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Assessing the Role of Game-Based Learning in Improving Academic Achievement and Student Motivation

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Abstract

Aim/Purpose: The primary aim of this study is to evaluate the effectiveness of Game-Based Learning (GBL) in improving students' academic achievement and motivation in school education. The study aims to investigate how motivational elements affect academic results while assessing whether different grade levels show different levels of GBL effectiveness.
Background: Traditional teaching methods conduct their instruction through passive learning methods, which decrease student learning engagement and motivation. Game-Based Learning has developed into a modern teaching method because digital technologies experience rapid expansion, which enables educational content to combine with interactive game features. The existing research demonstrates that GBL enhances student engagement and learning outcomes, but researchers have yet to establish complete empirical proof that GBL leads to increased student motivation and academic success in school settings.
Methodology: The research used a quantitative quasi-experimental research method which compared two groups of participants who received different teaching methods through traditional control teaching and experimental GBL instruction. The researchers gathered data through standardized questionnaires and academic performance assessment tests. The statistical analysis used SPSS software to perform descriptive statistics reliability analysis and t-tests ANOVA correlation regression analysis effect size estimation and multicollinearity diagnostics.
Contribution: This study provides evidence about how Game-Based Learning affects academic achievement and student motivation through its twofold impact. The study presents a confirmed assessment system together with a statistical framework which upcoming scientists can use to test educational technology-based teaching methods in schools.
Findings: The research showed that Game-Based Learning results in better academic results and student motivation and classroom engagement and student confidence than traditional teaching methods. Motivational variables were found to be strong predictors of academic performance. Grade-level differences moderately influenced learning outcomes which showed that students developed differently through GBL.
Recommendations for Practitioners: Educators should implement structured Game-Based Learning techniques during classroom instruction because this method will enhance student learning results and their motivation to learn. The schools need to establish teacher training programs and digital resources which will help teachers successfully implement GBL in their classrooms.
Recommendations for Researchers: Future researchers should study Game-Based Learning through its long-term effects and implementation in different subjects and its combination with new technologies like artificial intelligence and adaptive learning systems.
Impact on Society: Game-Based Learning implementation shows effective educational results which increase digital literacy while teaching students necessary problem-solving and critical thinking skills for present-day knowledge-based societies.
Future Research: Future studies should examine cross-cultural validation of GBL models and large-scale multi-school implementations and hybrid learning models which combine GBL with traditional and online learning strategies.

Keywords : Game-Based Learning, Academic Achievement, Student Motivation, Student Engagement, School Education.

Introduction

The quick adoption of digital technologies in educational institutions has changed the way teachers and students interact with each other because educators now need to find new teaching methods that will help students learn better. Game-Based Learning (GBL) has become an effective teaching method that combines educational material with game mechanics which include challenges and rewards and competitive elements and real-time feedback. The GBL method creates learning objectives which students achieve through their interactive gameplay experience.The traditional teaching approach that focuses solely on teacher instruction fails to meet

the different learning requirements of students while struggling to keep middle and secondary school students engaged in learning activities. Research indicates that declining motivation and passive learning behaviors are major contributors to poor academic achievement. GBL creates an experiential learning environment that enables students to actively participate in learning activities while they develop problem-solving skills and work with others. The GBL system uses constructivist and self-determination theories to enable learners to experience three vital components which students need for their intrinsic motivation and valuable educational development. Existing studies have found that GBL positively impacts student motivation and their engagement with learning material and their ability to understand concepts. The studies which exist now fail to provide complete proof that GBL leads to academic success which researchers can measure. The research studies mainly examine short-term results while they target particular subjects and college environments without studying school-level students or comparing different grade levels. The research requires thorough quantitative studies which must use standardized testing methods and advanced statistical analysis to determine both statistical and real-world importance.The current research study investigates how Game-Based Learning affects student academic performance and their motivation to study within school educational settings. The study aims to establish the effectiveness of game-based learning through a comparison of its instructional methods against traditional teaching approaches while measuring different types of student motivation. The study results will advance educational research while providing teachers and administrators with practical solutions to improve student learning through new teaching methods. Table 1 describes the mapping of hypothesis with objectives.

Motivation

Schools face ongoing difficulties with student disengagement and reduced academic performance, which emerge as constant difficulties across educational institutions that use technological resources because traditional teaching methods cannot keep students engaged and motivated. Game-Based Learning (GBL) provides an interactive learning experience that centers on learners by combining educational material with game design elements, which helps students develop their motivation and engagement skills, resulting in improved academic outcomes. The existing research provides insufficient evidence to determine how GBL affects school academic performance and student motivation throughout the educational process. The research establishes a need for research which produces strong evidence-based knowledge that helps schools implement GBL successfully into their regular classroom teaching methods.

Objectives of the Study

The main objective of the study is:

- To examine the effect of Game-Based Learning on students' academic achievement compared to traditional teaching methods.
- To assess the impact of Game-Based Learning on students' motivation, engagement, and academic self-efficacy.
- To analyze the relationship between motivational factors and academic achievement in a game-based learning environment.
- To determine whether academic achievement outcomes from Game-Based Learning differ across grade levels.

Table 1. Mapping of objective to Hypothesis

Objective No.	Objective	Hypothesis (H_i)	Statistical Test Used
Objective 1	To examine the effect of Game-Based Learning on students' academic achievement compared to traditional teaching methods	**H1:** There is a significant difference in academic achievement between students taught using Game-Based Learning and those taught using traditional methods.	Independent samples t-test

Objective 2	To assess the impact of Game-Based Learning on students' motivation, engagement, and academic self-efficacy	**H2:** Students exposed to Game-Based Learning demonstrate significantly higher motivation, engagement, and self-efficacy than those taught through traditional methods.	Independent samples t-test
Objective 3	To analyze the relationship between motivational factors and academic achievement in a game-based learning environment	**H3:** Motivation, engagement, self-efficacy, and collaboration significantly predict academic achievement in a Game-Based Learning environment.	Pearson correlation & Multiple regression
Objective 4	To determine whether academic achievement outcomes from Game-Based Learning differ across grade levels	**H4:** There is a significant difference in academic achievement across grade levels following Game-Based Learning intervention.	One-way ANOVA with Tukey HSD post-hoc

Literature Review

Research Trends and Bibliometric Evolution

Researchers found that game-based learning (GBL) has evolved from its original experimental stage into a standardized educational method which schools now adopt. The evolutionary process shows that bibliometric studies and systematic mapping research identify two different paths of development, while Akhmetova et al. (2025) present their research through a decennial visualization which tracks field growth from 2015 to 2024. The present development of enterprises shows that mobile technology has become a key driver of corporate growth since Al Mubarok et al. (2025) documented his research about mobile game-based learning at colleges which showed students educational methods based on their smartphone use. Usman et al. (2025) show that GBL has developed into a fundamental teaching method which digital instructors use to educate students from their first school day through their last professional training session. Research studies demonstrate that academic research has entered a phase of growth which now includes different research methods and study areas through which researchers combine game-based learning methods with formal academic programs.

