



The Effects of Geopardy! as a Formative Assessment on Learners' Perceptions of the Learning Environment and Geometry Achievement

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ABSTRACT

This study examined the effects of Geopardy! as a formative assessment tool on learners' perceptions of the learning environment and Geometry achievement. Using a mixed-method approach with a non-equivalent pretest-posttest design, the study involved 64 Grade 7 students from Iligan City National High School. The experimental group used Geopardy! for formative assessment, while the control group completed traditional paper-and-pencil tests. Data were collected through an achievement test, perception questionnaire, and mathematics journals. The findings showed that Geopardy! improved learners' enjoyment, engagement, teamwork, and classroom perceptions. However, the difference in achievement gain scores was not statistically significant. Geopardy! may support positive classroom experiences, but its academic impact requires further investigation.

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1. INTRODUCTION

Geometry is one of the most challenging branches of Mathematics because it requires conceptual understanding, logical reasoning, spatial visualization, problem-solving skills, and the ability to construct proofs. These difficulties may affect learners' achievement and their perceptions of the classroom learning environment. Therefore, instructional strategies that promote interaction, motivation, collaboration, and active participation are needed to support meaningful Geometry learning. Interactive learning environments can enhance students' motivation and participation, which are essential for effective Mathematics teaching and learning (Muñoz et al., 2020).

Game-based learning is one strategy that may address these challenges. Educational games can increase students' interest, engagement, and participation by creating a more interactive and enjoyable classroom environment. In Mathematics-related subjects, games can also help learners collaborate, reinforce concepts, and participate in a less stressful learning setting (Afari et al., 2012; Rosni et al., 2024; Yong et al., 2016). In this study, Geopardy! was introduced as a formative assessment tool in Geometry to provide opportunities for concept review, collaborative problem-solving, and feedback during learning. Adapted from the television quiz game Jeopardy!, Geopardy! allows students to work in teams, select Geometry-related questions, discuss solutions, and earn points for correct responses. This structure supports collaboration while enabling teachers to monitor students' understanding interactively (Afari et al., 2012; Zabala-Vargas et al., 2022). Although game-based learning is widely associated with student engagement and motivation, its effects on academic achievement remain context-dependent. Educational games may improve learning outcomes when implemented consistently, aligned with learning objectives, and supported by effective facilitation (Plass et al., 2015; Sailer and Homner, 2020). However, game-based formative assessment may not always produce immediate or statistically significant achievement gains, especially when implementation is brief or interrupted. Therefore, further investigation is needed to examine how Geopardy! influences both learners' perceptions of the learning environment and Geometry achievement.

This study examined the effects of Geopardy! as a formative assessment tool on Grade 7 learners' perceptions of the learning environment and Geometry achievement. Specifically, it sought to answer the following questions:

- (i) What is the achievement level of Grade 7 learners?
- (ii) What are the learners' perceived learning-environment conditions?
- (iii) What are the achievement gain scores of Grade 7 learners?
- (iv) Is there a significant pretest-posttest difference in the achievement levels of Grade 7 learners between the control and experimental groups?
- (v) Is there a significant pretest-posttest difference in the learners' perceptions of their learning environment between the control and experimental groups?
- (vi) Is there a significant difference in the achievement gain scores between the control and experimental groups?
- (vii) What reflective insights can be drawn from the learners' Mathematics journals?

Figure 1 presents the conceptual framework of the study. It illustrates the use of Geopardy! as a formative assessment tool and its expected effects on learners' Geometry achievement and perceptions of the learning environment. The experimental group used Geopardy! as a formative assessment activity every Friday, while the control group used traditional paper-

and-pencil assessment. Both groups received the same instructional strategies; the only difference was the formative assessment approach.

