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

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A B S T R A C T

This study examined the effects of Geopardy! as a formative assessment tool on learners' perceptions of the learning environment and their achievement in Geometry. Employing a mixed-method approach with a non-equivalent pretest–posttest design, the research involved 64 Grade 7 students from Iligan City National High School. The experimental group used Geopardy! for formative assessments, while the control group completed traditional paper-and-pencil tests. Data were collected through an achievement test, perception questionnaire, and mathematics journals. Results indicate that students exposed to Geopardy! reported greater enjoyment, improved classroom engagement, and enhanced teamwork, contributing to a more positive perception of the learning environment. Although both groups demonstrated improvement in Geometry achievement, the difference in gain scores was not statistically significant. The findings suggest that Geopardy! is a promising formative assessment strategy that promotes engagement and positive classroom experiences, though further research is needed to examine its long-term impact on academic performance.

A R T I C L E   I N F O

1. INTRODUCTION

Learning mathematics has always been an issue for many people ever since. Among its branches, Geometry is considered one of the hardest and most challenging ones. The fact that there are concepts that are difficult to understand, dealing with the rules, and solving mathematical problems may also seem inconvenient and stressful. Moreover, writing proofs is actually what made it receive such a title. How the learners interact and perceive their environment during Geometry classes affects their learning. Thus, strategies are highly needed to create an interactive and effective learning process. The use of active learning strategies significantly contributes to making classroom instruction more engaging and effective, as it allows learners to interact, collaborate, and construct knowledge meaningfully. Similarly, interactive learning environments enhance student motivation and participation, which are essential components of effective teaching and learning (Muñoz *et al.*, 2020).

Whenever academic dilemmas arise, there are still solutions that can be discovered. One of these is the utilization of games. Usage of games for educational purposes for mathematics-related subjects inspired proponents to utilize a game called Geopardy! as a formative assessment in Geometry. Some researchers indicate that games have the potential to draw students into the learning process and to encourage them to participate through a more interactive environment (Afari et al., 2012; Rosni *et al.*, 2023; Yong *et al.*, 2023).

Jeopardy! is an American quiz show that features a wide range of topics such as history, literature, the arts, pop culture, science, and sports. The show follows a distinctive question-and-answer format in which contestants are presented with clues in the form of answers and must respond in the form of a question. In mathematics classes, when playing the Geopardy! -type game, students are typically grouped into teams and take turns selecting a mathematical concept and its corresponding question from a board. Team members collaborate to solve the problem and earn points for correct responses. Recent studies have emphasized that Geopardy! -Type or game-based learning activities enhance learners' engagement, motivation, and collaboration, allowing teachers to assess students' knowledge and reinforce critical information in a fun, interactive environment (Afari *et al.*, 2012; Zabala-Vargas *et al.*, 2022; Sager & Sherard, 2023). In this study, the game Geopardy! was utilized as a formative assessment tool; however, necessary modifications were made to align it with the objectives of the present study, resulting in its adapted and renamed version, Geopardy! This study examined the achievement-related and perception-based effects of Geopardy! on Grade 7 learners. 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?; and (vii) What reflective insights can be drawn from the learners' Math journals?

In **Figure 1**, the goal and main concern of the study basically involve the effects of Geopardy! on the learners' achievements and their perception of the learning environment. We looked into the effectiveness of Geopardy! in the learning achievements of the learners and the improvements of their performances in mathematics. We acted as facilitators of the game while the teacher assisted. Finally, the same teaching strategies were used for both groups. The experimental group utilized Geopardy! as a formative assessment every Friday,

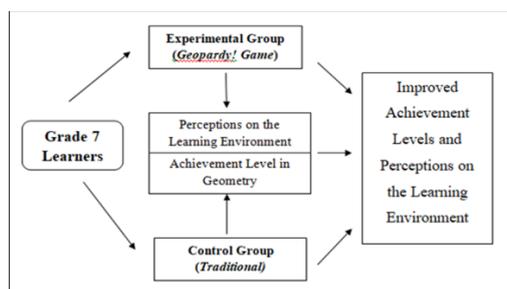while the control group used the traditional teacher-based assessment, specifically the paper-and-pencil test.

Figure 1. The Conceptual Framework.