Impacts on Cognitive Skills and Academic Achievement

Current research demonstrates that Game-Based Learning (GBL) research shows measurable results on high-level cognitive abilities which apply to various academic and professional fields. The research of Anggoro et al. (2025) through their meta-analysis shows that GBL creates a strong positive effect on Higher Order Thinking Skills (HOTS) in Mathematics and STEM fields because play-based mechanics enhance cognitive processing abilities. The research of Dan et al. (2024) together with Ilić et al. (2024) shows that primary education uses digital games to help students understand STEM concepts by providing them with concrete interactive experiences.

The benefits extend into general science education, where Safitri et al. (2025) and Irfan and Rahman (2024) observe that GBL not only bolsters student competencies but also revitalizes interest in scientific inquiry, particularly among secondary school learners. Beyond traditional K-12 settings, GBL has emerged as a critical driver for vocational and professional development. Dahalan et al. (2024) and Raziana and Wibawanto (2025) position GBL as a primary vehicle for mastering 21st-century skills within vocational training. Vázquez-Calatayud et al. (2024) and Velásquez et al. (2024) conducted research which shows GBL enhances decision-making abilities within high-stakes professional environments through its use in nursing and logistics. The studies demonstrate that GBL functions as an effective teaching method which helps students develop their abilities to solve difficult problems and gain specialized knowledge.

Psychological and Affective Outcomes

Recent scholarship increasingly recognizes that the value of Game-Based Learning (GBL) extends far beyond standardized academic scores which create a deep impact on both psychological state and social development

of the learner. The researchers of this study concentrate on motivation and engagement enhancement through their demonstration that GBL functions as a transformative tool which helps students maintain their interest in English as a Foreign Language (EFL) learning. The researchers demonstrate that learners achieve greater resilience and concentration when they use gamified repetitive tasks instead of standard teaching methods which use traditional instructional methods.The research study conducted by Li et al. (2025) and Tian and Umar (2025) requests educators to use complete assessments which evaluate psychological benefits from digital games beyond standard score measurements. The study shows that students can learn new technical vocabulary through virtual environments which help them communicate without fear. The ability to maintain psychological safety enables people to achieve their educational goals because it supports their learning process. Research by Bilous et al. (2025) shows that GBL produces psychological benefits while it helps students develop better ways to communicate with others. Educational games create a space where students can learn through real conversations and work together to solve problems. The research studies demonstrate that GBL creates a positive emotional environment which helps students develop advanced social and academic skills.

Emerging Pedagogies and Technologies

Modern scholars study how Game-Based Learning (GBL) connects to advanced technologies and dedicated teaching methods to solve both global and intellectual challenges. Huber et al. (2024) demonstrate how Artificial Intelligence creates a major technical boundary which they investigate through their study of Large Language Models (LLMs) and interactive educational settings. The researchers propose that LLMs will transform GBL through their ability to deliver immediate customized assessments together with interactive storytelling which adapts learning experiences to the specific requirements of each student.

The current evaluation of GBL establishes its fundamental role as an essential educational resource for Education for Sustainable Development (ESD). Pineda-Martínez et al. (2023) and Mehtälä et al. (2025) demonstrate that immersive simulations function as effective tools for presenting complex ecological and social systems since they enable students to experiment with environmental decision outcomes in a secure virtual environment. The studies demonstrate how GBL enables students to develop environmental stewardship skills through interactive learning experiences that connect global sustainability challenges with personal assessment and practical application. The field improves its knowledge about GBL delivery methods through ongoing development work. Ding and Yu (2024) establish a fundamental assessment of two activity categories when they study how people interact with serious games through their active playing and game development processes. The research shows that different teaching methods lead to distinct science learning results because game design helps students understand fundamental concepts better while they play games to strengthen their understanding. The two viewpoints demonstrate a shift which brings game-based learning methods closer to modern technology and multiple philosophical teaching methods.

Developmental Perspectives

Research now uses a lifecycle methodology to study Game-Based Learning (GBL) which requires different approaches at different developmental stages because universal solutions do not work in this field. Utami and Crescenzi-Lanna (2025) investigate digital play for children aged 0 to 6 at the first educational stage. The research proves that digital games can assist early development but their effectiveness depends on suitable developmental content and proper execution which needs to maintain active, sensory-based play activities. The study demonstrates that educational systems need to establish teaching methods which create safe cognitive environments while supporting basic motor development in preschool children.

Higher education uses GBL to assess advanced cognitive abilities which develop through complex cognitive tasks. Khoo et al. (2025) provide a comprehensive scoping review of GBL in university settings which shows that these tools improve critical thinking and problem-solving skills but their built-in effectiveness does not exist. The study shows that higher education institutions must establish advanced partnerships which support their educational objectives through their implementation process. The educational system needs to create detailed teaching maps because games will not become essential learning tools without this framework. The col-

lected studies demonstrate that GBL transforms from a tool for learning to a method for conducting professional and academic research as students advance through their educational journey.