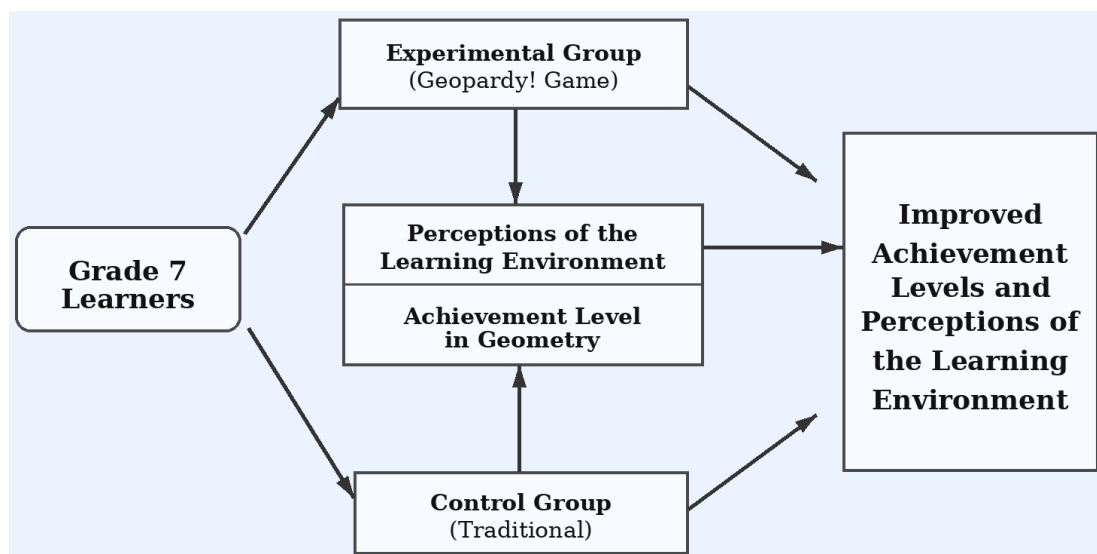


Figure 1. The conceptual framework.

2. METHODS

This study employed a mixed-method approach with a non-equivalent pretest–posttest design to examine the effects of Geopardy! as a formative assessment tool on Grade 7 learners’ perceptions of the learning environment and Geometry achievement. Quantitative data were collected through an achievement test and a perception questionnaire, while qualitative data were obtained from learners’ Mathematics journals. The study was conducted at Iligan City National High School, Mahayahay, Iligan City, Philippines. The participants were 64 Grade 7 learners from two pre-assigned sections taught by the same Mathematics teacher. The experimental group consisted of 37 students and used Geopardy! as a formative assessment activity, while the control group consisted of 27 students and completed traditional paper-and-pencil assessments. The same Geometry lessons and instructional strategies were applied to both groups, with the formative assessment approach serving as the main difference. Three instruments were used in the study: an achievement test, a perception questionnaire, and Mathematics journals. The achievement test was administered as a pretest and posttest to measure learners’ Geometry achievement before and after the intervention. The perception questionnaire (Afari, 2012) consisted of 30 positive and negative items measuring learners’ perceptions of the learning environment. Mathematics journals (Afari, 2012) were used to gather learners’ reflective insights after Geopardy! sessions.

Achievement scores were interpreted using the achievement level classification (Table 1). Learners’ perceptions of the learning environment were interpreted using the classification (Wantouw *et al.*, 2014; Table 2). The interpretation of learning-environment responses was supported by the view that classroom climate and learner perception are important indicators of instructional effectiveness (Aldridge and Fraser, 2016). Achievement gain scores were computed to describe learners’ improvement from pretest to posttest, consistent with the use of gain scores as indicators of learning progress after instructional intervention (Hake, 1998). The gain score classification was used in this study (Table 3). Descriptive statistics were used to summarize achievement scores, perception scores, and gain scores. The Wilcoxon

signed-rank test was used to determine significant pretest–posttest differences within each group, while the Mann–Whitney U test was used to examine differences between the experimental and control groups. Qualitative data from Mathematics journals were analyzed thematically to identify learners’ reflective insights regarding enjoyment, engagement, collaboration, motivation, and perceived learning support during the Geopardy! activities.

Table 1. Achievement level classifications.

