

Archery-Themed Game Based Learning Activities: Effects on Grade 8 Students' Conceptual Understanding and Engagement in Physics

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Abstract

The study investigated how archery-based learning activities affected Grade 8 students at Lumbang Integrated National High School in their physics understanding and classroom participation. The research used a pre-experimental design to evaluate students' understanding of abstract concepts which included force and motion and projectile trajectory after they experienced archery-themed simulation and strategy and role-playing and puzzle games. The results demonstrated that students made significant progress in their physics understanding through enhanced learning of concepts which included their ability to apply knowledge and demonstrate understanding through various scientific disciplines. The students displayed higher levels of engagement through better performance in four different areas which included: 1.) behavioral, 2.) emotional, 3.) cognitive and 4.) social aspects of their schoolwork. The greatest improvement occurred in social interactions as students began to work together and share information while they assisted one another. The active learning spaces created by using contextualized learning methods together with interactive learning methods and experiential learning methods for physics instruction enable students to understand better while their motivation and engagement levels increase. The archery-themed game-based learning method created a fun yet real-world environment which enabled students to learn course materials while they practiced teamwork skills and critical thinking abilities and problem-solving methods. The study demonstrates that science education benefits from game-based methods which lead to improved student performance and academic development and provide critical knowledge to educators and curriculum designers and policymakers who want to enhance physics learning outcomes and defeat academic challenges in other subjects.

Keywords: Game-Based Learning, Archery, Conceptual Understanding, Engagement

Introduction

Science education in the Philippines plays a crucial role in developing learners' critical thinking and problem-solving skills, as emphasized in the K to 12 curriculum. However, national assessments and studies have consistently shown that Filipino students perform below the global average in science literacy, indicating challenges in conceptual understanding and application of scientific principles (DepEd, 2023; TIMSS, 2019). These difficulties are often attributed to traditional teaching approaches, limited resources, and the abstract nature of scientific concepts.

Among the science disciplines, Physics is widely recognized as one of the most challenging subjects due to its abstract concepts and strong mathematical foundation (Nguyen & Silver, 2020). Many students struggle to grasp fundamental ideas, particularly in topics such as kinematics and projectile motion, which require both theoretical insight and practical application (Lee & Kim, 2021). Conventional pedagogy in Physics often relies heavily on lecture-based instruction, which often limits students' active participation and engagement in learning. This issue is evident at Lumbang Integrated National High School, where students frequently find it difficult to comprehend core Physics concepts, resulting in low levels of engagement and reduced motivation to learn.

Teachers started to research new teaching methods which help students to understand concepts while participating in classroom activities. The classroom uses game-based learning (GBL) which provides interactive and hands-on learning experiences through its goal-oriented activities. Research shows that game-based learning (GBL) enhances students' ability to understand concepts while it improves all four dimensions of their engagement which include behavioral and emotional and cognitive and social aspects (Hamari et al., 2020). GBL provides an effective method for teaching Physics because it lets students understand abstract concepts through practical application (Zeng et al., 2020; Abenes et al., 2020; Low, 2020).

The study used archery-themed game-based learning activities to teach Physics to Grade 8 students. Archery provided an authentic real-world environment which students can use to understand vital physics concepts about force and motion and velocity and acceleration and projectile motion (Gaurina et al., 2025). The archery theme provided students with spaces which they can use to experience and practice real-world physics concepts through direct contact with physical elements and their virtual counterparts.

The research studies on educational archery games through their simulation games and strategy games and role-playing games and puzzle games which serve as research variables. Students use simulation games to control bow settings and arrow weight and release angle settings which they use to test how these factors affect arrow flight patterns and shooting accuracy. Simulation games helped students learn the essential concepts through their hands-on experience (Shute et al., 2020). In strategy games learners must create shooting plans which they will use to deal with distance shooting and environmental force challenges. Students used role-playing games to interact with shared story experiences which enable them to

develop their archery knowledge through physical understanding which they need to progress through the game. Through puzzle games students must find solutions to physics challenges which require them to figure out the best angles and speeds for achieving their goals (Shute et al., 2020).

The educational space transforms into an interactive experience which focuses on learners due to its main teaching method of archery. Through two separate methods, students learn Physics because they can experience force and motion directly through archery-related activities and they can explore Physics concepts through digital and game-based activities which use archery themes to create authentic Physics experiences. The dual-modality approach aims to improve students' understanding of physics concepts through three learning outcomes which students demonstrate by explaining physics concepts, applying them to real-life situations, and making connections across different subjects while students show their Physics engagement through their behavioral, emotional, cognitive, and social involvement which serves as the study's primary measurement methods.