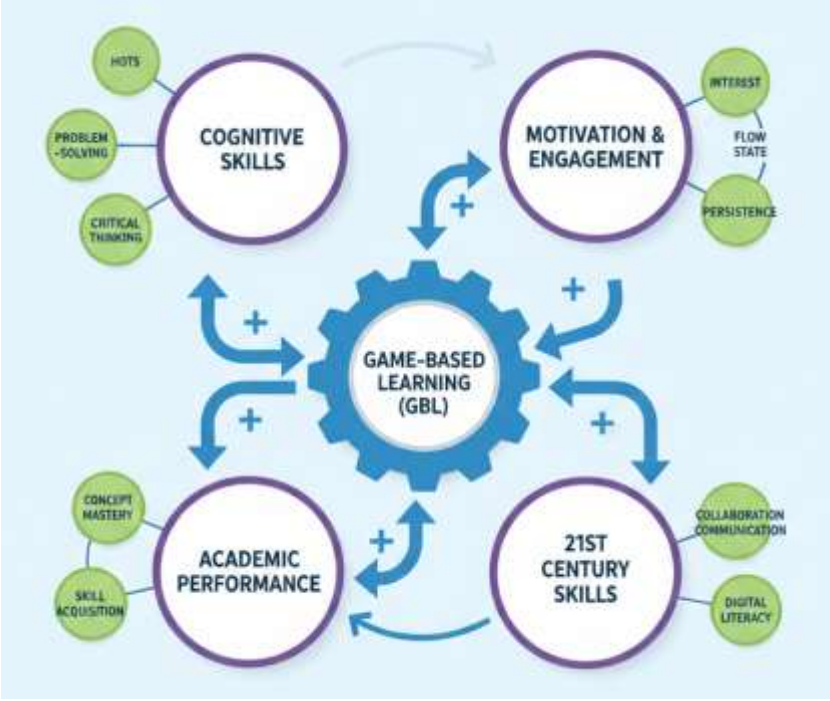

Fig.1. The hypothesis structural model

The hypothesis structural model for the relationship between the indicators and the studied variables influenced by game based learning is describe in figure 1.

Methodology and Materials

The researchers utilized a quantitative quasi-experimental research design to investigate how Game-Based Learning (GBL) affected student academic performance and school motivation. The participants included school students from various grade levels who were assigned to an experimental group which received Game-Based Learning and a control group which received Traditional Teaching Method. The researchers used intact classrooms to select study groups because this method provided better ecological validity.

The GBL intervention took place during a designated instructional period when educational games that matched the curriculum standards were used in regular classroom instruction for the experimental group. The control group received instruction through conventional lecture-based and textbook-oriented methods covering the same content and duration. The research team collected data through two main tools which included (i) achievement tests used as pre-tests and post-tests to evaluate student academic performance and (ii) standardized questionnaires which measured motivational factors such as motivation and engagement and academic self-efficacy and collaboration abilities. The reliability of the questionnaire scales was established using Cronbach's alpha.

The researchers used SPSS software to perform data analysis. The researchers applied descriptive statistics to provide a summary of both demographic information and study variables. The researchers used paired and independent samples t-tests to evaluate pre-test and post-test scores while one-way ANOVA with Tukey HSD post-hoc tests enabled them to assess grade-level differences. The researchers used Pearson correlation and multiple regression analyses to study how different variables interact and which variables most effectively predict outcomes. The researchers used effect sizes Cohen's d and η^2 to measure practical significance and they calculated Variance Inflation Factor VIF to assess multicollinearity. The researchers established a statistical significance threshold at the 0.05 level.

