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Research Article

The Application of Enhanced Damath in Learning Operations on Integers and Developing Strategic Thinking

Cherrylee M. Buhay [1,*], Leorence C. Tandog [1]

[1] University of Southern Mindanao, Philippines
* Correspondence: cherryleeb1@gmail.com

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Abstract: This study examined the effect of using enhanced Damath on learning integer operations and developing strategic thinking. Enhanced Damath is an educational board game which is a Philippine traditional Damath game with a dice modifier. Damath has been used in Philippine schools mainly to improve students' mathematical competency in computing. This research aimed to expand the application of Damath to improve strategic thinking which naturally develops in game playing. A randomized pretest-posttest control group experimental research design with matched subjects was used to gather empirical evidence. The respondents for the experimental group were randomly chosen high school students. The respondents for the control group were randomly chosen matched pairs of the subjects in the experimental group determined based on the school enrolled, grade level, academic performance, sex, and age. Results revealed that playing enhanced Damath significantly improves students' level of knowledge in integers involving single and multiple operations. The game also significantly contributes to the development of students' strategic thinking. Students affirmed the positive effect of enhanced Damath in terms of improved performance and a fun way to learn mathematical skills.

Keywords: Damath; enhanced Damath; integer operations; strategic thinking; experiment

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1. Introduction

Sufficient knowledge of integer operations is an important skill for the fundamentals of mathematics. Unluckily, some students find it difficult to deal with integer operations. It is common in the Philippines that students finish their secondary mathematics without learning how to deal with integer operations (Verzosa et al., 2017). This results to a serious concern for the mathematics instructors teaching advanced topics in mathematics.

In mathematics, difficulties in dealing with basic integer operations have been widely documented globally, especially in those involving addition and subtraction (Sen et al., 2017; Makonye & Fakude, 2016). It is also difficult for students to determine which integer is bigger and are confused to decide the correct calculation operation (Van de Walle et al., 2009). This is an alarming concern because the topic of integers is one of the fundamental concepts needed in understanding algebra and other advanced topics in mathematics especially in solving equations.

That is why deciding on an appropriate teaching strategy remains elusive since there is no single best strategy of teaching. But since students are generally playful thus, they can learn and comprehend the topics better if taught with game integration rather than teaching it merely in the traditional way.

Games naturally bring forth the concept of "play" in every child and even adolescent, which can be very helpful for discovering abstract ideas (Vygotsky, 1967). This is similar to the concept of situated learning theory which states that an environment that permits "play" to happen opens an opportunity for learners to have meaningful learning and interactions (Brown et al., 1989).

Situated cognition theory is related to the theory of James Paul Gee (meaning as action image) which states that, because individuals think more practically than rationally, learners must be exposed to a learning environment where types of learning are rooted in routines. The learners can slowly adapt to new concepts by continuously experiencing those concepts

(Gee, 2004). Mathematical games can present concepts during the time spent in playing. This happens when objectives are made in such a way that may challenge the learner to detour from the forward path and delve into previously taken content, or content that enlaces concepts from previous game experiences (Devlin, 2011). The mathematical consciousness of the students tends to increase when game-based approaches are used in classrooms (Marcus et al., 2016). In addition, even in situations where learners compulsorily play again a game due to mistakes or failures, learning still happens (Devlin, 2011; Squire & Barab, 2004).

There is an improvement in students' learning in mathematics when games are employed in the classroom (Clark et al., 2016; Wouters et al., 2013), that manifest in learners' increased cognitive capacity (Lamb et al., 2018), clearer comprehension of mathematical concepts (Yusoff et al., 2014), improved learners' achievement in mathematics (Cohrssen & Niklas, 2019), and engagement in mathematics (Lindenskov & Lindhardt, 2020). Chen and McNamee (2011) reported that games are certainly a good way of increasing students' performance. They stated that students who experienced playing games had more explicit goals, better skills to utilize materials in solving problems, and lucid actions to reach goals. This paved the way for the learners to have their own creative thinking while they were into the games. Games have been used to improve students' mathematics achievement in different domains including problem-solving and algebra skills (Abramovich, 2010), and strategic and reasoning abilities (Bottino et al., 2007). Teachers' use of games and creative pedagogical applications is also considered helpful for improving students' perceptions of mathematics (Afari et al., 2013).

Several studies have shown that Damath improves students' computing skills (Afari et al., 2013; Beserra et al., 2014; Marcus et al., 2016). Damath is a two-player board game that has been used in the Philippines since 1975 to improve students' mathematical competency, especially in computing. Several variations of the game were also introduced using the rules of a traditional game called "dama". The integer Damath is commonly played in schools mainly to improve students' competency in adding, subtracting, multiplying, and dividing signed integers. Damath encompasses the concept of a local strategy game used in Philippine education system with the intent to utilize local culture to enhance the mathematics teaching and learning process (Red, 2013). Damath as an educational game was also exposed in different studies. According to Bofferding and Hoffman (2019) playing board games that included negative integers improved young school children's understanding of these numbers. Red (2013) stated that Damath makes the mathematics teaching and learning process becomes child-friendly, challenging, and interactive. According to him, when learners play Damath they learn to explore, deepen their understanding of the concepts of real numbers and their properties. Damath has been utilized in the Philippines as a game to increase awareness of students in learning mathematics.

