

TRENDS AND INSIGHTS OF GAME-BASED LEARNING IN MATHEMATICS RESEARCH IN THE PHILIPPINES: A SCOPING REVIEW WITH BIBLIOMETRIC ANALYSIS

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ABSTRACT: Game-based learning (GBL) has emerged as an innovative strategy to address achievement gaps in Philippine basic mathematics education, yet empirical literature remains fragmented across multidisciplinary outlets and institutional repositories. Following PRISMA-ScR protocols, a systematic literature search across Google Scholar (via Publish or Perish) and Philippine E-Journals identified 597 raw records published between 2012 and 2025. After deduplication and screening, 74 unique empirical studies ($N = 74$) met all inclusion criteria for Reflexive Thematic Analysis across four pre-defined domains and scientometric network mapping via VOSviewer. Scholarly output surged from 2021 to 2025 (76.0%), with 81.0% of papers scattered across 60 unique journals. Interventions heavily favor Junior High School algebra (59.5%, dominated by Grade 7) and supplementary/remedial drills (79.7%) evaluated through short-term quantitative quasi-experiments (55.4%). Co-authorship networks remain isolated and provincial, relying on a dual-track citation model balancing Western theoretical models with Department of Education curricular frameworks. GBL research in Philippine basic education is performance-driven yet structurally fragmented. Sustainable integration requires expanding into early primary numeracy, Senior High School, and Special Education, alongside institutionalized DepEd-university research partnerships and offline-capable software standards.

Keywords: mathematics teacher professional standards, pedagogy, personal attributes

1. INTRODUCTION

Over the past decade, game-based learning (GBL) and educational gamification have emerged as prominent instructional innovations aimed at addressing persistent challenges in mathematics education [1, 2]. In the Philippines, where national diagnostic benchmarks and international evaluations such as the Programme for International Student Assessment (PISA) and TIMSS [3] reveal substantial gaps in foundational numeracy, algebraic reasoning, and mathematical literacy, educators and researchers have increasingly turned to digital applications[4, 5], localized game boards, and gamified instructional modules[6]. Despite a growing body of literature documenting these interventions, local research remains scattered across diverse multidisciplinary journals, institutional repositories, and conference proceedings, leaving a critical gap in systematic, domain-wide synthesis.

To establish a comprehensive understanding of how game-based learning is operationalized, evaluated, and contextualized within Philippine mathematics classrooms, this study conducts a systematic scoping review following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) protocol [7, 8]. Analyzing a corpus of 74 unique research studies published between 2012 and 2025, this inquiry employs Braun and Clarke's "Reflexive Thematic Analysis (RTA)" [9] alongside scientometric co-authorship mapping via VOS viewer [10] to investigate four core domains:

(1) Game Design & Mechanics [11], (2) Pedagogical Integration [12,], (3) Learner Outcomes [13], and (4) Socio-Contextual Factors [14]. Additionally, the review maps the distribution of research methodologies, target learner demographics, and institutional collaboration networks across the country.

2. OBJECTIVE OF THE STUDY

This scoping review and bibliometric analysis aimed to systematically map the research landscape, pedagogical integration, and scientometric patterns of game-based learning

(GBL) in Philippine basic mathematics education from 2012 to 2025. Moving beyond a superficial catalog of mathematical topics, this study evaluated the structural architecture of local GBL research across four core conceptual domains, methodological choices, and institutional collaboration networks to provide a data-driven foundation for future curriculum policy and inter-institutional research alliances.

Specifically, this study addressed the following questions:

1. What is the publication trajectory and venue distribution of game-based mathematics education research in the Philippines from 2012 to 2025?
2. How are game-based learning interventions in local mathematics education conceptualized and operationalized across the four core domains:
 - Domain 1 (Game Design and Mechanics): What architectural paradigms and interactive loops govern local mathematics games?
 - Domain 2 (Pedagogical Integration): How are game mechanics positionally integrated into instructional delivery models?
 - Domain 3 (Learner Outcomes): What cognitive, affective, and system usability metrics are prioritized to measure intervention success?
 - Domain 4 (Socio-Contextual Factors): How do environmental, cultural, and policy realities shape game development and adoption?
3. What methodological designs and target demographic cohorts characterize the local GBL research base?
4. What are the bibliometric co-authorship networks, citation behaviors, and institutional output distributions driving Philippine game-based mathematics research?