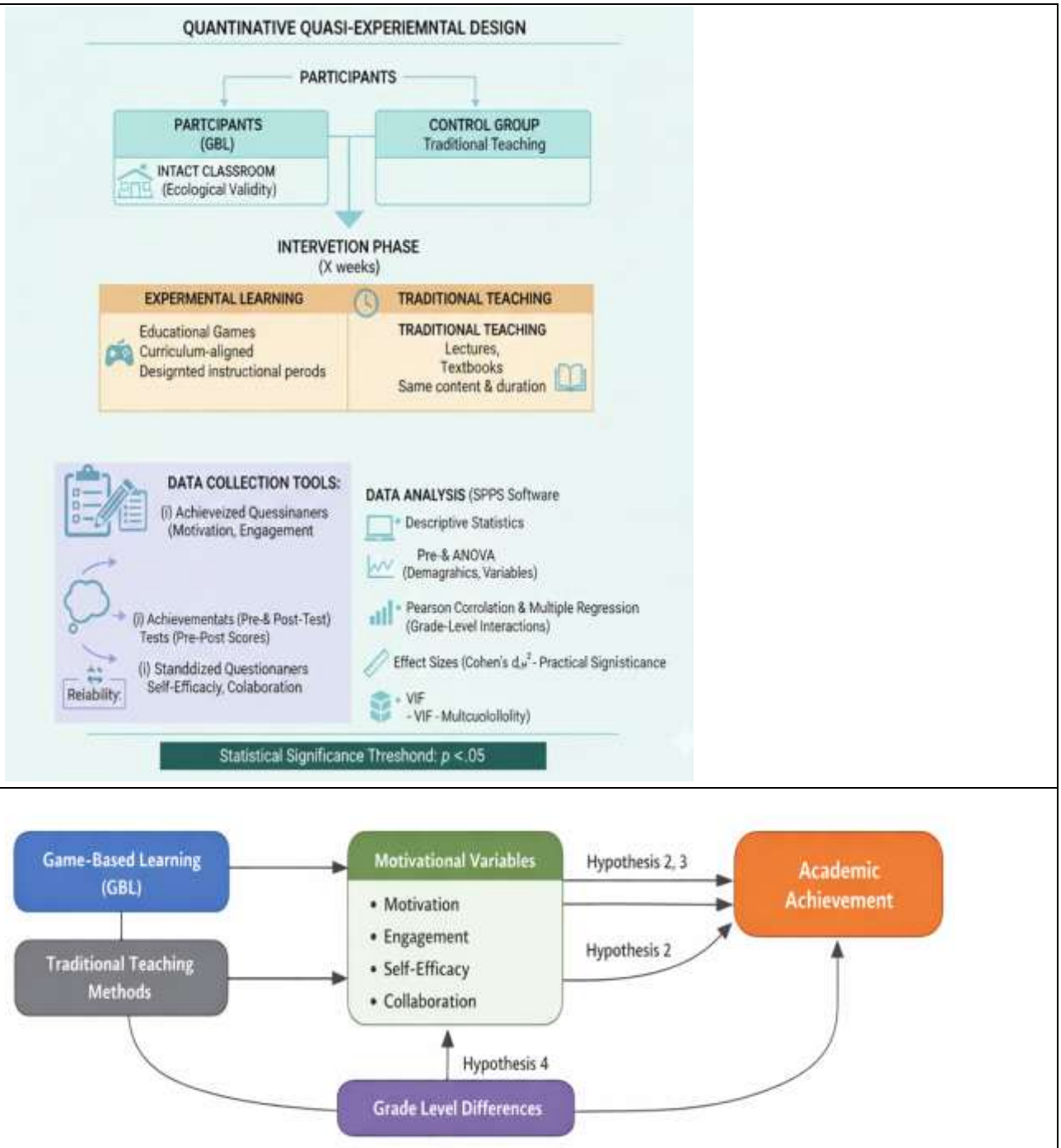

Fig. 2. Conceptual framework of the study

The conceptual framework establishes a structural pathway to evaluate how Game-Based Learning (GBL), compared to Traditional Teaching Methods, influences Academic Achievement through a series of mediating and moderating factors. The model establishes teaching methods as the independent variable which leads to direct effects on a specific group of Motivational Variables that includes motivation and engagement and self-efficacy and collaboration. The psychological indicators function as mediators because GBL enhances a student's internal drive and collaborative skills which leads to academic success as the primary dependent variable. The framework establishes Grade Level Differences as a key moderating factor which shows that GBL affects both student motivation and academic achievement based on their developmental stage. The model uses specific hypotheses to assess these relationships through the direct connection between engagement and test

scores and the different effectiveness of educational methods across various grades to create a complete framework which shows how playful pedagogy changes classroom learning processes. The conceptual framework with the methodology is describe in figure 2.

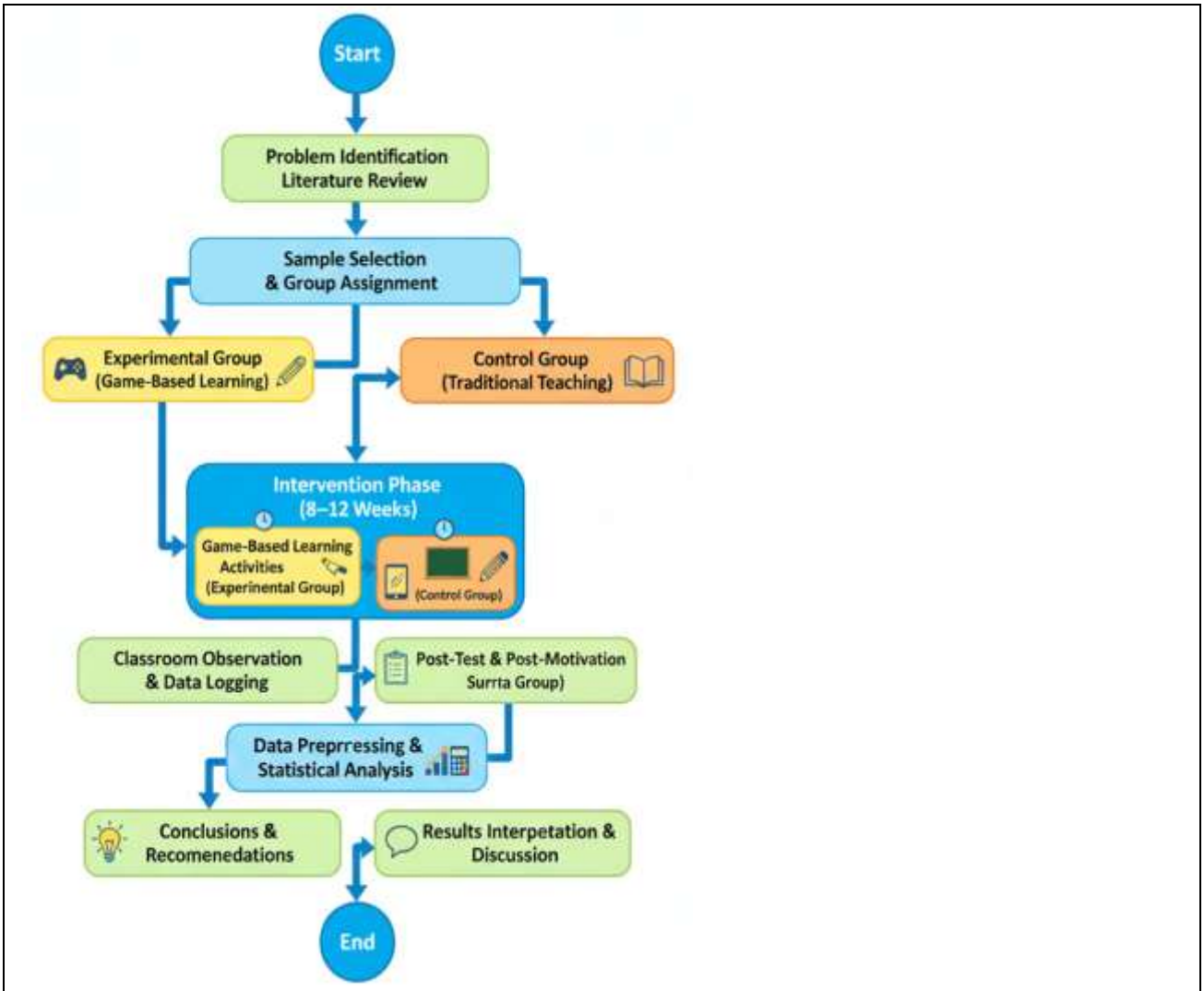

Fig. 3. Architectural representation of the process

The experimental workflow of the study follows a systematic and structured process, which commences with problem identification and a comprehensive literature examination that identifies research gaps within game-based learning. The research objectives and hypotheses were developed based on the findings of this review, which established research objectives. The researchers selected samples after they completed their hypothesis development work. Students were assigned to an experimental group, which received Game-Based Learning instruction, and a control group which received Traditional Teaching instruction. Researchers conducted pre-tests and pre-motivation surveys before the study to gather student data that would help them understand student academic performance and their motivation to learn. The intervention phase, which lasted between 8 and 12 weeks, involved the experimental group using educational games, which matched their curriculum while the control group received traditional teaching methods. The researchers gathered classroom observation data as well as student engagement data throughout this period. The researchers conducted post-tests and post-motivation surveys after the intervention to assess student learning achievements and changes in their motivational levels. The researchers conducted data cleaning and preprocessing before they applied statistical methods, which included t-tests ANOVA correlation analysis and effect size estimation for their analysis. The research results were interpreted and discussed in relation to the hypotheses, which resulted in conclusions as

described in figure 3, and recommendations that educators and policymakers and future researchers should follow.