This research aimed to expand the application of Damath to developing higher-order thinking skills. The traditional integer Damath was modified in a way that not only computing skills can be developed but also strategic thinking. Strategic thinking naturally develops in game playing. It engages students in deep learning activities such as the analysis of information, planning, and analysis of possible solutions, and choosing the best action. Strategic thinking is very important in problem-solving, and the mathematics community considers this skill far more important than computing. In line with this, this study specifically aimed to examine the effect of using enhanced Damath in learning operations on integers and in developing strategic thinking; and to determine the benefits of playing enhanced Damath.

2. Materials and Methods

2.1. Research Design

This study utilized an experimental research design specifically the randomized pretest-posttest control group design using matched subjects. Subjects under the experimental group were randomly chosen high school students from two communities. Their matched pairs in the control group were determined based on the subjects' qualifications such as grade level, school, sex, age, and academic performance. A pretest was conducted to establish the comparability of groups in terms of their prior knowledge of the topic and the skill included in the experimental testing. The experimental design used in this study can be illustrated by the following equation:

Experimental Group	M_r	0_1	X	0_2
Control Group	M_r	0_3		0_4

where,
M_r – mactching of respondents
$X-$ treatment given to the experimental group
O_1 and O_2 – pretest of the experimental group and control group
O_3 and O_4 – posttest of the experimental group and control group

2.2. Sampling Procedure

Thirty high school students were randomly selected from two different communities in Cotabato, a province in Southern Philippines for the experimental group. For each student in the experimental group, a matched pair was determined based on the following qualifications: school, grade level, sex, age, and academic performance. The matching was facilitated by the respective teachers of students in the experimental group after which a random sampling of a matched pair was made.

2.3. Research Material

Enhanced Damath makes use of a two-player board and a dice modifier introduced to enhance strategic thinking in playing the game (see Appendix A). Figure 1 shows the materials used in this educational board game.

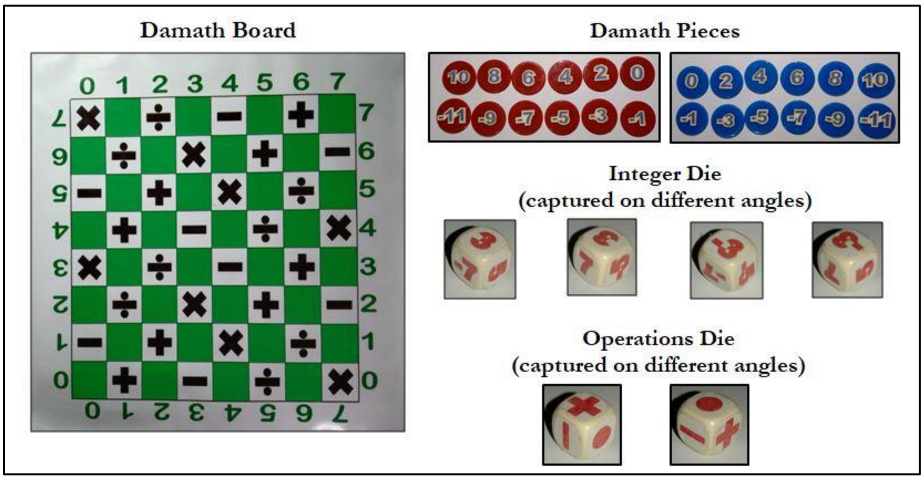

Figure 1. Enhanced Damath board game materials.

The rules for the traditional Damath were applied where two players take turns in moving the Damath pieces laid on the board. The only difference is on enhanced Damath when a player captures the opponent's piece, he/she has the chance to roll the dice. The first to roll is the integer die numbered 3, -3, 5, -5, 7, -7 followed by the operation die. The player then decides to whom to operate the integer in a way that maximizes the score difference between the player and the opponent. The odd integers used in the die were chosen to uphold fairness in the game in the game because even integers are easier to multiply while 1 and -1 do not bear a lot of change to the scores. Integers greater than 7 were also not considered as they might be more difficult to calculate as players are penalized for wrong answers. The combination of integers on the die is open for any variation but in this game, the operation with signed numbers is given more emphasis rather than computing the sum or product.

2.4. Research Instrument

This study utilized a 24-item researcher-made achievement test composed of two parts (see Appendix B). The first part was used to measure respondents' performance on integer operations. It was divided into two sections where the first section is a 15-item test involving single operations only. Each correct item was scored 1 point. The second section is a 5-item test that involved a combination of operations without the MDAS rule. A combination of operations was included because there are cases of multiple operations in Damath when a single Damath piece captures two or more Damath pieces of the opponent. The MDAS rule is not applied in Damath and to avoid the MDAS rule in the test, a grouping of terms was introduced. Thus, the test concentrated mainly on integer operations. Each item that required multiple operations scored 2 points for every correct answer making a total of 25 points for the first part.