SCORE RANGE	RATING	CLASSIFICATION
36-40	90% and above	Outstanding
34-35	85-89%	Proficient
32-33	80-84%	Approaching proficient
30-31	75-79%	Developing
0-29	74% and below	Beginning

Table 2. Perception of the learning environment classification.

MEAN SCORE	PERCEPTION CLASSIFICATION
1.00-1.40	Very low
1.41-1.80	Low
1.81-2.20	Medium
2.21-2.60	High
2.61-3.00	Very high

Table 3. Gain score description.

MEAN SCORE	DESCRIPTION
1.00-1.40	Very low
1.41-1.80	Low
1.81-2.20	Medium
2.21-2.60	High
2.61-3.00	Very high

3. RESULTS AND DISCUSSION

3.1. Achievement level

Table 4 presents the mean scores and achievement classifications of both groups. Both the control and experimental groups were classified under the “Beginning” achievement level before and after the intervention. The control group obtained a pretest mean score of 16.93 and a posttest mean score of 23.19, while the experimental group obtained a pretest mean score of 18.84 and a posttest mean score of 26.70. Although both groups showed improvement from pretest to posttest, the increase was not sufficient to move the overall classification beyond the “Beginning” level. The implementation period may not have been long enough to produce substantial improvement in learners’ overall Geometry achievement. The limited improvement may also be associated with external factors, such as class interruptions, holidays, and the short duration of exposure to the intervention. Previous studies have emphasized that instructional interventions require sufficient exposure time, consistent implementation, and sustained learner engagement to produce stronger academic effects (Cook et al., 2013; Fasco et al., 2024). Thus, although Geopardy! appeared to support classroom engagement, its measurable effect on achievement level may have been constrained by the limited intervention period.

Table 4. Mean score per group.

GROUP	PRETEST MEAN SCORE	INTERPRETATION	POSTTEST MEAN SCORE	INTERPRETATION	N
Control	16.93	Beginning	23.19	Beginning	27
Experimental	18.84	Beginning	26.70	Beginning	37

To provide a more detailed view of learners' achievement levels, **Table 5** presents the frequency and percentage distribution of learners across achievement categories in both groups. All learners in both groups were classified as "Beginning" in the pretest. After the intervention, 25 learners in the control group, or 92.6%, remained in the "Beginning" category, while 28 learners in the experimental group, or 75.7%, remained in the same category. However, the experimental group showed a greater movement toward higher achievement categories. Nine learners from the experimental group moved beyond the "Beginning" category, compared with only two learners from the control group.

Table 5. Learners' achievement level classification.

RANGE SCORES	CONTROL GROUP				EXPERIMENTAL GROUP				INTERPRETATION
	PRETEST		POSTTEST		PRETEST		POSTTEST		
	F	P	F	P	F	P	F	P	
36-40	0	0%	0	0%	0	0%	1	2.7%	Outstanding
34-35	0	0%	0	0%	0	0%	1	2.7%	Proficient
32-33	0	0%	0	0%	0	0%	3	8.1%	Approaching proficient
30-31	0	0%	2	7.4%	0	0%	4	10.8%	Developing
0-29	27	100%	25	92.6%	37	100%	28	75.7%	Beginning
Total	27	100%	27	100%	37	100%	37	100%	

Geopardy! may have supported improvement among some learners, even though the overall achievement classification of the group remained low. Game-based formative assessment can promote participation, motivation, and retention of mathematical concepts by creating interactive and collaborative learning opportunities (Maryana *et al.*, 2024; Plass *et al.*, 2015; Rahim and Mohammed, 2025). Similarly, interactive and collaborative learning environments have been associated with improved engagement, motivation, and conceptual understanding (Eltahir *et al.*, 2021; Zhaopeng, 2023). Therefore, Geopardy! appears to have contributed to positive learning movement among learners, although its impact on overall achievement remained modest.

