS), the School Principal, the Teacher, the Student, and the Parents through informed consent. Upon approval of the request, the researchers prepared the necessary materials, including the mechanics of the respective traditional games aligned with the Most Essential Learning Competencies (MELC) in the First Quarter of eighth-grade mathematics. The researcher-made mathematics test (pre-test and post-test) for conceptual understanding, students' journal guides, teacher observation guides, and open-ended questionnaires for assessing social skills and attitudes toward Mathematics were also prepared for validation. The validators were all licensed professional mathematics teachers, had at least five years of experience in teaching mathematics in public secondary high schools, had at least one research publication, and held a master's degree in mathematics education.

The open-ended questionnaires for assessing social skills and attitudes toward mathematics were validated through face and content validity. In preparation for the researcher-made mathematics test, pilot testing was conducted with 50 ninth-grade students from the same school. The initial researcher-made mathematics test was comprised of 75 items, which were subjected to content validation, pilot testing, item analysis, and reliability testing. After revision from the content validation and pilot testing, item analysis was conducted to determine the index of difficulty and discrimination index as a guide to whether to retain,

revise, or discard the item. For the index of difficulty, the waste item should have at least 0.21 and above the difficulty index to retain or revise. For the discrimination index, the item should have at least 0.20 and above to be included and considered a marginal or very good item (Navarro, Santos, & Corpuz, 2012). After item analysis, 35 items were discarded, resulting in a 40-item researcher-made mathematics test with a Cronbach alpha of 0.60 interpreted as acceptable. The lessons integrating TMG were also validated by the validators using the DepEd-validated tool for lesson plans and instructional materials.

After validation of all the research instruments, a pre-test using the validated researcher-made mathematics test was administered to all Grade 8 students to select the study groups. Informed consent was secured from the students and parents. Permission was obtained from the teacher of the selected classes, who was provided with a teacher observation guide to observe the implementation of traditional gamesin Mathematics instruction. This procedure was repeated for each game implementation.

The comparison group used the traditional activities found in the textbooks facilitated by the teacher, which also followed the 4As learning model (Activity, Analysis, Abstraction, Application). A necessary scaffolding process was also conducted to help all the students learn the lessons except for the use of the TG.

In the implementation group, the developed TG integrated into mathematics lessons was used and facilitated by the cooperating teacher. Following the completion of each traditional game session, students received game analyses and were prompted to complete the students' journal guides for each activity. A week before the examination, the post-test was administered to assess students' conceptual understanding of Mathematics. Toward the end of the quarter, class time was allocated for surveying the effects of integrating traditional games on social skills and ATM using open-ended questionnaires. Clarke and Braun's thematic analysis (Byrne, 2022) was applied to qualitative data to deduce the findings. Subsequently, data gathered from these instruments were analyzed to conclude the study.

Data Analysis

A comprehensive analysis of qualitative and quantitative data was conducted through a rigorous statistical examination using Excel to organize the data and the Statistical Package for Social Science (SPSS) to analyze it. The mean (M) was used to measure the students' level of conceptual understanding in mathematics.

The Shapiro-Wilk test was used to assess the data's normality and ascertain whether the data was suitable for using a parametric test. The students' pre-test scores in the researcher-made test in the comparison group ($W = .921$, $p = .103$) and implementation group ($W = .913$, $p = .073$) were found to be both normally distributed and suited for using a parametric test. A t-test for independent samples was used to determine if there was no significant difference between the scores of the students in the two groups and to decide if the two groups were comparable. Results showed no significant difference between the students' pre-test scores in the comparison group and implementation group ($M = 10.5$, $SD = 2.48$), $t(40) = .07$, $p = .95$. The two groups qualified for comparison.

The paired t-test for dependent samples was employed to measure whether the observed differences in the pre-test and post-test mean scores in the researcher-made mathematics test were significant. Further, Cohen's index (d) was employed to measure the effect size of using TG in mathematics on students' conceptual understanding. An effect size $d \leq 0.2$ indicates a

small effect, $0.21 \leq d \leq 0.5$ indicates a medium effect, $0.51 \leq d \leq 0.80$ indicates a large, and $d \geq 0.81$ indicates a very large effect (Cohen, 1988). On the other hand, Clarke and Braun's thematic analysis (Byrne, 2022) used the teacher's observations, students' game analysis, journal entries, and informal interviews. Results & Discussion

Lessons and Activities Integrated with Traditional Games

The main objective of this study is to integrate TG into mathematics lessons to enhance students' conceptual understanding, social skills, and attitude toward mathematics. Table 1 shows the lessons and corresponding learning competencies, integrated TG, and the time allotment. The learning competencies are aligned with the mathematics 8 Most Essential Learning Competencies of the Department of Education in the Philippines.