The second part of the instrument was used to measure the respondents' strategic thinking. It was a 4-item word problem test. An analytic rubric was used to rate the respondents' answers per item. The rubric has three criteria and for each, the highest score was 3 and the lowest was 0. Hence, the score range for each item is 0 to 9 and 0-36 for the whole of the second part of the instrument.

The instrument was subjected to a content validity test by four mathematics professors at the University of Southern Mindanao. Fifteen respondents were also used in the pilot testing of the instrument and the reliability test was done using Cronbach's alpha. The computed alpha values of 0.74 and 0.72 for integer operations and strategic thinking respectively indicate that the instruments used in this study were acceptable.

2.5. Data Gathering Procedure

The data collection process started by forming the comparison groups and administering the pretest to both the control and experimental groups. After the pretest, an orientation was conducted including a demonstration on how to play the traditional Damath (integers category) and then enhanced Damath during session 1. The respondents were taught first the rules in playing the traditional Damath (integers category). The orientation included the arrangement of Damath pieces on the game board, making moves, writing every move on the score sheet, solving the scores, using the dice to one's advantage, and penalty scores for wrong computations.

The research was conducted in each of the two communities for 4 sessions, at one-week intervals between sessions. The respondents played in round-robin giving a total of 15 games per community and each game lasted 20-30 minutes on the average. The researcher together with the two facilitators guided the respondents while they are playing. They ensured that everything that was written by the respondents on the score sheet was correct and settled disputes between players regarding the scores. They also ensured that the respondent himself was the one writing his own moves and solving his own scores and deducted points at the instant that the player provided a wrong computation during the game.

The control group was a static group. They did nothing but took the pretest and posttest. The control group took the pretest and posttest a day after the tests were administered to the experimental group. A focus group discussion was conducted with the experimental group after the treatment to gather information about the perceived benefits and some concerns of the respondents while playing the enhanced Damath.

2.6. Data Analysis

The statistical techniques used for the descriptive analysis were frequency count, percentage count and percentage distribution, box-and-whisker plot, and quantile-quantile plot. The normality of the respondents' scores on integer operations and strategic thinking were assessed. The Kolmogorov-Smirnov test indicated that the respondents scores on integer operations were normally distributed, $KS(60)=0.099$, $p=.15$. Also, the Kolmogorov-Smirnov test indicated that the respondents scores on strategic thinking were normally distributed, $KS(60)=0.098$, $p=.15$. A reliability test was done using Cronbach's alpha. The Levene's test of homogeneity was used to determine equality of variance for the groups compared.

The independent sample t-test was used for the mean difference of the pretest scores between control group and experimental group to determine the equivalence between groups. The same test was used to determine the significant difference between the posttest scores of the control group and experimental group in solving problems involving integer operations and in strategic thinking. It was also used to determine the significant difference between the gain scores of the control group and experimental group in solving problems involving integer operations and in strategic thinking.

The paired sample t-test was used to determine the significant difference between the pretest and posttest scores of the experimental group in solving problems involving integer operations and in strategic thinking. The same test was used to determine the significant difference between pretest and posttest scores of the control group in solving problems involving integer operations and in strategic thinking.

3. Results

3.1. Pretest of the Control and Experimental Group

The pretest is composed of two parts. The first part was used to measure respondents' performance on integer operations and the second part was used to measure their strategic thinking. The first part was divided into two sections where the first section is a 15-item test which involved single operation only. Each item worth 1 point for every correct answer. The second section is 5-item test which involve combination of operations and each item was scored 2 points for every correct answer. Thus, the first part of the pretest has a total of 25 points.

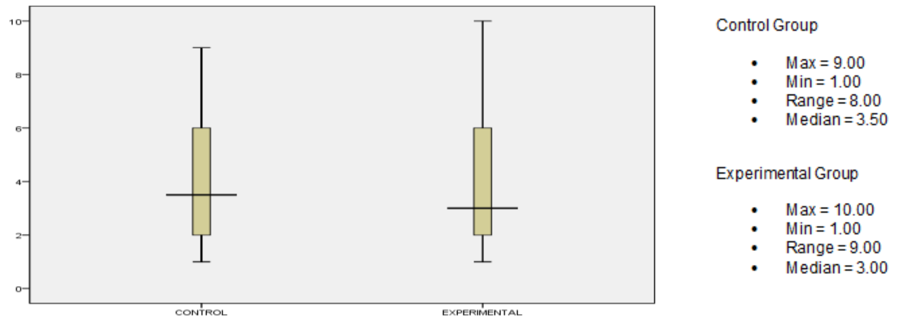

Figure 2. Distribution of pretest scores of control and experimental groups in integer operations.