3.2. Perception of the learning environment

Learners' perceptions of the learning environment were examined to determine whether Geopardy! influenced classroom experience, engagement, collaboration, and participation. **Table 6** presents the pretest and posttest perception mean score ranges of the control and experimental groups. The experimental group demonstrated improvement in learners' perceptions after the use of Geopardy!. Their perception range shifted from "Low to very high" in the pretest to "Medium to very high" in the posttest. The control group also showed a shift, but the improvement was less pronounced. This suggests that Geopardy! contributed to a more positive classroom learning environment by encouraging enjoyment, participation, and collaboration. This interpretation is supported by the use of learning-environment perception measures adapted from literature (Afari, 2012), as well as research emphasizing that students' perceptions of classroom climate are important indicators of instructional

effectiveness, learner engagement, and classroom experience (Aldridge and Fraser, 2016). The findings are also consistent with studies showing that game-based and interactive learning environments can foster engagement, cooperation, and positive perceptions of learning (Afari et al., 2013; Bovermann and Bastiaens, 2019; Rahim and Mohammed, 2025). In the context of Geometry learning, where students often experience difficulty and anxiety, a game-based formative assessment may help reduce tension and make classroom activities more enjoyable.

Table 6. Learners' perception of the learning environment.

GROUP	MEAN RANGE SCORE				n
	PRETEST	INTERPRETATION	POSTTEST	INTERPRETATION	
Control	2.0741-2.8148	Low to very high	1.9630-2.8148	Medium to very high	27
Experimental	2.0541-2.8108	Low to very high	2.1351-2.8919	Medium to very high	37

Using the perception classification adapted from literature (Wantouw et al., 2014), Table 7 presents the distribution of learners' perceptions of the learning environment in both groups according to very high, high, medium, low, and very low categories. The experimental group showed an increase in "Very high" perception responses from 40.00% in the pretest to 46.67% in the posttest. The combined "High" and "Very high" responses also increased from 86.67 to 93.33%. In contrast, the control group showed a decrease in "Very high" responses from 30.00 to 23.33%, while "Medium" responses increased from 20.00 to 26.67%. These results indicate that Geopardy! had a more positive effect on learners' perceptions of the learning environment than traditional paper-and-pencil formative assessment.

The improvement in learners' perceptions suggests that Geopardy! helped create a classroom atmosphere that was more engaging, cooperative, and motivating. This supports previous research showing that games and interactive learning activities can make Mathematics classrooms more enjoyable and can increase students' willingness to participate in learning activities (Afari et al., 2012; Bovermann and Bastiaens, 2019).

Table 7. Learners' perception of the learning environment classification.

RANGE SCORES	EXPERIMENTAL GROUP				CONTROL GROUP				INTERPRETATION
	PRETEST		POSTTEST		PRETEST		POSTTEST		
	F	P	F	P	F	P	F	P	
2.60-3.00	12	40.00%	14	46.67%	9	30.00%	7	23.33%	Very high
2.21-2.60	14	46.67%	14	46.67%	15	50.00%	15	50.00%	High
1.81-2.20	4	13.33%	2	6.67%	6	20.00%	8	26.67%	Medium
1.41-1.80	0	0%	0	0%	0	0%	0	0%	Low
1.00-1.40	0	0%	0	0%	0	0%	0	0%	Very low
Total	30	100%	30	100%	30	100%	30	100%	

3.3. Gain scores

Achievement gain scores were analyzed to compare the degree of improvement between the control and experimental groups. Gain score analysis was used to describe learners' progress from pretest to posttest, consistent with the use of gain scores as indicators of learning improvement after instructional intervention (Hake, 1998). Table 8 presents the average gain scores of both groups. The experimental group obtained a slightly higher average gain score than the control group. However, both groups were still classified as

having a “Low increase.” This indicates that although the experimental group showed somewhat greater improvement, the increase was not large enough to indicate a strong achievement effect. The limited gain may be explained by the short intervention period and inconsistent implementation schedule. Previous research suggests that game-based learning can enhance engagement and short-term understanding, but substantial gains in academic achievement often require sufficient exposure, instructional alignment, and sustained implementation (Alomari *et al.*, 2019; Partovi and Razavi, 2019; Sailer and Homner, 2020). Thus, the low gain scores do not necessarily indicate that Geopardy! has no instructional value. Rather, they suggest that its effect on achievement may depend on how long and how consistently it is implemented.