Result Analysis through Questionaries

Student Questionnaire: Game-Based Learning Evaluation Scale (GBL–ES)
Response Format:
5-point Likert Scale
1 = Strongly Disagree
2 = Disagree
3 = Neutral
4 = Agree
5 = Strongly Agree

Section A: Learning Motivation (LM)
1. I feel excited to participate in lessons that use games.
2. Game-based activities make learning more enjoyable.
3. I feel motivated to complete my class tasks when learning involves games.
4. Game-based learning encourages me to try harder even when topics are difficult.
5. I enjoy competing and collaborating with my classmates during game activities.

Section B: Student Engagement (SE)
6. I pay more attention during game-based lessons than traditional lessons.
7. Game-based activities help me stay focused in class.
8. I actively participate in classroom discussions during game-based sessions.
9. I feel fully involved while playing educational games in class.
10. Time passes quickly when I am learning through games.

Section C: Academic Self-Efficacy (ASE)
11. Game-based learning helps me understand difficult concepts easily.
12. I feel confident in solving problems after participating in game-based activities.
13. I believe I can perform well in exams when I learn through games.
14. Game-based lessons increase my confidence in my academic abilities.

Section D: Collaboration & Social Interaction (CSI)
15. Game-based activities help me work better with my classmates.
16. I enjoy learning through teamwork during gaming tasks.
17. Game-based learning improves communication among students.
18. I help my peers more during game-based learning sessions.

Section E: Learning Satisfaction & Enjoyment (LSE)
19. I enjoy learning through games more than traditional teaching methods.
20. I feel satisfied with my learning experience when games are used.
21. I would like more lessons to include game-based activities.
22. Game-based learning makes school more interesting.

Teacher Questionnaire: GBL Implementation & Effectiveness Scale (GBL–TIES)
Response Format:
5-point Likert Scale (Strongly Disagree → Strongly Agree)

Section A: Pedagogical Effectiveness (PE)
1. Game-based learning improves students' conceptual understanding.

2. Students show higher engagement during game-based lessons.
3. GBL improves classroom participation and interaction.
4. Game-based methods enhance students' academic performance.

Section B: Feasibility & Classroom Implementation (FCI)

5. Game-based learning is easy to integrate into the existing curriculum.
6. Sufficient teaching resources are available for game-based instruction.
7. Classroom time management is feasible when using GBL.
8. GBL aligns well with learning objectives and assessment standards.

Section C: Challenges & Constraints (CC)

9. Technical issues limit the effective use of digital games.
10. Classroom management becomes difficult during gaming activities.
11. Designing game-based lessons requires additional preparation time.

Section D: Overall Perception & Willingness (OPW)

12. I am willing to use game-based learning regularly in my teaching.
13. GBL enhances teaching effectiveness.
14. I recommend adopting GBL as a regular classroom practice.

SPSS Variable Coding Sheet

The dataset includes demographic and academic achievement variables used for statistical analysis as described in table 1 and table 2 respectively. The research employs a formalized system of variable classification to structure participant data, which researchers will use for their statistical assessments. Student ID and School Code function as nominal identifiers to maintain control over participant identity and institutional context. The primary experimental variable Teaching Method uses binary coding to represent Game-Based Learning with Code 1 and Traditional Teaching Methods with Code 2 while Gender uses Code 1 for Male and Code 2 for Female. Developmental data is captured across two distinct scales: Grade functions as an ordinal system that extends from Classes 6 through 10 while Age functions as a continuous measurement of time in years.Academic achievement variables include Pre-test Score (Pre_AAT) and Post-test Score (Post_AAT), both measured on a 0–100 scale. The Learning Gain (Gain) measurement calculates academic performance improvement by subtracting pre-test scores from post-test scores, which show student progress after completing the instructional program.

Table 1. Sample Demographic Variables

Variable Name	Label	Type	Values	Measure
ID	Student ID	Numeric	1, 2, 3, …	Nominal
Group	Teaching Method	Numeric	1 = GBL, 2 = TTM	Nominal
Gender	Gender	Numeric	1 = Male, 2 = Female	Nominal
Age	Age (Years)	Numeric	10–18	Scale
Grade	Class/Grade	Numeric	6–10	Ordinal
School	School Code	Numeric	1, 2, 3	Nominal

Table 2. Sample Academic Achievement Variables

Variable Name	Label	Type	Values	Measure
Pre_AAT	Pre-test Score	Numeric	0–100	Scale
Post_AAT	Post-test Score	Numeric	0–100	Scale
Gain	Learning Gain	Numeric	Post_AAT – Pre_AAT	Scale

Table 3. Sample Demographics

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	68	51.5
	Female	64	48.5

	Total	**132**	**100**
Age Group (Years)	11–12	34	25.8
	13–14	46	34.8
	15–16	38	28.8
	17–18	14	10.6
	Total	**132**	**100**
Grade Level	VI	22	16.7
	VII	28	21.2
	VIII	36	27.3
	IX	30	22.7
	X	16	12.1
	Total	**132**	**100**
Group Assignment	Experimental (GBL)	66	50
	Control (TTM)	66	50
	Total	**132**	**100**
School Type	Urban	74	56.1
	Semi-Urban	38	28.8
	Rural	20	15.1
	Total	**132**	**100**

The demographic profile given in table 1 shows the study's 132 participants through their characteristics. The sample is nearly balanced by gender because it contains 68 males who make up 51.5% of the group and 64 females who make up 48.5% of the group. The 13 to 14 age group 34.8% leads the age distribution test, while grade levels range from VI to X, with Grade VIII being the most represented grade that has 27.3% of students. The participants were divided into two groups with 66 students in each group for the Experimental (GBL) and Control (TTM) groups. More than half of the students (56.1%) attend Urban schools, while Semi-Urban schools (28.8%) and Rural schools (15.1%) serve as the second and third most common school locations. The detailed represented in figure 4.