Figure 2 presents the distribution of the pretest scores of control and experimental groups in integer operations. The box-and-whisker plot shows that the scores in the control group ranged from 1 to 9 and 1 to 10 in the experimental group. The median score of the control group is slightly higher than the experimental group but for both groups the median scores are below 15% of the pretest for integer operations.

A 4-item word problem test was used to measure students' strategic thinking that was each scored using an analytic rubric that has 3 criteria namely, understanding the problem, using information appropriately and answering the problem. Each criterion has 3 as the highest score and 0 as the lowest. Hence, each item has a perfect score of giving a total score of 36 for the strategic thinking test.

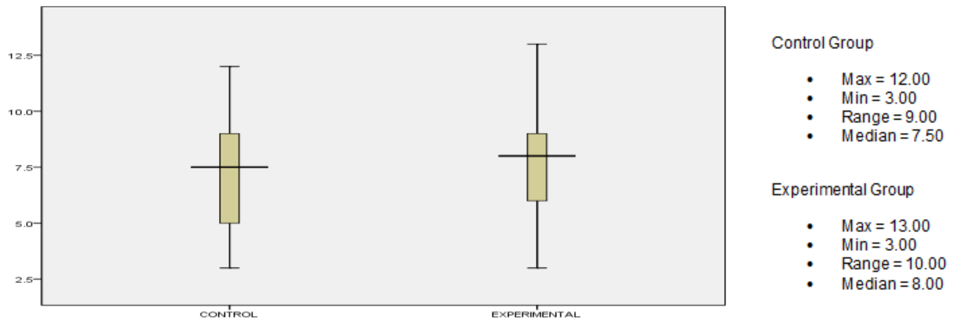

Figure 3. Distribution of pretest scores of control and experimental group in strategic thinking.

Figure 3 presents the distribution of the pretest scores of control and experimental groups in strategic thinking. The box-and-whisker plot shows that the scores in the control group ranged from 3 to 12 and 3 to 13 in the experimental group. For both groups, the median score indicated a performance which is below 21% of pretest in strategic thinking. The normality of pretest scores on integer operations (KS(60)=0.099, p=.15) and strategic thinking tests (KS(60)=0.098, p=0.15) was established using Kolmogorov-Smirnov test.

Table 1. Test of difference between the pretest scores of control and experimental groups.

Group	Mean	%	s.d	t	df	p-value
Integer Operation						
Control	4.10	16.40	2.75	0.14^{ns}	58	.89
Experimental	4.20	16.80	2.82			
Strategic Thinking						
Control	7.30	20.28	2.64	0.33^{ns}	58	.75
Experimental	7.53	20.92	2.90			

Note: ^{ns} – not significant at 0.05 level

The result of the pretest in Table 1 reveals a very low prior knowledge of integer operations by the study participants. In both groups, the average correct response was less than 17%. The respondents were in grades 7-12 students indicating that even at this stage they still did not have a full grasp of basic integer operations.

For strategic thinking, both groups have almost the same performance and based on the rubrics used the average scores indicated a lack of understanding of an appropriate approach to use. The computed t-test values indicated that the two groups were comparable with reference to their prior knowledge in integer operations (t=0.14, df=58, p-value=.89) and strategic thinking skills (t=0.33, df=58, p-value=.75) before the start of the experiment.

3.2. Posttest of the Control and Experimental Groups

Figure 4 presents the posttest scores of the control and experimental group in integer operations. The highest score of the control group in the pretest has increased by one only in the posttest and the range of scores remained almost the same. On the other hand, the scores in the experimental group ranged from 6 to 20 yielding a wider range of scores of 14. The highest score of the experimental group during the posttest has doubled. The highest score in the experimental group was higher by 10 points and the median score higher by 8 points than the control group. These are indications of better performance among respondents in the experimental group that could be attributed to the positive effect of enhanced Damath on the performance as two were equivalent and comparable before the experiment started.

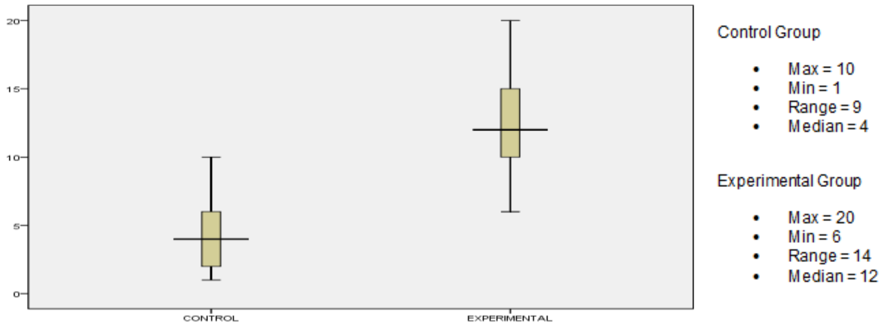

Figure 4. Distribution of the posttest scores of control and experimental groups in integer operations.