2. METHODS

The study employed both quantitative and qualitative data through the use of three primary research instruments. The Achievement Test served as a measure of Grade 7 learners' academic performance, administered as both a pretest and posttest to determine changes in achievement following exposure to the Geopardy! intervention. To assess students' perceptions of their learning environment, we utilized a modified version (Afari, 2012) about Perception of the Learning Environment Questionnaire, consisting of 30 items equally divided into positive and negative statements. In addition, qualitative data were gathered through a Math Journal, which incorporated guide questions (Afari, 2012) about interview protocol. After each game session, learners wrote reflective, diary-style entries, enabling we to gain deeper insights into their experiences, validate questionnaire responses, and capture their reactions to the use of Geopardy! as a formative assessment tool.

2.1. Study Setting

The study was conducted at Iligan City National High School (ICNHS) located in Mahayahay, Iligan City, Philippines, with respondents drawn from two pre-assigned sections of the same grade level. The school principal designated two Grade 7 sections taught by the same mathematics teacher, who applied identical instructional strategies to both classes. The selection of the experimental and control groups was carried out purposively. The section with an available television screen in the classroom was designated as the experimental group, consisting of 37 students, while the control group comprised 27 students. Both sections were deemed comparable in terms of academic standing and learning conditions.

2.2 Data Analysis

The tables below are used for the interpretation of data. These tables were used as a basis to classify and determine the description of the intervals they belong to. The tables were modified suited for the present study. Here are the **Table 1**. **Table 1** was developed based on the K–12 curriculum grading system prescribed by the Department of Education (DepEd) of the Philippines, which adopts a standards- and competency-based approach to assessing student performance (See https://www.deped.gov.ph/wp-content/uploads/2015/04/DO_s2015_08.pdf?utm_source). This grading framework provides a transmutation table that classifies learners' achievement levels according to their numerical scores, ensuring consistent interpretation of learning outcomes across subject areas. The use of such classification allows educators to objectively measure students' mastery of competencies before and after instructional interventions. Consistent with the principles of

performance-based assessment, the K–12 grading system aligns with international standards that emphasize learner-centered evaluation and evidence-based interpretation of academic progress. In this study, the grading system was used to determine the classification of learners' achievement levels based on their pretest and posttest scores in Geometry.

Table 1. Achievement Level Classifications. Data was adopted from reference (https://www.ciit.edu.ph/k-to-12-grading-system/).

Score Range	Rating	Classification
36-40	90% above	Outstanding
34-35	85-89%	Proficient
32-33	80-84%	Approaching Proficient
30-31	75-79%	Developing
29-0	74% - below	Beginning

Table 2 the study (Wantouw *et al*, 2014) and was utilized to determine the classification of learners' perceptions of their learning environment based on their responses to the perception questionnaire administered during both the pretest and posttest. This framework categorizes students' perceptions according to specific levels, allowing we to analyze how instructional strategies influence the overall learning climate. The use of perception-based classification has been recognized as an effective method for assessing learners' engagement and attitudes toward the learning process (Aldridge & Fraser, 2016). Such an approach supports the validation of instructional interventions by capturing changes in learners' affective and cognitive responses to classroom practices.

Table 2. Perception of the Learning Environment Classification. Data was adopted from reference (https://www.researchgate.net/figure/Classificationofcommunitypercept on_tbl1_314381713).

Mean Score	Perception Classification
1-1.40	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 was adapted from the study, which examined the effects of video-captured lectures through a systematic grouping method. In this study, the table was utilized to assess the level of increase in learners' gain scores between the experimental and control groups. Gain score analysis serves as a reliable measure of learning improvement, as it reflects students' progress after instructional interventions (Hake, 1998). This approach allows we to identify the effectiveness of the implemented strategy in enhancing student performance and comprehension.

Table 3. Gain Score Description. Data was adopted from reference.

Mean Score	Perception Classification
1-1.40	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 pre-test and post-test results of both groups, showing relatively close mean scores. On average, learners, regardless of treatment group, were classified as "Beginning" in terms of their achievement levels. This suggests that there was no substantial difference in learning ability between the experimental and control groups before and after the intervention. Although a slight increase in the mean scores within each group was observed, the improvement was not significant enough to elevate their achievement level. The minimal change in performance may be attributed to external factors such as the interruption of classes due to holidays and the limited duration of the study's implementation. Similar findings were noted (Fasco *et al.*, 2024), who emphasized that the effectiveness of instructional interventions depends heavily on sufficient exposure time and consistent learning engagement. Likewise, brief or disrupted instructional periods can reduce knowledge retention and hinder meaningful academic improvement (Cook *et al.*, 2013). Hence, the short implementation time and inconsistent schedule likely constrained the potential impact of the Geopardy! formative assessment activity on students' overall achievement in Geometry.