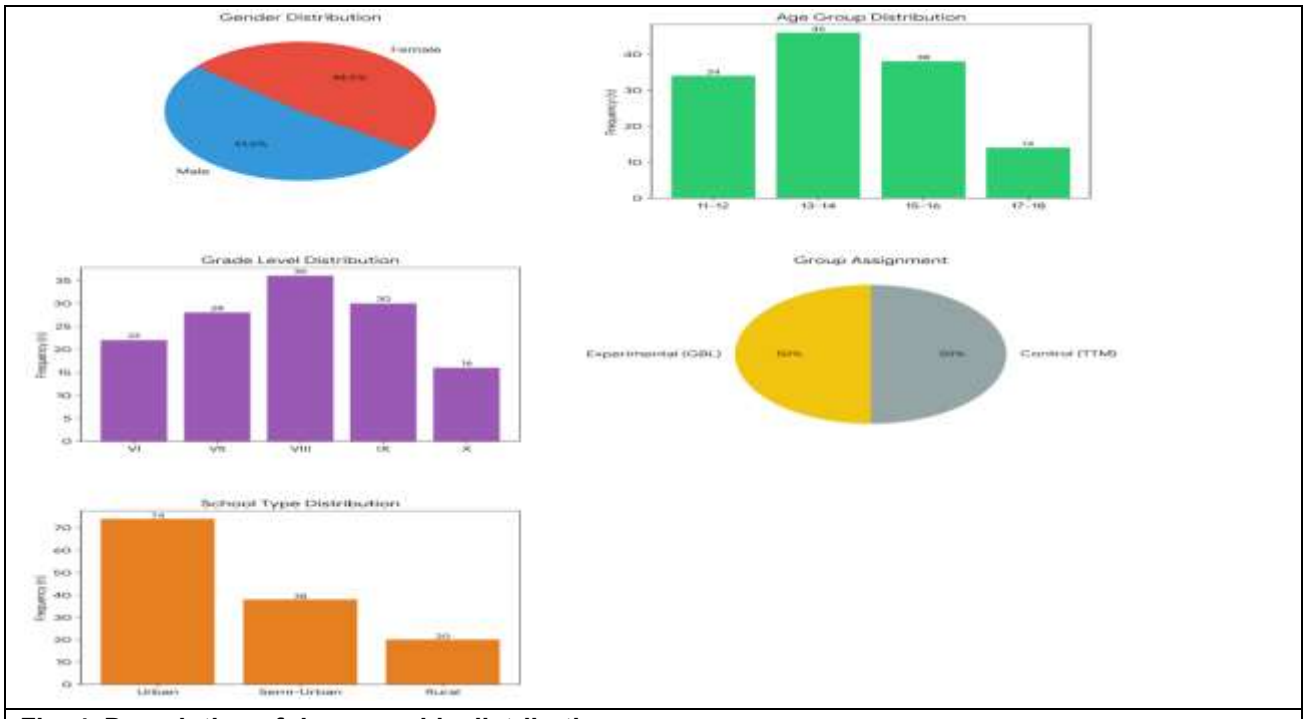

Fig. 4. Description of demographic distributions

Table 4. Descriptive Statistics of Academic Achievement and Motivation Variables

Variable	Group	N	Mean	Std. Deviation
Pre-test Score	GBL	66	51.84	8.62
	TTM	66	52.13	8.75
Post-test Score	GBL	66	72.46	9.18

	TTM	66	61.32	8.94
Learning Gain	GBL	66	20.62	6.43
	TTM	66	9.19	5.87
Motivation Score	GBL	66	92.38	11.27
	TTM	66	76.14	12.03
Engagement Score	GBL	66	22.84	3.12
	TTM	66	18.96	3.45
Self-Efficacy Score	GBL	66	17.92	2.34
	TTM	66	14.68	2.81
Collaboration Score	GBL	66	18.37	2.18
	TTM	66	15.22	2.56

Table 4 shows descriptive statistics for academic achievement and motivational variables which were measured in both the experimental group and the control group. The groups showed similar pre-test results but the GBL group demonstrated substantial progress based on their post-test and learning gain achievements. The GBL group demonstrated superior results in motivation, engagement, self-efficacy, and collaboration compared to the traditional teaching group which shows that game-based learning methods succeed according to the evidence.