Figure 5 presents the posttest scores of the control and experimental group in strategic thinking. The highest score of the control group in the pretest barely increased by one in the posttest. On the other hand, both lowest and highest scores in the experimental group increased, from 3 to 16 and 13 to 34, respectively. The experimental group had highest score higher by 21 points and median score higher by 15 points than the control group. These results reflect strong performance among the respondents in the experimental group, which may be credited to the positive impact of the enhanced Damath, given that the two groups were initially equivalent and comparable before the experiment began.

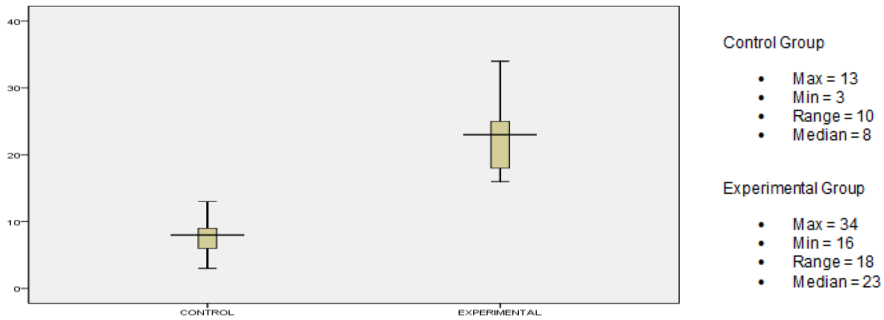

Figure 5. Distribution of the posttest scores of control and experimental groups in strategic thinking

Table 2 shows a significantly higher posttest mean score of 51.2% by the experimental group over the control group's 22.8%. The difference was highly significant (t=8.513, df=58, p-value<.001) indicating a positive effect of enhanced Damath had on the respondents' performance on integer operations.

Table 2. Test of difference between the posttest scores of control and experimental group.

Group	Mean	%	s.d	t	df	p-value
Integer Operation						
Control	5.70	22.8	2.71	8.51^{**}	58	<.001
Experimental	12.80	51.2	3.68			
Strategic Thinking						
Control	9.1	25.3	2.47	14.37^{**}	58	<.001
Experimental	22.7	63.1	4.56			

Note: ** - significant at 0.01 level

Similarly, the positive effect of enhanced Damath was demonstrated through the better posttest performance in the strategic thinking of students in the experimental group (t=14.37, df=58, p-value<.001). On average, respondents who experienced playing Damath scored higher by 37.8%.

3.3. Gain Score Result

Table 3 shows on average, students who were exposed to the enhanced Damath game improved their integer operation skill by 34.4% against the 6.4% gained by the control group (t=13.54, df=58, p=value<.001). On strategic thinking, the experimental group also increased their performance by 42.1% much higher than the 5% gain score by the control group (t=15.65, df=58, p-value<.001). This means that significant improvement in both integer operations and strategic thinking already occurred after the 4-session engagement of respondents in enhanced Damath playing.

Table 3. Test of difference between gain scores.

Group	Mean	%	s.d	t	df	p-value
Integer Operation						
Control	1.6	6.4	0.8	13.54^{**}	58	<.001
Experimental	8.6	34.4	2.7			
Strategic Thinking						
Control	1.8	5.0	1.0	15.65^{**}	58	<.001
Experimental	15.2	42.1	4.6			

Note: ** - significant at 0.01 level

3.4. Pretest-Posttest Scores

Table 4 shows the crosstabulation of the pretest and posttest scores of the control and experimental group in integer operations. For the control group 29 out 30 respondents in the control group remain at the same level of performance during the posttest. Specifically, the 21 respondents who performed very low on integer operations during the pretest remained very low during the posttest. On the other hand, 100% of the respondents in the experimental group increased their level of performance on integer operations after playing enhanced Damath. Specifically, there were seven respondents who performed from low to high and three respondents from low to average. The result of the t-test showed no significant increase in the performance of the control group (t=1.40, df=29, p-value=.15) while the performance of the experimental group was significantly higher in the posttest (t=20.03, df=29, p-value<.001).

Table 4. Crosstabulation of pretest and posttest scores of respondents in integer operations.

Group	Pretest Score	Posttest Score 1-5	6-10	11-15	16-20	21-25	Test Statistic
Control	1-5	21	1	-	-	-	t-value: 1.40 ^{ns} p-value: .15
	6-10	-	8	-	-	-	
	11-25	-	-	-	-	-	
Experimental	1-5	-	8	12	-	-	t -value: 20.03^{**} p-value: <.001
	6-10	-	-	3	7	-	
	11-25	-	-	-	-	-	

Note: ^{ns} – not significant at 0.05 level; ** - significant at 0.01 level

Table 5 shows the crosstabulation of the pretest and posttest scores of the control group and experimental group in strategic thinking. All the respondents in the control group showed no improvement in their strategic thinking. Specifically, 26 (86.67%) of the respondents who performed low during the pretest, still performed low during the posttest. In the experimental group, 100% have increased their level of performance in strategic thinking. The 18 (60%) respondents who showed low strategic thinking in the pretest manifested high during the posttest while the other 9 (30%) performed from low to average and two (6.67%) of the respondents performed from average to high and very high strategic thinking. The result of the t-test showed no significant difference between pretest and posttest scores in the control group (t=1.15, df=29, p-value=.26) while the significant improvement in strategic thinking in the experimental group was confirmed (t=20.03, df=29, p-value<.001).