As shown in table 1, the study integrated TG to the 10 mathematics lessons implemented in 12 weeks (24 hours) through the following activities: (1) Lawin at Sisiw for illustrating rational algebraic expressions, (2) Agawan Base for simplifying rational algebraic expressions, (3) Tagu-taguan for solving problems involving rational algebraic expressions, (4) Saranggolahan for illustrating the rectangular coordinate system and its applications, (5) Holen for illustrating linear equations in two variables and finding the slope of a line given two points, equations, and graphs, (6 & 7) Piko for graphing a linear equation and describing its intercepts and slopes, (8) Tumbang Lata for finding the equation of a line given two points, the slope and a point, and the slope and intercepts, (9) BINGO for illustrating and graphing a system of linear equations in two variables, and (10) Patintero for categorizing when a given system of linear equations in two variables has graphs that are parallel, intersecting, and coinciding.

The lessons and activities adhered to the 4A's lesson format, which consists of Activity, Analysis, Abstraction, and Application. Experiential learning has been integrated into the development of lessons and activities based on traditional games. These activities served as a strategic approach to learning, helping students understand mathematical concepts through gameplay. By providing additional exercises that encourage analysis of the mathematical principles underlying the activities, students are further supported in reinforcing their comprehension. Additionally, game analysis questions included in each activity assist students in learning the topics presented in each lesson and making informed decisions.

Table 1. *Learning Competencies, Integrated Traditional games (TG), and Time Allotment*

Lesson no.	Learning Competencies	Integrated TG	Week and time spent
1	Illustrate rational algebraic expressions	Lawin at Sisiw	Week 1 (2 hours)
2	Simplify rational algebraic expressions	Agawan Base	Week 2 (2 hours)
3	Solve problems involving rational algebraic expressions	Tagu-taguan	Weeks 3 & 4 (4 hours)
4	Illustrate the rectangular coordinate system and its uses	Saranggolahan	Week 5 (2 hours)
5	Illustrate linear equation in two variables and illustrates and finds slope of a line given two points, equations, and graphs	Holen	Week 6 (2 hours)
6	Graph a linear given any two points, the x- and y- intercepts, the slope and a point on the line.	Piko	Week 7 (2 hours)
7	Describe the graph of a linear equation in terms of its intercepts and slopes	Piko	Week 8 (2 hours)
8	Find the equation of a line given two points, the slope and a point, the slope and its intercepts,	Tumbang Lata	Week 9 (2 hours)
9	Illustrate and graph a system of linear equations in two variables	BINGO	Weeks 10 & 11 (4 hours)
10	Categorizes when a given system of linear equations in two variables has graphs that are parallel, intersecting and coinciding.	Patintero	Week 12 (2 hours)
		Total	12 weeks (24 hours)

Integrating "Lawin at Sisiw," The localized materials included question cards. In this game, each team selects one hawk and one hen, with the remaining players acting as chicks. The hen leads the chicks, who hold each other's waists. The goal is for the hen to extend her "wings" (arms) to defend her chicks from the hawk. When the hen moves to block the hawk, all the chicks must move in the same direction to avoid being caught. If the players lose their grip on each other's waists, one member is eliminated, granting the opposing team an automatic point. Each chick carries a question. When the hawk captures a chick, the players must answer the question. If the answer is correct, they earn a point; if incorrect, the captured chick is eliminated from the game. The game concludes when a team runs out of chicks (see Figure 1).

Figure 1. Lawin at Sisiw

As shown in Table 2, While the teacher had already introduced the topic, the researcher provided guide questions and an outline of the procedure. Subsequently, the students were expected to explain and draw conclusions on the relationship between the game and the topic based on their experiences, findings, and evaluations during the game. The activity begins with orientation, including background context and safety awareness instructions. This preparatory phase ensures that students are well-informed about the rules and objectives of the game, as well as any necessary precautions to ensure their safety. Following this briefing, students engage in the actual playing of the game, which serves as an interactive and experiential learning activity.