3. MATERIALS AND METHODS

This inquiry utilized a systematic scoping review design following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) protocol [7] and Joanna Briggs Institute (JBI) methodology guidelines [8]. The study population comprised peer-reviewed journal articles and conference proceedings

Table 1
Linear Regression Analysis Result

Variables	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	-2434.66	402.293		-6.05	.001*
1 Year	1.21	.199	.868	6.07	.001*

a. Dependent Variable: Publications

Table 2
Journal Sources for Game-Based Learning Research in the Philippines

Journal Sources	Number of Publications
Psychology and Education: A Multidisciplinary Journal	8
Science International (Lahore)	2
United International Journal for Research & Technology (UIJRT)	2
Journal of Interdisciplinary Perspectives	2
Other Journals (60 unique journals)	60
Total	74

published between 2012 and 2025 focusing on game-based learning (GBL) and educational gamification in Philippine basic mathematics education (K–12). The setting encompassed basic education environments across public Department of Education (DepEd) schools, State Universities and Colleges (SUCs), and private higher education institutions nationwide.

Literature retrieval was conducted using Harzing's Publish or Perish (PoP) software [16] interfacing with Google Scholar [17, 18, 19] alongside manual searches in Philippine E-Journals (PEJ). Field-constrained search strings targeted pedagogical interventions, mathematical domains, and local context (e.g., Title: "game-based learning" OR "educational game" OR "serious game" OR "gamification" OR "SIM" AND Keywords: (mathematics OR math OR numeracy) AND (Philippine OR Philippines OR Filipino)). Following established search and reporting protocols [20, 21], initial database querying yielded 597 raw records. All records were imported into Zotero reference management software [22], where 40 duplicate records were removed, leaving 557 unique records for title and abstract screening. Screening excluded 428 records falling outside eligibility boundaries, leaving 129 full-text reports retrieved and evaluated. Following full-text appraisal, 55 reports were excluded, yielding a final analytical dataset of 74 unique studies ($N = 74$). A standardized 14-column data extraction matrix was developed in Microsoft Excel to record bibliometric metadata, target grade levels, mathematical content strands, game mechanics, pedagogical models, methodological designs, learner outcome metrics, and socio-contextual factors.

Extracted data underwent descriptive, bibliometric [15], and thematic analysis. Descriptive frequencies, percentages, and linear regression modeling (R^2) evaluated annual publication trajectories and venue distributions. Braun and Clarke's (2006) Reflexive Thematic Analysis (RTA) [9] was applied

across six phases to synthesize qualitative findings across four core pre-defined domains: (1) Game Design & Mechanics, (2) Pedagogical Integration, (3) Learner Outcomes, and (4) Socio-Contextual Factors. Additionally, scientometric co-authorship collaboration networks and institutional distributions were mapped macroscopically using VOSviewer software (v1.6.20).

4. RESULTS AND FINDINGS

Publication Trends and Venue Distribution

Analysis of the 74 reviewed studies reveals an accelerating publication trajectory in Philippine game-based mathematics education, particularly in recent years. As shown in Table 1, linear regression modeling confirms a statistically significant upward growth trend over time ($R^2 = 0.754$, $p < .001$).

Approximately 76.0% ($f = 56$) of the total research corpus was published between 2021 and 2025, contrasting sharply with only 14 publications between 2012 and 2019. This structural shift points to heightened academic interest and institutional support following remote learning transitions during the COVID-19 pandemic.

Regarding venue distribution, the publishing landscape remains highly fragmented. While Psychology and Education: A Multidisciplinary Journal serves as the primary publishing outlet ($f = 8$, 10.8%), 81.0% ($f = 60$) of the studies are scattered across 60 unique multidisciplinary journals contributing only a single paper each. This indicates that local GBL research has not yet converged into a specialized set of core mathematics education journals.