Table 5. Crosstabulation of pretest and posttest scores of the respondents in strategic thinking.

Group	Pretest Score	Posttest Score				Test Statistic
		1-9	10-18	19-27	28-36	
Control	1-9	26	-	-	-	t-value: 1.15 ^{ns}
	10-18	-	4	-	-	p-value: .26
	19-36	-	-	-	-	
Experimental	1-9	-	9	18	-	t-value: 18.17**
	10-18	-	-	1	2	p-value: <.001
	19-2	-	-	-	-	

Note: ^{ns} – not significant at 0.05 level; ** - significant at 0.01 level

Table 6 presents the result of the focus group discussion which was done after giving the treatment. The focus group discussion was done in order to gather information from the respondents about the benefits and some concerns of playing enhanced Damath.

Table 6. Perceived benefits of playing enhanced Damath.

Theme	Sample transcripts from the focus group discussion
Developed strategic thinking	It helps in thinking what would happen if I moved (Damath pieces) here or there.
	My brain really works, for example, in thinking strategically where to operate the indicated symbols on the dice in order to get a high score. It helps in making you to be good in solving.
Improved performance on integer operations	I don't have any idea about "negative" before. I really don't get it. But now that we played, I've already learned something.
	I am fast in solving now.
	The moment we started playing, I really learned something since I keep on recalling it.
	It's really nice because you will really learn something about solving and it can also be used in our study.
	My learning in subtraction and division has increased.
	I've learned because before I really don't know how to solve.
	My knowledge in Math increased since I am really slow in Math.
	I've only learned it now because I think we didn't have a lesson on that.
	At first, I don't get it but eventually I already did.
	Damath is of help because I already forgot about integers.
Promotes fun and excitement	Exciting and it feels good.
	I find playing interesting and enjoyable and I've also learned something.
Develops intrinsic motivation	I really want learn Damath. That is why, I made my own board and chips and played all by myself.

The descriptive data corroborates with the result of quantitative data that playing enhanced Damath develops students' strategic thinking and improves their performance on integer operations. In addition, it promotes fun and excitement, and develops their intrinsic motivation to learn independently. The overall result confirms that mathematical game is a powerful learning tool (Devlin, 2011; Plass et al., 2015) and can potentially change students' perceptions about mathematics and mathematics learning.

4. Discussion

The results provide compelling evidence for the effectiveness of the enhanced Damath game in improving students' mathematical performance, particularly in the areas of integer operations and strategic thinking. The pretests confirmed that the control and experimental groups were statistically comparable prior to the intervention, as indicated by non-significant differences in their pretest scores. Both groups exhibited low initial proficiency, a finding that aligns with previous research documenting widespread difficulties among students in dealing with basic integer operations (Sen et al., 2017; Makonye & Fakude, 2016). These challenges have been noted globally and are recognized as barriers to the successful progression into more advanced mathematical topics (Van de Walle et al., 2009).

Following the implementation of the enhanced Damath, the experimental group demonstrated statistically significant improvements in both integer operations and strategic thinking, surpassing the performance of the control group, which showed negligible gains. This supports earlier findings that incorporating games into instruction can improve learners' achievement in mathematics (Clark et al., 2016; Wouters et al., 2013) and foster clearer comprehension of mathematical concepts (Yusoff et al., 2014).

Posttest analyses revealed that students exposed to enhanced Damath achieved markedly higher maximum, minimum, and median scores. The gain score analysis further substantiated these results, demonstrating significantly larger mean gains for the experimental group, with p-values well below the .001 threshold. Crosstabulation analyses showed that while most control group respondents remained within their initial performance brackets, all experimental group members progressed to higher performance levels. This trend echoes the work of Abramovich (2010), Bottino, Ferlino, Ott, and Tavella (2007), who reported that game-based strategies contribute significantly to developing students' problem-solving, strategic thinking, and reasoning abilities.

The qualitative findings further enriched the quantitative results. Focus group discussions revealed that participants perceived enhanced strategic thinking, improved computational proficiency in integer operations, heightened engagement, and increased motivation to learn mathematics after exposure to enhanced Damath. These student experiences resonate with situated learning theory, which emphasizes that environments allowing "play" to happen encourage meaningful learning and rich interactions (Brown et al., 1989; Vygotsky, 1967). Furthermore, the learning experiences reflect Gee's (2004) theory of meaning as action and image, suggesting that when learners repeatedly engage in authentic activities, such as game-based learning, conceptual understanding is strengthened.