Table 2. *Sample Learning Plan for Lesson One, Game Description, and Mathematical Concepts*

Lesson Topic	Learning Competencies and Objectives	Students' and Teacher's Activities	Game Description and Mechanics	Mathematical Concepts
Rational Algebraic Expressions	Lawin at Sisiw Learning Competency: Illustrating rational algebraic expression. Learning Objectives: 1. Define rational expression. 2. Illustrate rational algebraic expression; and 3. Explain rational algebraic expression.	Activity: The integration of the traditional game (Lawin at Sisiw) in the lesson. The rule of the game was explained well. The cooperating teacher, with the help of the selected students, facilitated the activity. The students actively participated in the game. Analysis & Abstraction: The teacher discussed the rational algebraic expressions and provided examples to understand the topic clearly. Then, the students analyze and relate the game (Lawin at Sisiw) in illustrating algebraic expressions. The students generalize the concept of the topic. Application The teacher asked the students to relate the topic to their daily activities and explain it.	Mechanics 1. The class will be divided into two teams, and each team will select one hawk or hen, and the rest of the players will be chicks. 2. The chicks of the hen should hold each other's waists, and then the hen will lead them. The hen's goal is to widen out her wings, literally her hands, and defend her chicks, for the hawk will try every possible way to catch the chicks. 3. When the hen moves to block the hawk, all the chicks should also move in the same direction so the hawk cannot attack them. 4. Once they lose the grip of each other's waists or clothes and the chain is broken, one of your team members will be eliminated, giving the other side an automatic point. 5. Every chick has a question. When the chick is captured by the hawk, the players must answer the question. If the answer is correct, they will get a point; if it is incorrect, they receive none, and the chick that will be caught is eliminated from the game. 6. The game ends when whoever is in the group runs out of chicks. The one with the most points will be the winner.	Ratio is a comparison of two or more numbers that indicates how many times one number contains another. Polynomial is a mathematical expression of one or more algebraic terms, each of which consists of a constant multiplied by one or more variables raised to a non-negative integral power. Rational Algebraic Expression is a ratio of two polynomials. A negative Exponent means how many times to divide by the number.

Upon completion of the game, students are required to answer a set of game analysis or guide questions. The questions are designed to prompt students to relate the game to the mathematical concepts covered in the lesson. The questions were: "Based on the game, how can you relate it to rational?" "How can you say that game is related to rational?" "What scenario shows the rational?", "What is your basis for the expression being rational?" and "Based on the game, describe rational algebraic expression?" These questions enabled the students to relate the game to the concepts of the lesson.

Lessons and Activities Integrated with Traditional Games

Effects of the Developed Lessons using TG on Students' Conceptual Understanding

Conceptual understanding is the student's ability to reason in settings involving the careful application of concept definitions, relations, or representations of either. A conceptual understanding of mathematics is one of the main foundations for procedural fluency (The National Council of Teachers of Mathematics, 2014).

The integration of TG into Grade 8 Mathematics lessons and activities aims to promote active engagement and enjoyable learning experiences. This approach encourages students to participate in meaningful and authentic activities, allowing them to comprehend mathematics concepts within their context. As a result, in turn, it fosters a deeper understanding and appreciation for the lessons as students recognize the relevance of these concepts to their personal experiences, ultimately enhancing their academic performance. The study employed t-tests for independent samples to determine the effect of the developed lessons and activities utilizing traditional gameson students' conceptual understanding.

Table 3. *Independent t- test Results on Conceptual Understanding for Pre-test and Post-test*

	Comparison		Implementation				
	M	*SD*	*M*	*SD*	*df*	*t*	*p*
Pre-test	10.55	1.97	10.5	2.48	22	.07	.95
Post-test	13.41	2.3	20.6	2.93	22	-0.89**	<.001

** $p < .001$

Table 3 presents the results of the independent t-test in comparing the pre-test and post-test scores of the implementation group and comparison group in mathematical conceptual understanding. For the pre-test scores, the test revealed insignificant results between the comparison group (M = 10.55, SD =1.97) and implementation group (M = 10.5, SD =2.48), t (40) = .07, p = .95. Insignificant test result indicates that the two test scores being compared are not statistically different. Results imply that, initially, the level of mathematics conceptual understanding of the two groups is the same and valid for comparison. However, when the post-test scores of the two groups are compared, the test showed a highly significant difference between the comparison group (M =13.41, SD = 2.3) and the implementation group (M = 20.6, SD = 2.93), t(40) = -8.89, p < .001.