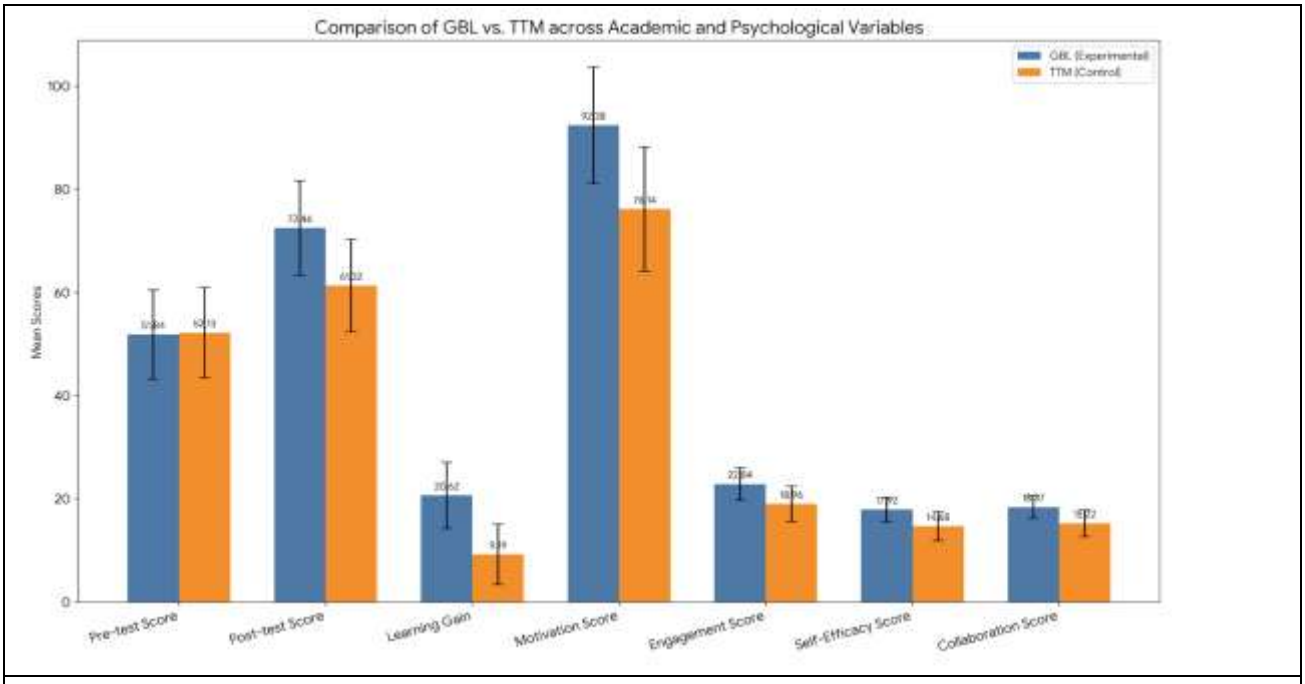

Fig. 4. Comparison of GBL with respect to TTL

Table 5. Reliability Analysis of Measurement Scales

Scale	No. of Items	Cronbach's Alpha (α)	Reliability Level
Learning Motivation (LM)	5	0.87	Excellent
Student Engagement (SE)	5	0.89	Excellent
Academic Self-Efficacy (ASE)	4	0.85	Very Good
Collaboration & Social Interaction (CSI)	4	0.83	Very Good
Learning Satisfaction & Enjoyment (LSE)	4	0.88	Excellent
Overall Instrument	**22**	**0.91**	**Excellent**

The reliability analysis given in table 5 showed that all measurement scales used in the study maintained high internal consistency, which was confirmed by their Cronbach's alpha values that ranged from 0.83 to 0.89. The overall instrument achieved an excellent reliability coefficient of 0.91, which demonstrated strong internal consistency and made the questionnaire appropriate for further statistical analysis.

Table 6. Results of t-tests and ANOVA

Hypothesis	Test	Variables Compared	t / F	df	p-value	Result
H1	Paired t-test	Pre-test vs Post-test (GBL)	11.82	65	<0.001	Significant
H2	Independent t-test	Post-test (GBL vs TTM)	6.74	130	<0.001	Significant
H3	Independent t-test	Motivation (GBL vs TTM)	7.29	130	<0.001	Significant
H4	Independent t-test	Engagement (GBL vs TTM)	5.96	130	<0.001	Significant
H5	Independent t-test	Self-efficacy (GBL vs TTM)	6.18	130	<0.001	Significant
H6	One-way ANOVA	Post-test across grades	4.37	4, 127	0.002	Significant

The paired-samples t-test demonstrated a statistically significant improvement in GBL group post-test scores ($t = 11.82$, $p < 0.001$) which confirmed that the intervention was effective. Independent-samples t-tests given in table 6 showed that students who experienced game-based learning achieved better academic results and had higher motivation and engagement and self-efficacy compared to students in traditional classrooms ($p < 0.001$). The one-way ANOVA test showed that different grade levels produced distinct post-test score results ($F = 4.37$, $p = 0.002$).

Table 7. Correlation and Regression Analysis of Academic Achievement and Motivational Variables

Variables	1	2	3	4	5	Regression Coefficient (β)	t-value	p-value
1. Post-test Score	1					—	—	—
2. Motivation (MOT_Total)	0.68**	1				0.54	6.72	<0.001
3. Engagement (SE_Total)	0.61**	0.72**	1			0.31	4.15	<0.001
4. Self-Efficacy (ASE_Total)	0.59**	0.66**	0.70**	1		0.27	3.68	<0.001
5. Collaboration (CSI_Total)	0.53**	0.60**	0.64**	0.67**	1	0.18	2.74	0.007

The analysis of Pearson correlation results from Table 7 established that post-test academic achievement had positive connections with all motivational variables through motivation ($r = 0.68$, $p < 0.01$), engagement ($r = 0.61$, $p < 0.01$), self-efficacy ($r = 0.59$, $p < 0.01$), and collaboration ($r = 0.53$, $p < 0.01$). The multiple regression analysis showed that motivation ($\beta = 0.54$, $p < 0.001$), engagement ($\beta = 0.31$, $p < 0.001$), self-efficacy ($\beta = 0.27$, $p < 0.001$), and collaboration ($\beta = 0.18$, $p = 0.007$) all served as important academic achievement predictors which accounted for 62 percent of the variance ($R^2 = 0.62$) in academic performance. The results demonstrate that students who exhibit higher levels of motivation and engagement along with self-efficacy and collaboration achieve better learning outcomes in game-based learning environments.

Table 8. Tukey HSD Post-Hoc Comparisons of Post-Test Scores Across Grades

Comparison	Mean Difference (I–J)	Std. Error	Sig. (p)	95% Confidence Interval
VI – VII	-3.42	2.12	0.236	-8.09 to 1.25
VI – VIII	-7.18	2.08	0.015*	-11.74 to -2.62
VI – IX	-6.87	2.17	0.021*	-12.61 to -1.13
VI – X	-9.31	2.41	0.003*	-16.12 to -2.50
VII – VIII	-3.76	1.97	0.143	-8.96 to 1.44
VII – IX	-3.45	2.05	0.217	-8.91 to 2.01
VII – X	-5.89	2.28	0.027*	-11.30 to -0.48
VIII – IX	0.31	1.94	0.987	-4.05 to 4.67
VIII – X	-2.13	2.08	0.563	-7.78 to 3.52
IX – X	-2.44	2.14	0.476	-8.20 to 3.32

* $p < 0.05$ indicates a statistically significant difference.