Respondents specifically cited the game's ability to make abstract concepts, such as integer operations, more tangible and enjoyable. This supports Devlin's (2011) assertion that mathematical games can heighten mathematical consciousness and reinforce understanding even through repeated play resulting from mistakes or failures (Devlin, 2011; Squire & Barab, 2004).

Overall, these findings affirm that enhanced Damath is an effective pegagogical tool for promoting both mathematical competence in integer operations and strategic thinking. Additionally, the study corroborates prior research indicating that game-based instruction can improve students' perceptions of mathematics learning (Afari et al., 2013) and can serve as a viable solution for addressing persistent learning gaps identified by Verzosa, Tulao-Fernando, and Vistro-Yu (2017) in the Philippines.

5. Conclusions

Playing enhanced Damath significantly improves students' level of knowledge in integers involving single and multiple operations as well as their strategic thinking skills. The results of the study, specifically the posttest score, gain score, and crosstabulation analyses revealed statistically significant improvements among students who played enhanced Damath. Also, in the focus group discussions, the students affirmed the positive effect of enhanced Damath in terms of improved performance in integer operations and strategic thinking and indicated positive emotions felt during game-playing learning engagement. This further means that, the quantitative findings of the study were supported by the qualitative data.

Despite these positive outcomes, the study has limitations. The study did not go beyond the context of determining the effects of using enhanced Damath in learning operations on integers and developing strategic thinking. As for the dice of the research material, there were only three fundamental operations that were utilized namely addition, subtraction, multiplication as these are the only operations closed on the set of integers.

This study emphasized the effectiveness of enhanced Damath in addressing students' difficulties in dealing with integer operations and developing strategic thinking. This further implies that, students who played enhanced Damath have engaged in various deep learning activities such as analysis of information, planning, analysis of possible solutions, and choosing best action. These deep learning activities lead to the development of students; higher-order thinking skill specifically, strategic thinking. Also, this suggests that incorporating educational games in mathematics teaching can help in creating training programs for teachers that encourage innovative and effective teaching approaches for a better teaching and learning process.

Future studies may explore the potential of developing an online application using enhanced Damath to entice students to play educational games. Researchers may also examine the impact of implementing enhanced Damath in community learning centers as a tool for promoting numerical literacy and fostering positive social interactions among adult learners.

Author Contributions: Cherrylee M. Buhay conceived the paper and the study intervention, wrote the RRL, arranged and asked permission from the community and submitted required documents for data gathering, pilot tested the research instrument, collected data, encoded data, performed statistical analysis, and wrote the paper. Dr. Leorence C. Tandog conceived the design of the study, validated the research instrument, specified the statistical tools needed, cleaned the data, reviewed the statistical outputs, designed data presentation, co-wrote the paper, and did the final editing.

Funding: This research received no external funding.

Informed Consent Statement: The researcher thoroughly explained the study, its purpose, and its methods to the respondents. The respondents were asked for their consent verbally. The respondents, in turn, verbalized their con-sent to the researcher. Participation in the research was also voluntary. They were informed that they could withdraw from the research process at any time that they wish or whenever they felt dis-comfort.

Acknowledgments: We would like to acknowledge the respondents for their time, enthusiasm, and constant participation in this study. We would like also to thank the game facilitators and the teachers who assisted in matching the respondents for their most valued help during the data gathering.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

The appendix A contains the research material or the enhanced Damath. This includes everything about the enhanced Damath – from arranging the Damath pieces on the Damath board, making and recording a move, capturing opponent's piece/s, computing scores and using the dice to one's advantage. It's a seven-page file so the researcher prefer to save it in pdf file and upload it in google drive. To have access on the file, please click the link below.

https://drive.google.com/file/d/1HvbrW-zcVuCGfusZBLS5soHdOcEVnj2R/view?usp=sharing

Appendix B

The Research Instrument

Instruction: Perform the indicated operation/s.

Test I-A

1. 13 + 26
2. -18 + (-19)
3. 48 + (-32)
4. 32 - 19
5. -15 + 26
6. -67 – (-19)
7. (14) (8)
8. -34 – 17
9. 16 – (-22)

10. (-32) (-5)
11. (12) (-13)
12. (-23) (17)
13. $\frac{-95}{5}$
14. $\frac{-108}{-18}$
15. $\frac{102}{-17}$

Test I-B
1. (-11 + 30) + (-9 – 17)
2. [(-7) (24)] + (-33 + 16)
3. (112 ÷ 7) + [(-9) (-12)]
4. [(43) (-6)] + (-56+45) + [48-(-29)]
5. (-171÷ 9) + [(-3)(15)] + (-52 – 29) + (-46 + 39)

Test II
Instruction: Analyze and solve the problems below thinking that you were in the given situation. Give an answer that is advantageous on your part.