Table 4. Mean Score per Group.

Group	Mean Score				N
	Pre-test	Interpretation	Post-test	Interpretation	
Controlled	16.93	Beginning	23.19	Beginning	27
Experimental	18.84	Beginning	26.7	Beginning	37

Table 5 presents the detailed distribution of learners' achievement levels, including the frequency and percentage of score ranges from the pre-test and post-test results of both the experimental and control groups. The data reveal that the pre-test scores of both groups fell within the "Beginning" category, as classified in the achievement level framework of the Department of Education. However, post-test results indicate that the experimental group, which participated in the Geopardy! The formative assessment activity showed a greater number of learners demonstrating improvement in achievement levels compared to the control group, which used traditional paper-and-pencil tests. Specifically, nine students from the experimental group exhibited advancement, while only two students from the control group showed notable improvement. These findings suggest that game-based formative assessments can foster higher engagement, motivation, and retention of mathematical concepts (Maryana *et al.*, 2024; Rahim *et al.*, 2025; Plass *et al.*, 2015). Similarly, research (Eltahir *et al.*, 2021; Zhaopeng, 2023) emphasized that interactive and collaborative learning environments enhance student performance and conceptual understanding more effectively than conventional assessment approaches. Hence, the results affirm that the use of Geopardy! as a formative assessment tool positively influenced students' learning outcomes in Geometry.

3.2. Perception of Learning Environment

Table 6 presents the pre-test and post-test mean scores of the experimental and control groups, indicating learners' perceptions of their learning environment. The experimental group showed an increase from medium to high perception levels, particularly on negative statements, suggesting that Geopardy! positively influenced learners' attitudes and

collaboration. In contrast, the control group exhibited minimal improvement, though a decrease was observed in statement 25 ("I don't help my groupmates in class activities"), implying enhanced teamwork. These findings align with some papers (Bovermann and Bastiaens, 2019), who found that game-based and interactive learning environments foster engagement and cooperation, and with some papers (Afari *et al.*, 2013; Rahim & Mohammed, 2025), who noted improved motivation and positive perceptions through game-based formative assessments.

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 *(90%-100%)*	0	0%	0	0%	0	0%	1	2.7%	Outstanding
34-35 *(85%-89%)*	0	0%	0	0%	0	0%	1	2.7%	Proficient
32-33 *(80%-84%)*	0	0%	0	0%	0	0%	3	8.1%	Approaching Proficient
30-31 *(75%-79%)*	0	0%	2	7.4%	0	0%	4	10.8%	Developing
29-0 *(74%-0%)*	27	100%	25	92.6%	37	100%	28	75.7%	Beginning
Total	27	100%	27	100%	37	100%	37	100%	

Table 6. Learners' Perception of the Learning Environment

Group	Mean Range Scores				n
	Pre-test	Interpretation	Post-test	Interpretation	
Controlled	2.0741 – 2.8148	Low to very high perception	1.963 - 2.8148	Medium to very high perception	27
Experimental	2.0541 – 2.8108	Low to very high perception	2.1351- 2.8919	Medium to Very high perception	37

Table 7 shows that both groups obtained mean score ranges of 1.81–2.20, indicating a "Medium" perception level. However, the experimental group demonstrated more positive responses in both the pre-test and post-test. Positive responses within the "High–Very High" classification increased from 86.67% to 93.33% after the intervention, whereas the control group declined from 80% to 73.33%. This suggests that the Geopardy! Formative assessment contributed to more favorable perceptions of the learning environment. These findings are consistent with studies showing that game-based and interactive learning environments significantly improve student engagement, perception, and cooperation (Afari *et al.*, 2012; Bovermann and Bastiaens, 2019).

Table 7. Learners' Perception of the Learning Environment Classification.

Mean Range	Experimental				Controlled				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%	7	23.33%	Very High
2.21-2.60	14	46.67%	14	46.67%	15	50%	15	50%	High
1.81-2.20	4	13.33%	2	6.67%	6	20%	8	26.67%	Medium
1.41-1.80	0	0%	0	0%	0	0%	0	0%	Low
1-1.40	0	0%	0	0%	0	0%	0	0%	Very Low
Total	30	100%	30	100%	30	100%	30	100%	

3.3. Gain Scores

Table 8 presents the summary of average gain scores for both the control and experimental groups, along with their corresponding interpretations. Although the experimental group obtained a slightly higher average gain score, both groups were still classified as having a "Low Increase." This aligns with the earlier findings on achievement levels, where the difference between groups was minimal despite the use of Geopardy! in the experimental group. The limited increase in gain scores may be attributed to factors such as short intervention duration and inconsistent schedules, which have been shown to affect the effectiveness of instructional innovations (Alomari et al., 2019). Recent research also notes that while game-based learning can enhance engagement and short-term understanding, substantial improvements in achievement require sufficient exposure, consistent implementation, and instructional alignment (Sailer & Homner, 2020; Partovi & Razavi, 2019). These studies support the observation that both groups exhibited only slight gains despite the presence of interactive strategies.