The negative t-value implies that the mean score of the implementation group is significantly higher than the mean score of the comparison group. It means that the innovation or treatment applied to the implementation group was effective in improving post-test scores. Moreover, the very low p-value indicates a high level of confidence in the results. Statistically, it suggests that there is less than a 0.1% chance that the observed difference occurred by random

chance, reinforcing the reliability of the findings. This finding has important implications for practice and further research.

Further, Table 4 shows the paired t-test result when the pre-test and post-test scores of the implementation group are compared. As shown in the table, the test was found to be highly significant, t (19) = -14, p < .001. A highly significant test result indicates that the pre-test score (M = 10.5, SD = 2.48) and post-test score (M = 20.6, SD = 2.93) are statistically different. The large negative t-value reflects the direction and magnitude of the change, with the post-test scores being significantly higher than the pre-test scores. Furthermore, a very small p-value indicates a high level of confidence in the results. Findings mean the observed improvement in scores is not due to random chance but likely due to the intervention.

Table 4. *Paired t- test Results for Pre-test and Post-test of Implementation Group*

	Pre-test		Post-test				
	M	SD	M	SD	df	t	p
Implementation Group	10.5	2.48	20.6	2.93	19	-14**	<.001

** p < .001

In summary, the results indicate that the utilization of lessons and activities integrating TG has positively influenced students' comprehension of mathematical concepts. It is important to acknowledge the variability in student performance, with some achieving exceptionally high scores while others demonstrated lower proficiency. Nonetheless, the overall mean difference supports the assertion that there is a statistically significant improvement in students' conceptual understanding.

Game analysis was conducted to support the above result. Game analysis refers to the systematic examination and evaluation of various aspects of games, which can include video games, board games, card games, sports, or any other interactive activities with defined rules and objectives. However, in this study, the goal of game analysis is to gain a deeper understanding of the game's design, mechanics, player experiences, and overall impact. This process involves breaking down the elements of a game and studying how they interact to create the overall gaming experience.

Findings showed that the possible reason for this improved performance level was due to the use of TG as the main activity in the lesson, which enabled the students to understand the mathematical concepts. This claim was supported by the students' reflection, as manifested in their answers to the game analysis.

One student made an interesting connection between the game "Lawin at Sisiw" and the concept of rational algebraic expressions, particularly in how they are illustrated. In the game, players demonstrated an understanding of rational algebraic expressions by engaging in a process where the hawk (lawin) captured the chicks (sisiw), symbolizing a ratio relevant to illustrating rational algebraic expressions. The student likened rational algebraic expressions to fractions, emphasizing that they represent the ratio of two polynomials, which aligns with the mathematical foundation of rational expressions. The student's analogy of the captured chicks as a ratio within the game helped visualize the concept of rational algebraic expressions as fractions and reinforced the idea that these expressions involve the relationship between two polynomial components. The results of the study confirmed the findings of the

studies of Carmen (2015) and Morales (2017) that the use of "laro ng lahi," or traditional games, enhances students' conceptual understanding.

Effects of the Developed Lessons using TG on Students' Social Skills

Social skills play a vital role in mathematics education by enhancing students' motivation, engagement, and capacity for peer collaboration and effective communication. Research has shown that traditional games, including those with social elements, can have a positive impact on the social skills and behavior of the students (Yuliyanto et al., 2023). In this study, an open-ended questionnaire consisting of five (5) questions was given to students to measure the student's social skills towards mathematics to share their experiences during the implementation of the games.

Table 5 presents the students' responses to the open-ended questionnaires on social skills. Findings showed that students have developed communication skills, collaboration abilities, enjoyment in the activities, self-confidence, and active participation. The findings aligned with the observations of the classroom teacher, suggesting a noticeable shift in students' interactions and increased confidence in participating and sharing ideas during discussions. The results of the present study confirmed that the use of traditional games in the classroom can improve students' socialization, relationships, and interactions (Yuliyanto et al., 2023). Traditional games with social elements have been found to have a better influence on students' social skills and behavior, particularly among students with a cultural background (Tasnim et al., 2022). These findings suggest that integrating TG into mathematics can enhance social development and improve social skills among students.