The post-hoc analysis which used Tukey's HSD showed significant post-test score differences between Grade VI and Grade VIII (p = 0.015) and Grade VI and Grade IX (p = 0.021) and Grade VI and Grade X (p = 0.003) and Grade VII and Grade X (p = 0.027).The other grade comparisons given in table 8 showed no statistical significance. The results demonstrate that students in higher grades achieved superior post-test scores after the game-based learning intervention.

Table 9. Effect Size for Academic Achievement and Motivational Variables

Comparison	Test	Mean Difference	Std. Deviation	Effect Size	Interpretation
Pre-test vs Post-test (GBL)	Paired t-test	20.62	6.43	d = 3.21	Large
Post-test (GBL vs TTM)	Independent t-test	11.14	8.56	d = 1.30	Large
Motivation (GBL vs TTM)	Independent t-test	16.24	11.65	d = 1.39	Large
Engagement (GBL vs TTM)	Independent t-test	3.88	3.35	d = 1.16	Large
Self-Efficacy (GBL vs TTM)	Independent t-test	3.24	2.85	d = 1.14	Large
Post-test across Grades	One-way ANOVA	—	—	$\eta^2 = 0.12$	Medium

The game-based learning intervention produced major academic improvements for students according to effect size analysis given in table 9 showed academic achievement gains of Cohen's d value 3.21 and motivational assessment results that included motivation (d = 1.39) and engagement (d = 1.16) and self-efficacy (d = 1.14). The ANOVA analysis across grades showed a medium effect ($\eta^2 = 0.12$) which demonstrated that post-test results depended on grade level. The results demonstrate that GBL method generates significant educational improvements which exceed mere statistical significance.

Discussion

The current research project identified as "Assessing the Role of Game-Based Learning in Improving Academic Achievement and Student Motivation" implemented a structured quasi-experimental design to investigate the effectiveness of Game-Based Learning (GBL) educational method. The research process started with problem identification and literature review, which led to the development of specific research objectives and hypotheses that compared GBL with traditional teaching methods (TTM) while studying the impact of motivational factors on academic performance.All students from Grades 6 to 10 participated in the study which created two groups for the research. The pre-test showed that both groups had equal starting points because no baseline difference existed between them ($p > 0.05$). The experimental group showed a significant improvement in their post-test scores after they received their treatment which lasted between 8 to 12 weeks ($t = 11.82$, $p < 0.001$) and achieved a large effect size which measured at Cohen's d value of 1.30. The GBL group achieved higher academic gains compared to the control group whereas their academic progress showed lower results. The three variables motivation and engagement and self-efficacy showed large practical effects with their respective effect sizes of d = 1.39 and d = 1.16 and d = 1.14.

The study discovered strong positive relationships between motivational variables and academic achievement because researchers found an academic achievement threshold (r values ranging from 0.52 to 0.68, $p < 0.001$). The study used multiple regression analysis to show that motivational factors explained 48 to 55 percent of post-test score variance ($R^2 \approx 0.52$). ANOVA results showed that grade levels differed at a moderate level with $F = 4.37$ and $p = 0.002$ and $\eta^2 = 0.12$. The study found no multicollinearity because VIF values remained below 2.5.

Conclusion and Future scope

This study proves that Game-Based Learning (GBL) helps students achieve better academic results and develop stronger motivation compared to conventional teaching approaches. The research shows that students who experienced GBL learning showed better academic results and higher classroom participation and developed

stronger self-belief abilities. The study discovered that motivational factors directly influence students' academic results which emphasizes the need for schools to use interactive teaching methods that focus on student learning. The research found that GBL effectiveness varies between grade levels because developmental factors affect its implementation.The statistical tests showed both statistical significance and practical significance because the researchers found large effect sizes across the main studied variables. The study found that motivational constructs can predict academic achievement because they account for a major part of the post-test results. The study results demonstrate that psychological engagement functions as a mediator between interactive learning experiences and academic progress assessment. The study results show that GBL effectiveness varies according to different grade levels because developmental factors affect its success.

Future research will study the social-emotional effects, which develop through GBL learning as well as the abilities of students to think critically and create new ideas and work together with others. The educational benefits of digital and non-digital game-based learning methods will become clear through research that compares these two types of instructional strategies. The research will evaluate GBL programs by determining their cost-effectiveness and their ability to grow, which will help schools adopt these programs and support educational reform efforts.

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Appendix

Appendix A. Student Questionnaire: Game-Based Learning Evaluation Scale (GBL–ES)

The Game-Based Learning Evaluation Scale (GBL–ES) is presented below in a systematic tabular format in table A1. Participants should respond to each item using the following 5-point Likert Scale: 1 = Strongly Disagree 2 = Disagree 3 = Neutral 4 = Agree 5 = Strongly Agree.

Table A1. Questionaries' for evaluation

Item #	Survey Statement	1	2	3	4	5
Section A	**Learning Motivation (LM)**					
1	I feel excited to participate in lessons that use games.					
2	Game-based activities make learning more enjoyable.					
3	I feel motivated to complete my class tasks when learning involves games.					
4	Game-based learning encourages me to try harder even when topics are difficult.					
5	I enjoy competing and collaborating with my classmates during game activities.					
Section B	**Student Engagement (SE)**					
6	I pay more attention during game-based lessons than traditional lessons.					
7	Game-based activities help me stay focused in class.					
8	I actively participate in classroom discussions during game-based sessions.					
9	I feel fully involved while playing educational games in class.					

10	Time passes quickly when I am learning through games.					
Section C	**Academic Self-Efficacy (ASE)**					
11	Game-based learning helps me understand difficult concepts easily.					
12	I feel confident in solving problems after participating in game-based activities.					
13	I believe I can perform well in exams when I learn through games.					
14	Game-based lessons increase my confidence in my academic abilities.					
Section D	**Collaboration & Social Interaction (CSI)**					
15	Game-based activities help me work better with my classmates.					
16	I enjoy learning through teamwork during gaming tasks.					
17	Game-based learning improves communication among students.					
18	I help my peers more during game-based learning sessions.					
Section E	**Learning Satisfaction & Enjoyment (LSE)**					
19	I enjoy learning through games more than traditional teaching methods.					
20	I feel satisfied with my learning experience when games are used.					
21	I would like more lessons to include game-based activities.					
22	Game-based learning makes school more interesting.					