This section evaluates the 74 reviewed studies across four core conceptual domains: (1) Game Design and Mechanics, (2) Pedagogical Integration, (3) Learner Outcomes, and (4) Socio-Contextual Factors. Moving beyond a superficial cataloging of mathematical topics, this multi-dimensional analysis maps target populations, research methodologies, and dominant educational patterns across the local landscape. To align with the theoretical framework, a hybrid deductive-inductive thematic approach was implemented. The four domains provided high-level deductive headings, while Braun and Clarke's (2006) six-phase Reflexive Thematic Analysis was applied inductively to identify emergent sub-themes. This approach explicitly illustrates who is being studied, how research is executed, and which priorities govern Philippine game-based mathematics education.

Domain 1 Game Design and Mechanics

Applying Reflexive Thematic Analysis (Braun & Clarke, 2006) to the technical configurations and interactive loops of the reviewed studies yielded three distinct sub-themes: (a) Reward and Progression Systems (PBL), (b) Rule-Based Board and Strategy Mechanics, and (c) Interactive Multimedia and

Animation

Table 3 Emergent Sub-themes and Mechanical Characteristics within Domain 1 (N = 74)			
Emergent Sub-theme	Frequency (f)	Percentage (%)	Core Empirical Indicators & Primary Codes
Reward & Progression Systems (PBL)	30	40.5%	Extrinsic structural feedback loops; numeric score tracking, badge achievements, multi-tier unlocking levels, status reward incentives, and real-time visual progress monitoring bars.
Rule-Based Board & Strategy Mechanics	25	33.8%	Specialized cognitive constraints; localized board-game modifications (e.g., Damath variations), turn-based strategy protocols, algorithmic dice allocations, and card-based mathematical execution systems.
Interactive Multimedia & Animation	19	25.7%	High-fidelity environmental assets; 2D/3D responsive graphic interfaces, customizable avatar assets, auditory narration cues, animated character layouts, and virtual learning environment simulations.
74			

Regarding game design and mechanics, three distinct architectural paradigms emerged across the literature: Reward and Progression Systems (40.5%), Rule-Based Board and Strategy Mechanics (33.8%), and Interactive Multimedia and Animation (25.7%). The primary paradigm relies on structural gamification frameworks prioritizing Points, Badges, and Leaderboards (PBL) as automated reinforcement engines; for instance, Oledan [27], embedded gamified levels while Lanuza *et al.* [28], leveraged progress trackers to mitigate cognitive fatigue and sustain motivation during self-paced learning. Concurrently, culturally situated interventions convert traditional or rule-bound structures into tactical learning tools, as demonstrated by Lanuza *et al.* [29], in probability instruction and Samonte *et al.* [30, 31], in assistive e-tutor interfaces for exceptional learners. Finally, multimedia configurations prioritize visual and sensory design by replacing static print modules with responsive setups, such as Buenviaje *et al.* [32], adaptive 3D geometric game and Faustino *et al.* [33], spatial volume visualization tool, making abstract mathematical concepts conceptually accessible through multi-sensory rendering.

Domain 2: Pedagogical Integration

To uncover how game-based learning is positionally situated within instruction, reflexive thematic analysis was applied to code operational deployment models, instructional modalities, and the roles of teachers and peers. Three emergent sub-themes define how local researchers integrate GBL into mathematics classrooms. Through thematic analysis, the overwhelming majority of local GBL literature emerged as conceptualizing games as downstream, post-hoc enrichment tools or targeted remedial safety nets (79.7%), as seen in Supangan *et al.* [34], special education e-tutor app and Buenviaje *et al.* [32], supplementary geometry framework. A smaller subset of studies embeds game mechanics directly into core delivery structures (16.2%), demonstrated by Oledan [27], through gamified video lessons and by Lanuza *et al.* [28] and Valdez *et al.* [35], within modular distance learning frameworks.