1. Marta's store is selling 125 grams of bananas for 5 pesos. Mary's store is selling 50 grams of bananas for 3 pesos. If you were in need of 750 grams of bananas, in which store would you prefer to buy?

2. Daniel's parking area charges 12 pesos for the first three-hour parking and 4 pesos for each additional hour. Jonah's parking area charges 18 pesos for the first six-hour parking and 5 pesos for each additional hour. If you were to park your car for 9 hours, in which parking area would you prefer to park?

3. John (white chip) and Paul (blue chip) are playing Damath. Initially, John's score is -9 and Paul's score is 10. Suppose John captured Paul's piece (as illustrated below). John then rolled the dice (as illustrated below). If you were John, where would you operate the "times 3"?

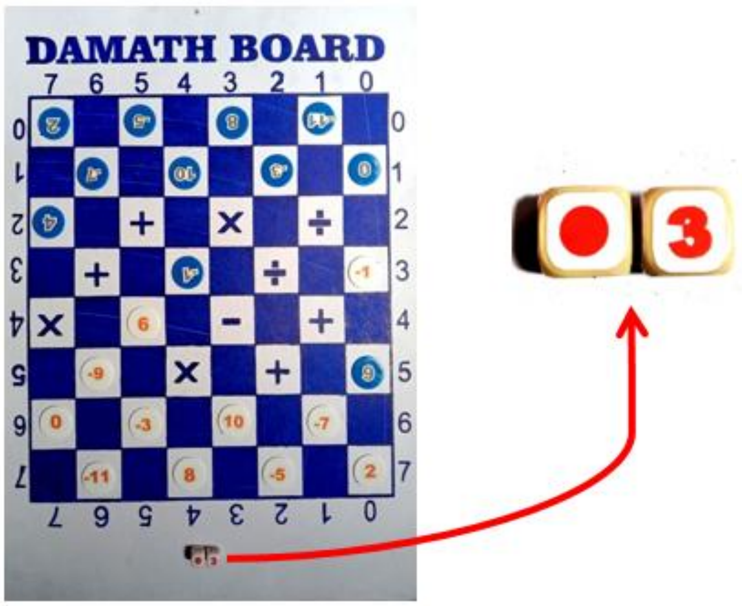

Figure B1. Damath board.

1. Teacher Esther makes set of cards (see Figure 1). She mixes the cards facedown. She gives 4 cards to two of her students and let them make a two-digit subtraction problem out of it. The subtraction problem with the smallest difference wins. One of her students immediately created a subtraction problem (see Figure 2). If you were the other student of teacher Esther, what subtraction problem would you make out of the four remaining cards in order to win?

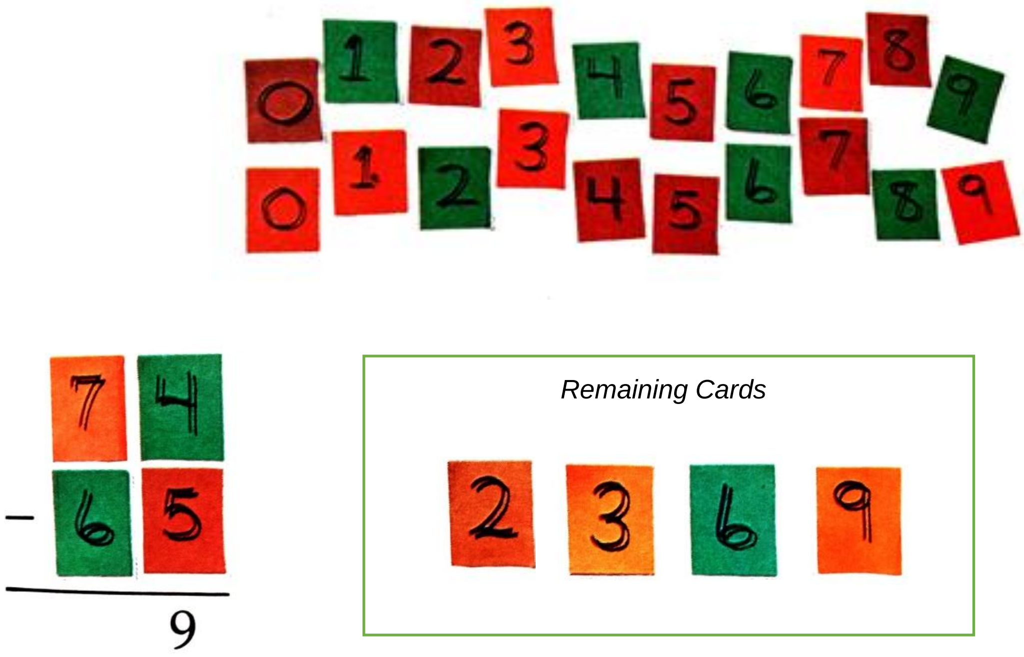

Figure B2. Set of cards.

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