Table 8. Experimental and Control Group Gain Scores.

Group	Gain Score		N
	Average Gain Score	**Interpretation**	
Controlled	6.25925926	Low Increase	27
Experimental	7.86486486	Low Increase	37

Table 9 shows the frequency and percentage of gain scores for both groups. Neither group achieved gain scores of 20 or above, although the experimental group showed slightly higher increases than the control group. This supports recent findings that while game-based learning like Geopardy! can boost engagement and participation, its effect on achievement is often modest, especially with brief interventions (Fadda *et al.*, 2022; Wang *et al.*, 2022; Pehlivan & Arabacioglu, 2023). Minimal negative gain scores further indicate that longer or more consistent implementation may be needed to produce significant improvements.

Table 9. Gain Score Ranges, Frequencies, and Descriptions.

Gain Score Ranges	Experimental Group n=37		Controlled Group n=27		Description
	F	**%**	**F**	**%**	
21-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
2- 1	0	0%	6	22.2%	Very low increase
0	2	5.4%	1	3.7%	No Increase
-1-beyond	1	2.7%	2	7.4%	Decrease
Total	37	100%	27	100%	

3.4. Difference in the Achievement Levels

In **Table 10**, these changes are due to the introduction of a new learning tool, lead to an overall statistically significant difference in their pre- and post- test scores.

Table 10. Difference in the Learners' Achievement Levels.

	Group	N	Mean Rank	Sum of Ranks	Test Used	p-value
Within Groups	Pre-post Test (Experimental)	37	18.50	629	Wilcoxon Signed Rank test	0.000*
	Pre-post Test (Controlled)	27	14.21	341		0.000*
Between Groups	Post-test (Experimental and Controlled)	37	25.35	684.50	Mann- Whitney U Test	0.008*
		27	37.77	1395.50		

Note: Significant: p < 0.05

With a significant value of p at α = 0.05, the study found a significant improvement in the learning ability of learners in the experimental group following the introduction of the new learning tool (p < 0.05). This finding aligns with recent research indicating that educational games can effectively enhance learner engagement, motivation, and cognitive skills. Some research papers (Hussein *et al.,* 2022) emphasize that game-based learning can improve attention, knowledge retention, and problem-solving abilities, while some papers reports that well-designed educational games foster higher-order thinking and reasoning, supporting meaningful learning experiences. Such outcomes suggest that integrating games as instructional tools can achieve not only improved academic performance but also increased learner interest, motivation, and cognitive development.

The achievement pre-test and post-test results of the controlled group have a significant value of p at α=0.05; the proponents also found a significant improvement in the students' learning ability with the traditional method of learning.

The results simply show that the experimental group has a larger mean rank than the control group, and thus it tends to take larger values. Furthermore, the Mann-Whitney U test showed that there is a significant difference (p<0.05) between the achievement level for the experimental group and the control group through using the Geopardy! game and paper-pencil test, respectively, as a learning tool.

In retrospect, the study states that game – based learning is more effective than pencil–and–paper–based learning processes (Turgut & Temur, 2017). As a result, the effects of using games on academic achievement are medium and positive in the mathematics teaching process. This implies the use of Geopardy! The game as a learning tool is effective in improving the achievement level of the students in mathematics.

3.5. Difference of Perception on Learning Environment

Based on the results shown in **Table 11**, no significant difference on the prêt-test in both groups with at p -value=0.174, greater than 0.0 5. Both groups started with closely related perceptions of their learning environment. A highly significant p-value is reported, from which there exists a statistically significant difference in the perception of the learners of their learning environment within the experimental Group. This means that there are improvements in the learners' perception of the learning environment. Furthermore, with a p-value of 0.208, which is greater than 0.05, it was found that there exists no significant difference in the perception of learners of their learning environment in the controlled group. This implies that there was no improvement in the learners' perception of the learning environment for the controlled group. Since it was clearly found out that there was a significant difference in the experimental group, while there was none in the control group, we can directly state that the Geopardy! The game is more effective than the traditional paper-and-pencil test in terms of establishing a positive perception of the learning