Table 4 Emergent Sub-themes and Instructional Deployment Patterns within Domain 2 (N = 74)			
Emergent Sub-theme	Frequency(f)	Percentage(%)	Core Empirical Indicators & Primary Codes
Supplementary Learning & Remedial Intervention	59	79.7%	Post-lecture enrichment tools; targeted remedial interventions, independent e-tutor systems, standalone app exercises, and learning packets bridging curriculum gaps.
Curricular Alignment & Structural Integration	12	16.2%	Systemic classroom delivery architectures; modular distance learning modules, flipped classroom configurations, blended learning structures, and sequential learning units.
Teacher-Led Collaborative Design & Facilitation	3	4.1%	Human-centered co-design frameworks; Lesson Study (LS) collaborative lesson planning, peer-to-peer tutoring structures, and custom teacher-made materials.
TOTAL	74	100.0%	

Finally, human-centered co-design and facilitation models (4.1%) prioritize teacher and peer roles, highlighted by Lanuza *et al.* [29]. integration of gamified probability tools with formal Lesson Study (LS), Javinez and Doronio’s [36], peer-tutoring dynamics, and Uy [37], teacher-made interactive comic strips for integer operations.

Domain 3: Learner Outcomes

Evaluating the cognitive, affective, and system metrics used across the reviewed studies through reflexive thematic analysis reveals three primary measurement paradigms: (a) Cognitive Gains and Academic Achievement, (b) Affective and Behavioral Engagement, and (c) Technical Usability and System Acceptance. Through thematic analysis, local GBL success is evaluated predominantly through concrete academic performance metrics (60.8%), relying heavily on quantitative pre-test/post-test designs; for instance, Samonte *et al.* [31], validated conceptual mastery shifts among exceptional learners, while Abuton *et al.* [38] documented significant achievement score gains following specialized intervention materials. Concurrently, studies tracking psychological and emotional impacts prioritize affective and behavioral engagement (28.4%), as seen in Oledan’s [27], evaluation of self-directed student experiences and Lanuza *et al.*’s [29], work on building confidence and lowering anxiety during complex probability units. Finally, technical usability and system acceptance metrics (10.8%) focus on operational viability and human-computer interaction standards, highlighted by Supangan *et al.* [34], baseline software acceptance evaluation for unique populations and Buenviaje *et al.* [32] usability testing measuring interface accessibility and user satisfaction.

Domain 4: Socio-Contextual Factors

Evaluating the environmental, cultural, and institutional forces across the reviewed studies through reflexive thematic analysis reveals three primary contextual sub-themes: (a) Curriculum Localization and Digitization, (b) Pandemic-Era Instructional Shifts, and (c) Inclusive Education for Diverse Learners.

Table 5
Emergent Sub-themes and Measurement Paradigms within Domain 3 (N = 74)

Emergent Sub-theme	Frequency(f)	Percentage(%)	Core Empirical Indicators & Primary Codes
Cognitive Gains & Academic Achievement	45	60.8%	Pre-test vs. post-test performance comparisons, normalized gain scores (g), concept mastery metrics, pass-rate percentages, and curriculum benchmark proficiency. Self-reported attitude shifts, reduction in subject-specific math anxiety, sustained attentional focus, user perceptions, and self-efficacy metrics.
Affective & Behavioral Engagement	21	28.4%	Technology Acceptance Model (TAM) variables, System Usability Scale (SUS) scores, ISO standard metrics, and multi-criteria interface quality validations.
Technical Usability & System Acceptance	8	10.8%	
Total	74	100%	

Table 6
Emergent Sub-themes and Contextual Settings within Domain 4 (N = 74)