The study investigated how archery-based educational games help Grade 8 students learn Physics while maintaining their academic interest. The research demonstrates how effective teaching methods create learning experiences which students use to achieve advanced science knowledge through research about modern teaching methods.

Methodology

The study used a pretest–posttest design with Grade 8 students to measure changes in physics understanding and engagement. A pre-test assessed students' prior knowledge of forces, motion, and energy, along with a survey measuring their behavioral, emotional, and cognitive engagement. The experimental group then participated in a three-week archery-themed game-based learning (GBL) intervention using simulation, strategy, RPG, and puzzle games. These activities provided interactive, hands-on experiences where students applied physics concepts. After the intervention, a post-test (with similar and more advanced questions) measured improvements in conceptual understanding, while a follow-up survey evaluated changes in student motivation and engagement. The comparison of pre-test and post-test results determined the effectiveness of the GBL approach.

The respondents consisted of 50 Grade 8 students from Lumbang Integrated National High School, selected through cluster sampling using one randomly chosen intact class. The group represented diverse backgrounds and abilities. Students participated in an archery-themed game-based learning (GBL) intervention alongside conventional lessons to improve their understanding of physics. Data collection included a pretest, intervention activities, a post-test, and an engagement survey measuring motivation and participation. All responses formed the study's data, with strict adherence to ethical standards ensuring confidentiality, voluntary participation, and a safe learning environment.

The study used a pre-test, post-test, and a student engagement survey to measure Grade 8 students' understanding of physics concepts and their engagement during the archery-themed game-based learning (GBL) intervention. The tests covered key topics such as forces, motion, energy, and Newton's laws through multiple-choice, short answer, and problem-solving items, with the pre-test establishing baseline knowledge and the post-test measuring learning gains. The engagement survey assessed behavioral, emotional, cognitive, and social engagement using a four-point Likert scale. It evaluated students' participation, interest, motivation, problem-solving skills, reflection, and collaboration during the activities. The survey was administered before and after the intervention to track changes in engagement. All instruments were carefully developed, validated through pilot testing, and aligned with the Grade 8 Physics curriculum to ensure reliability and relevance.

The study followed a structured three-week data collection process. In Week 1, students took a pre-test to assess their prior knowledge of key Physics concepts (forces, motion, and energy based on MELCs 1–3), along with a pre-engagement survey measuring their initial motivation and participation across behavioral, emotional, cognitive, and social aspects. During the three-week period, students participated in the archery-themed game-based learning (GBL) intervention. At the end of Week 3, a post-test was administered to evaluate improvements in conceptual understanding, followed by a post-engagement survey to measure changes in students' interest and participation. The collected data from pre- and post-tests and surveys were analyzed to determine the effectiveness of the archery-based GBL activities in enhancing students' understanding and engagement in Physics.

The study used both descriptive and inferential statistics to analyze students' conceptual understanding and engagement before and after the intervention. Descriptive statistics (mean, standard deviation, and percentages) summarized students' performance and engagement levels across four dimensions: behavioral, emotional, cognitive, and social. Inferential analysis involved paired-sample t-tests to determine if there were significant differences between pre-test and post-test scores, since the same group of students was measured at two points in time. Effect sizes (Cohen's *d*) were also computed to assess the practical significance of changes, while a 0.05 significance level was used to confirm if results were statistically meaningful. If normality assumptions were not met, the Wilcoxon signed-rank test was applied as an alternative. Performance and engagement were interpreted using set scales. All statistical analyses were conducted using Jamovi software.

Results and Discussion

This section presents the findings based on the research questions of the study, focusing on the impact of gamification on students' mathematical skills and confidence levels. To analyze the data, mean scores, standard deviations, and paired sample t-tests were

computed using IBM SPSS version 26.0 to determine the significance of differences between pre-test and post-test results for both the experimental and control groups.

The results related to the respondents' confidence levels are presented through a series of tables. These include the assessment of three key variables: Self-Efficacy, Anxiety Reduction, and Willingness to Participate. Tables are provided to illustrate the changes in these confidence indicators before and after the implementation of gamified instruction. These measures were used to describe the students' self-perception and confidence in engaging with mathematics tasks following the intervention.