Table 5. *Summary of Students' Responses on Social Skills Toward Mathematics*

Questions	Students` Response	Count
Q1: Through playing game, I developed my… *(Sa pamamagitan ng paglalaro, nabuo ang aking…)*	Self confidence in life	4
	Ability to collaborate and build connections with classmates	5
	Ability to cooperate with classmates	5
	Communication skills	8
	Thinking skills	2
	Trusting groupmates	1
Q2: Through playing game, I must say that… *(Sa pamamagitan ng paglalaro, masasabi kong…)*	Socialize with others	4
	Communicate with classmates	1
	Fun game	5
	Interesting and challenging game	4
	Effectiveness of teamwork	2
	Enjoy mathematics subject	4
	Collaborate with others	5

Q3: Through playing game, I'm able to… *(Sa pamamagitan ng paglalaro, kaya kong…)*	Socialize with others	5
	Enjoyable	1
	Connect with classmates	3
	Cooperation and active participation	9
	Confident in sharing ideas and opinions with others	2
	Good communication	2
	Understand math easily	1
	Leadership	2
Q4: Through playing game, I improved my… *(Sa pamamagitan ng paglalaro, pinagbuti ko ang aking…)*	Critical thinking skills	1
	Collaborate with others	8
	Speed and become more flexible	2
	Improved thinking skills	3
	Improved self confidence	7
	Communication skills	2
	Problem solving skills	2
Q5: Working with others in a group made me realize that… *(Ang pakikipagtulungan sa iba sa isang grupo ay napagtanto ko na…)*	Importance of adaptability	5
	Enhance self-confidence and build relationships with classmates	6
	Importance of sharing ideas with others	2
	Importance of effective communication	1
	Importance of teamwork	3
	Helping each other makes math easy	7
	Easy to understand mathematics	1

Effects of the Developed Lessons using TG on Students' Attitude towards Mathematics (ATM)

In mathematics education, the concept of attitude is not new. The study of Repuya & Repuya (2018) concludes that students' attitude towards mathematics is significantly correlated with mathematics performance and that improving students' ATM enhances mathematics learning. In this study, students' ATM will be measured using the attitudinal open-ended questionnaire.

There are five (5) questions in the attitudinal open-ended questionnaire. Students' experiences with the games are shared to measure how their attitude toward mathematics has developed. Table 6 presents the students' responses to the attitudinal open-ended questionnaires. Upon reviewing the data, it is evident that out of the twenty- five participants in Q1, seven students expressed that playing games helped them develop an interest in mathematics, while four students reported enhanced self-confidence. Additionally, four students noted increased motivation, another four mentioned improved sportsmanship, and three students cited the development of open-mindedness. Two students indicated a more positive perception of math, and one student mentioned the enhancement of strategic thinking. Observing the same table, responses in Q2 showed that nine students out of the twenty-five participants stated that playing games made mathematics an interesting subject for them. Additionally, five students

reported feeling happy and enjoying the process, while four students expressed feeling motivated to complete tasks. Another four students conveyed excitement, and three students mentioned that playing games made learning mathematics less daunting.

On the other hand, looking at the responses in Q3, it was found that eight students believe the game is beneficial because it makes mathematics more interesting. Six students highlighted that the game actively engages them in learning, and four students stated that it aids in easily understanding math. Moreover, four students recognized it as a tool for enhancing the effectiveness of lessons, two students mentioned improved student participation, and one student remarked on its ability to enhance problem-solving skills.

In Q4, most students reported finding mathematics enjoyable and interesting during the game, while others found it to be challenging, exciting, and difficult yet enjoyable. Moving on to Q5, fifteen out of 25 students expressed the belief that their mathematic skills can be improved, nineteen students indicated that their skills are good but not sufficient, and one student acknowledged that playing games helps foster perseverance and resilience.

These findings demonstrate that integrating traditional gamesinto mathematics education can make learning the subject more enjoyable and engaging. The students perceive mathematics as an intriguing subject, and playing these traditional games enhances their interest in learning mathematics. Furthermore, the incorporation of traditional games as mathematics learning activities has the potential to transform the mathematics classroom into a captivating and enjoyable environment where students develop a love for learning mathematics.