Table 8. Experimental and control group gain scores.

GROUP	AVERAGE GAIN SCORE	INTERPRETATION	N
Control	6.25925926	Low increase	27
Experimental	7.86486486	Low increase	37

Table 9 presents the distribution of gain score ranges for the experimental and control groups. No learner from either group achieved a gain score of 21 or above. However, the experimental group had more learners in the “Average increase” category than the control group, with 37.8% compared with 25.9%. The control group also had more learners in the “Very low increase” category. These results suggest that Geopardy! may have contributed to slightly better learning gains, although the overall difference remained limited. This result is consistent with recent studies indicating that game-based learning can increase motivation, engagement, and classroom participation, but its effects on achievement may be modest when interventions are brief or inconsistently implemented (Fadda *et al.*, 2022; Pehlivan and Arabacioglu, 2023; Wang *et al.*, 2022). Therefore, Geopardy! may be more immediately effective in improving engagement and classroom experience than in producing large achievement gains within a short period.

Table 9. Gain score ranges, frequencies, and descriptions.

GAIN SCORE RANGES	EXPERIMENTAL GROUP		CONTROL GROUP		DESCRIPTION
	F	%	F	%	
21 and above	0	0%	0	0%	Very high increase
15-20	2	5.4%	1	3.7%	High increase
9-14	14	37.8%	7	25.9%	Average increase
3-8	18	48.7%	10	37.1%	Low increase
1-2	0	0%	6	22.2%	Very low increase
0	2	5.4%	1	3.7%	No increase
-1 and below	1	2.7%	2	7.4%	Decrease
Total	37	100%	27	100%	

3.4. Difference in achievement levels

Inferential analysis was conducted to examine differences in learners’ achievement levels within and between groups (**Table 10**). Both the experimental and control groups had significant pretest–posttest improvements, with p-values of 0.000. This indicates that both Geopardy! and traditional paper-and-pencil assessment were associated with improved

Geometry achievement. The Mann–Whitney U test also showed a significant posttest difference between groups, with a p-value of 0.008. However, this result should be interpreted alongside the gain score analysis, which showed no significant difference in achievement gains. Thus, Geopardy! may support achievement improvement, but its measurable effect requires longer and more controlled implementation. These findings align with studies showing that game-based learning can improve attention, motivation, retention, and problem-solving engagement when well-designed and properly implemented (Hussein et al., 2022; Turgut and Temur, 2017).

Table 10. Difference in learners' achievement levels.

COMPARISON	GROUP	N	MEAN RANK	SUM OF RANKS	TEST USED	P-VALUE
Within groups	Pretest-posttest experimental	37	18.50	629.00	Wilcoxon signed-rank test	0.000*
Within groups	Pretest-posttest control	27	14.21	341.00	Wilcoxon signed-rank test	0.000*
Between groups	Posttest experimental	37	25.35	684.50	Mann-Whitney U test	0.008*
Between groups	Posttest control	27	37.77	1395.50	Mann-Whitney U test	

Note: Significant at $p < 0.05$.

3.5. Difference in learners' perceptions of the learning environment

The study also examined differences in learners' perceptions of the learning environment within and between groups (Table 11), the pretest comparison between the control and experimental groups was not significant ($p = 0.174$), indicating comparable initial perceptions. However, the experimental group showed a significant pretest–posttest improvement ($p = 0.017$), while the control group did not ($p = 0.208$). The posttest comparison also showed a significant difference between groups ($p = 0.000$), suggesting that learners exposed to Geopardy! developed more positive perceptions of the learning environment.

Table 11. Difference in learners' perception of the learning environment.