Table 1: Pretest and Post-Test Performance in Conceptual Understanding of Physics Through Archery-Themed Game-Based Learning in Terms of Ability to Explain Concepts

Pre- test Scores	Frequency	Percent	Post- test Scores	testFrequency	Percent	Verbal Interpretation
0–6	0	0.0%	0–6	0	0.0%	Poor
7–12	5	10.0%	7–12	0	0.0%	Needs Improvement
13–18	38	76.0%	13–18	2	4.0%	Satisfactory
19–24	7	14.0%	19–24	19	38.0%	Very Satisfactory
25–30	0	0.0%	25–30	29	58.0%	Excellent
	50	100%	—	50	100.0%	

Table 2: Pretest and Post-Test Performance in Conceptual Understanding of Physics Through Archery-Themed Game-Based Learning in Terms of Ability to Apply in Real-life Scenario

Pretest Scores	Frequency	Percent	Post- Test Scores	TestFrequency	Percent (%)	Verbal Interpretation
0–3	0	0.0%	0–3	2	4.0	Poor
4–6	9	18.0%	4–6	5	10.0	Need Improvement
7–9	41	82.0%	7–9	15	30.0	Satisfactory
10–12	0	0.0%	10–12	17	34.0	Very Satisfactory
13–15	0	0.0%	13–15	11	22.0	Excellent
	50	100.0%	total	50	100.0%	

Table 3: Pretest and Post-Test Performance in Conceptual Understanding of Physics Through Archery-Themed Game-Based Learning in Terms of Ability to make Connections Across Topics

Pre-test Scores	Frequency	Percent	Post-test Scores	Frequency	Percent	Verbal interpretation
0–4	16	32.0%	0–4	1	2.0%	Poor
5–8	27	54.0%	5–8	7	14.0%	Needs
9–12	7	14.0%	9–12	16	32.0%	Improvement Satisfactory
13–16	0	0.0%	13–16	16	32.0%	Very Satisfactory
17–20	0	0.0%	17–20	10	20.0%	Excellent
—	50	100.0%	—	50	100%	

Table 4: Level of Behavioral Engagement of Grade 8 Students Exposed to Archery-Themed Game-Based Learning Activities

Behavioral Engagement	Mean	SD	VI
1. Participates actively in physics discussions, experiments, and archery-themed activities.	3.48	0.58	Agree
2. Completes physics tasks, activities, and assignments on time.	3.26	0.75	Agree
3. Follows instructions carefully during experiments and hands-on activities.	3.12	0.87	Agree
4. Demonstrates sustained effort when solving physics problems, even when tasks are challenging.	3.32	0.84	Agree
5. Asks relevant questions or seeks clarification to better understand physics concepts.	3.28	0.78	Agree
Overall	3.29	0.77	High Engage

Table 5.:Level of Emotional Engagement of Grade 8 Students Exposed to Archery-Themed Game Based Learning Activities
Emotional Engagement

Emotional Engagement	Mean	SD	VI	
1. Shows interest and enjoyment in physics lessons and activities.	3.08	1.06	Agree	
2. Expresses positive attitudes toward learning physics concepts.	3.16	0.74	Agree 3.30	0.79
3. Demonstrates curiosity about how physics applies to real-life situations.	Agree 3.02	0.74	Agree 2.92	0.74
4. Feels motivated and confident when participating in physics activities.	Agree			
5. Values physics learning and considers it meaningful and relevant.				
Overall	3.01	0.85	High Engagement	

Table 6: Level of Cognitive Engagement of Grade 8 Students Exposed to Archery-Themed Game-Based Learning Activities

Cognitive Engagement	Mean	SD	VI
Applies appropriate strategies to solve physics problems and complete tasks.	3.54	0.54	Strongly Agree
Monitors understanding by checking answers and correcting mistakes.	3.40	0.49	Agree
Analyzes physics concepts by connecting ideas and explaining reasoning.	3.24	0.89	Agree
Persists in thinking through challenging problems until a solution is reached.	3.32	0.68	Agree
Reflects on learning to improve performance in future physics activities	3.16	0.77	Agree
Overall	3.33	0.68	High Engagement

Table 7: Level of Social Engagement of Grade 8 Students Exposed to Archery-Themed Game- Based Learning Activities

Social Engagement				Mean	SD	VI
1. Works well with classmates on physics activities.				3.58	0.64	strongly Agree
Helps classmates understand physics				3.46	0.50	Agree
concepts when they need it.						
3. Feels comfortable asking classmates for help with physics.				3.30	0.84	Agree
4. Shares ideas with classmates during group work.						
5. Enjoys collaborating with others on physics projects.				3.26	0.66	Agree
				3.08	0.78	Agree
Overall				3.34	0.69	High Engagement

Table 8: Test of Difference in the Level of Conceptual Understanding Before and After Using Archery-Themed Game-Based Learning Activities