Table 6. *Students' Attitude toward Mathematics*

Questions	Students' response	Count
Q1: Through playing games, I developed my … *(Sa pamamagitan ng paglalaro, nabuo ang aking ...)*	Interest in mathematics	7
	Self-confidence	4
	Being motivated	4
	Sportsmanship	4
	Open mindedness	3
	Positive perception in math	2
	Strategic thinking	1
Q2: Through playing games, I feel that … *(Sa pamamagitan ng paglalaro, naramdaman kong…)*	Mathematics is an interesting subject	9
	Happy and enjoyable	5
	Excited	4
	Motivated to do the task	4
	Learning math is not difficult	3
Q3: The game in math is beneficial because … *(Ang paglalaro sa matematika ay kapaki-pakinabang dahil…)*	It makes math more interesting	8
	Engage students in learning math	6
	Help me to easily understand math	4
	It makes a tool for the effectiveness of lessons.	4

	Help students to participate actively	2	
	Enhance problem-solving skills	1	
Q4: During the game, I found math to be … *(Habang naglalaro, napagtanto ko na ang matematika ay …)*	Fun and interesting		15
	Challenging	4	
	Difficult but enjoyable	3	
	Exciting	3	
Q5: Through playing games, I realized that my skills in mathematics are …. *(Sa pamamagitang ng paglalaro, napagtanto ko na ang aking kakayahan sa matematika ay …)*	Can improve		15
	Good but not enough	9	
	Help to foster perseverance and resilience	1	

The Teacher Observation Guide (TOG) also provided evidence to support the findings of the study. Below is a sample of the teacher observer's statement that students developed positive behavior toward the lesson in math by participating in the games.

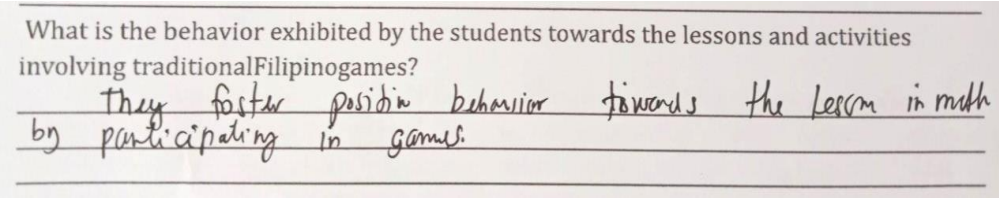

Figure 1. Sample Teacher-observer response on the Teacher Observation Guide

The results of the study also confirmed the findings of Hasan et al. (2014), who discovered that including games in the teaching process raises students' motivation and interest in the subject. It means that integrating TGs helped students develop positive attitudes.

Students' Challenges and Learning Experiences in During the Conduct of the TG Activities

Experiences during this study related to how students felt, behaved, and participated in the game during which they had important learning opportunities. They also include the relationships, difficulties, and conflicts that students run into while they play the game. Students who have experience are more likely to connect with the material and pick up new abilities. Students' comprehension becomes more significant, and they have more meaningful experiences. However, if the students feel unsatisfied by these encounters, they can end up just showing up physically without knowing why they are there. As a result, it could impair their performance and discourage them from engaging in the activity or the subject in the future.

The students were asked to share their experiences by answering the questions in their student journal guide to determine the students' experiences during the conduct of TG. The teacher-

observer notes during the conduct of the games were also a source to identify the significant learning experiences of the students.

Table 7 shows the students' challenges and learning experiences during the conduct of TG activities, as mentioned by students. The table comprises the students' experiences during the actual playing of Traditional Games, which includes their positive and negative experiences and their significant learning experiences.

Table 7. *Students' Experiences and Challenges in implementing the Traditional Games*

TG	Challenges	Learning Experiences
Lawin at Sisiw	Hard to get points Can't easily illustrate rational algebraic expression or not	Students were interested and excited about the activity Students share their ideas to their group. Work collaboratively to perform the task Students are being motivated.
Agawan Base	Students got tired and thirsty Students got frustrated	Students share their knowledge about rational algebraic expression with their group Students show teamwork Students felt excitement of the activity
Tagu-Taguan	Students have fun Other students are not cooperating because they don't have ideas.	The group leader gives the command to his/her members
Saranggolahan	Students feel excited and nervous at the same time. Students were triggered and became competitive. Difficulties in making a good strategy. Students were lacking in plans, communications, and speed. Other students don't know how to make a kite.	Students help to focus and enjoy while learning, think critically, experience being interactive and enjoyed the learning process. Students learned to respect their opponents and exhibit good sportsmanship.