COMPARISON	GROUP	N	MEAN RANK	SUM OF RANKS	TEST USED	P-VALUE
Within groups	Pretest-posttest experimental	37	14.64	322.00	Wilcoxon signed-rank test	0.017*
Within groups	Pretest-posttest control	27	11.06	251.50	Wilcoxon signed-rank test	0.208**
Between groups	Pretest control	27	28.80	777.50	Mann-Whitney test	0.174**
Between groups	Pretest experimental	37	35.20	1302.50	Mann-Whitney test	
Between groups	Posttest control	27	22.56	609.00	Mann-Whitney test	0.000*
Between groups	Posttest experimental	37	39.76	1471.00	Mann-Whitney test	

Note. $p < 0.05$ = significant; $p > 0.05$ = not significant.

These findings indicate that Geopardy! improved classroom experience, particularly enjoyment, engagement, collaboration, and participation. This aligns with studies showing that game-based learning can enhance motivation and classroom perception, although its achievement effects may depend on implementation duration (İlhan, 2021; Li *et al.*, 2023).

3.6. Difference in achievement gain scores

The difference in gain scores between the experimental and control groups was examined using the Mann-Whitney U test. The results are presented in **Table 12**. The Mann-Whitney U test yielded a p-value of 0.190, which is greater than 0.05. This indicates that there was no statistically significant difference in achievement gain scores between the experimental and control groups. Although the experimental group obtained a slightly higher average gain score, the difference was not large enough to confirm that Geopardy! produced significantly greater achievement gains than traditional paper-and-pencil assessment.

This finding is important because it provides a balanced interpretation of the intervention. Geopardy! improved learners' perceptions of the learning environment and supported classroom engagement, but its effect on achievement gains was not statistically significant. Research on game-based assessment cautions that gain scores can be unstable indicators of learning, especially when baseline scores differ or when measurement conditions are limited. Validating game-based assessment requires more than simple pretest-posttest comparisons and should involve rigorous evidence across multiple implementation cycles (Gomez *et al.*, 2022; Hidayat and Santoso, 2025). Therefore, Geopardy! should be understood as a promising formative assessment strategy that improves learner engagement and classroom experience, while its effect on academic achievement requires longer implementation, stronger instructional alignment, and further empirical validation.

Table 12. Gain score difference.

COMPARISON	GROUP	N	MEAN RANK	SUM OF RANKS	TEST USED	P-VALUE
Between groups	Experimental	37	35.09	1298.50	Mann-Whitney U test	0.190**
Between groups	Control	27	28.94	781.50	Mann-Whitney U test	

Note: $p > 0.05$ = not significant.

3.7. Reflective insights from learners' Mathematics journals

Learners' Mathematics journals provided qualitative insights into their experiences with Geopardy! as a formative assessment activity. The journal responses revealed generally positive perceptions of the game. Many learners reported that Geopardy! made Geometry lessons more enjoyable, engaging, and easier to understand. They also indicated that the game helped them approach problem-solving tasks with greater confidence and interest. Learners also emphasized the collaborative nature of the activity. During Geopardy!, students worked with group members to analyze questions, discuss possible solutions, and make collective decisions. This structure encouraged peer interaction, teamwork, and shared responsibility. For students who initially had negative attitudes toward Mathematics, the game helped reduce anxiety by creating a competitive but supportive classroom atmosphere. Geopardy! contributed to a more positive learning environment by promoting enjoyment,

collaboration, motivation, and active participation. These qualitative findings support the quantitative results on learners' perceptions of the learning environment. However, the journal insights also reinforce the need to interpret achievement outcomes cautiously: while students perceived the game positively and became more engaged, longer implementation may be needed to produce stronger and statistically significant achievement gains.

4. CONCLUSION

This study examined the effects of Geopardy! as a formative assessment tool on learners' perceptions of the learning environment and Geometry achievement. The findings showed that Geopardy! promoted enjoyment, motivation, collaboration, and active participation, resulting in more positive classroom perceptions than traditional paper-and-pencil assessment. Although both groups improved in Geometry achievement, the difference in gain scores was not statistically significant, indicating that Geopardy!'s academic effect was limited within the study period. Therefore, Geopardy! may be used as an engaging enrichment or review activity, while future studies should apply it longer with larger samples and improved game design.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

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