environment for the learners. This was proven when a highly significant p-value of 0.000 was seen in the post-test result between the groups. As support for this claim, neither group achieved gain scores above 20, although the experimental group showed slightly more positive gains. This is consistent with recent studies indicating that game-based learning (GBL) often enhances engagement and perception but typically yields only modest academic gains unless implemented over an extended period (Li, Ma, & Shi, 2023; İlhan, 2021). Therefore, while Geopardy! Improved learner motivation and classroom experience, more sustained use may be required to achieve significant improvements in academic performance.

Table 11. Difference of Learners' Perception on the Learning Environment.

	Group	n	Mean Rank	Sum of Ranks	Test Used	p-value
Within Groups	Pre-post Test (Experimental)	37	14.64	322.00	Wilcoxon Signed Rank test	0.017*
	Pre-post Test (Controlled)	27	11.06	251.50		0.208**
Between Groups	Pretest (Controlled and Experimental)	27	28.80	777.50	Mann-Whitney Test	0.174**
		37	35.20	1302.50		
	Post-test (Controlled and Experimental)	27	22.56	609.00		0.000*
		37	39.76	1471.00		

Note: Significant: p < 0.05, not significant: p > 0.05

3.6. Difference in the Achievement Levels

The Mann–Whitney test in **Table 12** shows no significant difference in learners' gain scores (p = .190), indicating that the Geopardy! -Style activity is not more effective than the paper-and-pencil test. Research cautions that gain scores are often unstable indicators of learning. Some research papers notes that simple pre–post differences are highly sensitive to measurement error, while some papers add that gain scores can distort growth when baseline scores vary. These limitations may have influenced the non-significant results. Moreover, validating game-based assessments requires rigorous evidence beyond score comparisons. Emphasize establishing validity in game-based assessments involves a complex, iterative process, making quick comparisons insufficient for judging effectiveness (Gomez *et al.*, 2022; Hidayat & Santoso, 2022).

Table 12. Gain Score Difference.

	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**
	Controlled	27	28.94	781.50		

Note: Not Significant: p > 0.05

3.6. Difference in the Achievement Levels

Learner responses revealed a generally positive perception of using Geopardy! as an instructional activity in mathematics. Many students reported that the game made mathematical concepts more engaging and allowed them to appreciate the subject beyond their previous experiences. The activity created an enjoyable learning environment, which increased their motivation and interest in mathematics. Journal entries indicated that

students found topics easier to understand and problem-solving tasks more manageable when the game was integrated into the lessons. Several learners also noted improvements in their skills as they became more actively involved in the learning process.

In addition, the use of Geopardy! promoted meaningful peer interaction. Students frequently described collaborating with group members to analyze questions, discuss possible solutions, and make collective decisions. This cooperative structure provided opportunities for teamwork and fostered a shared sense of responsibility toward achieving group goals. Although many learners initially held negative attitudes toward mathematics, exposure to the game helped reduce this aversion. The competitive yet supportive nature of the activity awakened their drive to participate, achieve higher scores, and engage more attentively in class discussions. Overall, Geopardy! contributed to a more positive classroom atmosphere that supported both academic performance and collaborative learning.

4. CONCLUSION

The study demonstrated that the modified classroom game Geopardy! effectively engaged learners in mathematics, fostering enjoyment, motivation, and positive perceptions of the learning environment. Despite its initial unfamiliarity, students exhibited increased interest, improved problem-solving skills, and enhanced collaboration through teamwork. While Geopardy! positively influenced engagement and attitudes, it did not produce significantly higher achievement gains compared to traditional paper-and-pencil tests, indicating that its effect on measurable academic performance warrants further investigation. Factors such as limited implementation time and school interruptions may have contributed to these outcomes. Overall, the game proved to be a valuable instructional tool that promotes active learning, collaboration, and a supportive classroom atmosphere. Based on these findings, we strongly recommend the use of Geopardy! in teaching mathematics and suggest that future studies consider enhancements to its rules, mechanics, or materials, implement it over longer periods with larger samples, and explore its use as an enrichment activity rather than solely as a formative assessment. Teachers are encouraged to personally deliver all included topics to optimize learning outcomes, and extending the game's application to other subjects such as English, Science, or the Arts may provide insights into its broader educational potential and effectiveness across diverse learning contexts.

6. AUTHORS' NOTE

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

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