Holen	Difficulties in shooting the marble to another marble.	Work Collaboratively to finish the task. Developed appreciation of traditional games. Slowly getting the topic.
Piko	Students interact with different genders. Hard to place the "pamato". Hard to hop	Students easily identified the connection of the game to the concepts. Students work in solidarity. Students have fun computing while playing. Students willingly accept the consequences
Tumbang Lata	Students felt tired and thirsty Students can't hit the can Issues about fairness Students got difficulty in answering	Students share ideas to their group in answering problems. Students work collaboratively Students felt excited to learn mathematics.
Bingo with a twist	Hard to step on to others player's foot	Students collaborate with their group to accomplish tasks Students engage in the activity
Patintero	Difficulty answering questions. Students cannot finish the task because of the time limits. Hard to escape from the taggers with a big body and long arms. Hard to tag the opponent.	Students collaborate with their group to finish and earn points. Slowly getting to the topic. Being active to learn mathematics.

Using Clarke and Braun's thematic analysis, the following themes emerged: Students actively participated in the activities, worked with their classmates, shared what they knew with their classmates, developed leadership ability, had fun computing while playing, easily identified the connection of the game to the concepts, learned and exhibited good sportsmanship, and developed a love for culture through appreciating the TG. It means that integrating TG into mathematics lessons also develops social skills necessary for learning and a positive attitude towards mathematics, in addition to developing appreciation and love for the culture.

While the students have positive experiences, they also have challenges in participating in the activities. Each challenge depends on the game and was found to be common in playing TG, especially for students who are not familiar with the game. Challenges such as getting tired, frustrated, nervous, and having difficulty in doing the tasks can be addressed and managed

through proper pre-game orientation, advising pupils to bring drinking water, snacks, and face towels, and encouraging the students to enjoy the game.

Conclusions and Recommendations

The analysis of pre-test and post-test scores for both the implementation and comparison groups revealed a positive outcome in favor of the implementation group. The results also indicated a substantial and statistically significant improvement in the implementation group's post-test scores. Results suggest that the innovation administered to the implementation group effectively enhanced their post-test performance. As a result, the study offers strong evidence that integrating traditional games into mathematics education has a beneficial effect on students' conceptual understanding. Additionally, integrating TG in mathematics lessons promotes collaborative problem-solving, effective communication, and sportsmanship, fostering a dynamic and inclusive classroom environment. The inclusion of these games infuses excitement and curiosity into the learning process, making mathematics more engaging.

Results suggest that integrating culturally relevant and enjoyable elements, such as traditional games, can be an effective pedagogical strategy for developing social skills and cultivating a positive attitude towards mathematics, which is crucial for long-term academic success.

The study also recognizes the difficulties students encounter during the activities, particularly when solving worded problems. These challenges, such as the need for more time and limited space, highlight potential areas for improvement in using traditional games in the learning environment. Addressing these challenges could further improve the effectiveness of this teaching approach. Overall, the study confirms that integrating traditional games into mathematics education is more than just a source of recreation. It acts as a transformative influence that positively affects conceptual understanding, social skills, and attitudes toward mathematics, ultimately contributing to a more comprehensive and rewarding educational experience for students.

Based on the findings of the study, the following recommendations were made: The teachers are encouraged to integrate TG into their instruction to enhance students' grasp of mathematical concepts and generate greater interest in the subject and develop social skills among the students. Teachers may integrate TG into their teaching methods to enrich students' mathematical learning experiences and deepen their understanding of mathematical concepts. Curriculum writers and textbook writers may include TG in the mathematics lessons in the textbook or manual to encourage meaningful activities while preserving cultural heritage. Future researchers may allocate sufficient time to carry out a comprehensive study on the integration of the TG in mathematics lessons to confirm the study results.

Limitations

The researchers' involvement in implementing the activities contributed to the study's limitations. However, the result of the study provides necessary preliminary investigation and valuable insights into the innovation and provides information on the possible effect of integrating traditional games into mathematics. Research into a long-term investigation involving larger samples is highly recommended.

Declarations

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