Conceptual Understanding	Pre-test		Post-test		t	df	Sig. (2-tailed)
	Mean	SD	Mean	SD			
Ability to explain concepts/Explanation	16.14	2.08	24.56	2.83	-18.52	49	.000
ability to apply in real-life scenario/	7.64	1.17	9.98	3.18	-4.78	49	.000
Application							
ability to make connections across topics/Integrate connection	5.94	2.69	13.04	4.05	-10.48	49	.000

If $p > 0.05$, the result is not significant; if $p \leq 0.05$, the result is significant

Table 9: Test of Difference in the Level of Engagement Before and After Using Archery-Themed Game-Based Learning Activities

Level of Engagement	Pre-test		Post-test		t	df	Sig. (2-tailed)
	Mean	SD	Mean	SD			
Behavioral Engagement	3.2040	.47893	3.3320	.39715	-2.082	49	.043
Emotional Engagement	2.9640	.73144	3.0960	.46641	-2.259	49	.028
Cognitive Engagement	3.1480	.61120	3.3320	.39715	-3.101	49	.003
Social Engagement	3.1160	.53160	3.3360	.35095	-3.904	49	.000

Discussion

The findings of this study indicate that archery-themed game-based learning (GBL) is an effective instructional approach for improving Grade 8 students' conceptual understanding and engagement in Physics. The results show that students were able to progress from basic knowledge toward higher levels of mastery, particularly in explaining concepts, applying them in real-life situations, and making connections across topics. This suggests that integrating meaningful, real-world contexts—such as archery—helps make abstract physics concepts more concrete and easier for students to understand.

The improvement in conceptual understanding can be attributed to the interactive and experiential nature of the GBL activities. By allowing students to manipulate variables, test ideas, and observe outcomes within game environments, the intervention supported active learning and deeper cognitive processing. These experiences helped students move beyond memorization toward application and analysis, which are essential for meaningful learning in science.

In terms of engagement, the study revealed that students demonstrated high levels of behavioral, emotional, cognitive, and social

involvement. The structured game-based tasks encouraged active participation, sustained effort, and curiosity, while also fostering confidence and positive attitudes toward learning Physics. The collaborative elements of the activities further enhanced social interaction, enabling students to share ideas, support peers, and develop communication skills. These findings highlight the value of GBL in creating a learner-centered environment that promotes both academic and social development.

Moreover, the significant improvements observed between pre-test and post-test results confirm that the intervention had a measurable impact. The use of themed, multi-genre games combined with physical and digital activities appears to have addressed common challenges in traditional instruction, such as student disengagement and lack of real-world relevance.

However, the discussion also acknowledges certain limitations. The short duration of the intervention and the possible influence of novelty effects may have contributed to increased motivation and performance. In addition, variations in teaching implementation and individual student differences may affect the consistency of results. Future research may explore long-term impacts, include control groups, and examine how different instructional strategies influence outcomes over time.

Overall, the study supports the use of archery-themed GBL as a promising and innovative approach to enhance both conceptual understanding and student engagement in Physics, particularly within the context of the Philippine educational setting.

Conclusion and Recommendation

Based on the findings of the study, it can be concluded that the implementation of archery-themed game-based learning (GBL) had a significant positive effect on both the conceptual understanding and engagement of Grade 8 students in Physics, leading to the rejection of the null hypotheses. The results demonstrated that students showed marked improvement in their ability to explain concepts, apply them in real-life situations, and make meaningful connections across different physics topics after participating in the intervention. This improvement can be attributed to the experiential and interactive nature of the archery-themed activities, which allowed students to directly observe and manipulate variables such as force, angle, motion, and energy. By linking abstract Physics principles to concrete, real-world scenarios, students were able to construct deeper understanding and transfer their knowledge more effectively across various contexts.

Furthermore, the study revealed a significant increase in students' levels of engagement across behavioral, emotional, cognitive, and social dimensions. Students became more active participants in class activities, demonstrated higher levels of motivation and interest in learning Physics, and showed improved critical thinking and problem-solving skills. The collaborative and game-based elements of the intervention also fostered stronger peer interaction, communication, and teamwork, creating a more dynamic and supportive learning environment. These findings suggest that archery-themed GBL not only enhances academic performance but also promotes a holistic learning experience by developing students' attitudes, skills, and engagement in the subject.

Overall, the study confirms that integrating real-world, themed game-based strategies into Physics instruction is an effective approach for addressing common challenges such as student disengagement and difficulty in understanding abstract concepts. The intervention provided meaningful learning experiences that strengthened both cognitive and affective aspects of learning, demonstrating its potential as a practical and innovative teaching strategy in science education.

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