Emergent Sub-theme	Frequency(f)	Percentage(%)	Core Empirical Indicators & Primary Codes
Curriculum Localization & Digitization	56	75.7%	Traditional educational frameworks; K-12 math competencies, native cultural game conversion (e.g., Damath digital migration), local school resource limits, and digital native engagement. Crisis-driven remote education; "New Normal" distance configurations, modular print packages, hybrid learning tracks, and home-bound instructional settings.
Pandemic-Era Instructional Shifts	15	20.3%	Specialized learner accommodations; diagnostic support systems for ADHD, assistive communication utilities for speech and hearing impairments, and adaptive special education services.
Inclusive Education for Diverse Learners	3	4.1%	
Total	74	100.0%	

Through thematic analysis, local GBL research is overwhelmingly anchored by curriculum localization and digitization (75.7%), where digital tools are engineered to meet mandated Department of Education (DepEd) competencies within resource-constrained K-12 classrooms;

for example, Oledan [27] aligned gamified video lessons with secondary curricula, Lanuza *et al.* [29] mapped game structures to high school probability units, and Buenviaje *et al.* [32] paired geometric shapes with everyday community objects. Concurrently, pandemic-era instructional shifts (20.3%) reflect crisis-driven remote learning adaptations, as demonstrated by Lanuza *et al.* [28] and Valdez *et al.* [35], who embedded progress tracking and gamified pathways into "New Normal" distance modules to mitigate home-learning isolation. Finally, inclusive education for diverse learners (4.1%) addresses equity through adaptive assistive technology, highlighted by Supangan *et al.* [34] specialized mobile app addressing ADHD cognitive needs and Samonte *et al.* [31] voice-recognition e-tutor supporting speech-impaired learners.

Methodological Approaches in Local GBL Research

To address the structural architecture of the reviewed literature, research designs across the 74 studies were categorized into three methodological pillars: (a) Quantitative Experimental and Quasi-Experimental Designs, (b) Developmental Research and Systems Engineering (R&D), and (c) Descriptive and Mixed Methods Frameworks.

Table 7
Distribution of Research Designs and Methodological Approaches (N = 74)

Research Design Category	Frequency (f)	Percentage(%)	Core Methodological Indicators & Data Sources
Quantitative Experimental & Quasi-Experimental	41	55.4%	Non-equivalent control group designs, pre-test/post-test tracking, randomized block designs, and inferential statistical evaluations (t-tests, ANCOVA). Prototyping pipelines, ADDIE/Waterfall frameworks, software functionality testing, and ISO/IEC 25010 usability evaluations.
Developmental Research & Systems Engineering (R&D)	18	24.3%	Convergent parallel designs, student perception surveys, thematic interviews, descriptive means, and classroom case study observations.
Descriptive & Mixed Methods Frameworks	15	20.3%	
Total	74	100.0%	

The methodological landscape is dominated by quantitative experimental and quasi-experimental designs (55.4%), reflecting a strong priority on generating numeric proof of learning gains through non-equivalent control group pre-test/post-test evaluations; for instance, Lanuza *et al.* (2021) [28] deployed a randomized block design to establish objective baselines, while Javinez and Doronio (2025) [36] operated a quasi-experimental setup to evaluate mathematical competence shifts. Concurrently, developmental research and systems engineering (24.3%) highlights local software creation tailored to DepEd competencies via classic engineering pipelines, as demonstrated by Treceña *et al.* (2022) [39] using the ADDIE model for a gamified Strategic

Intervention Material (SIM) and Valdez *et al.* [35], applying ISO/IEC 25010 benchmarks to evaluate mobile app reliability. Finally, descriptive and mixed-methods frameworks (20.3%) capture qualitative experiences and contextual feedback, illustrated by Alexander and Reyes-Chua [40], exploring motivation grounded in Self-Determination Theory and Paglomutan [41], utilizing an embedded mixed-methods design to track skill retention in combinatorics.

Target Demographic Distribution across Grade Levels

Analyzing the 74 reviewed studies reveals that GBL interventions in the Philippines are mapped across four consumer cohorts: (a) Junior High School (JHS) Cohorts, (b) Elementary & Primary School Learners, (c) Senior High School (SHS) Cohorts, and (d) Exceptional & Special Education (SPED) Learners.

Table 8

Demographic Distribution of Target Populations and Grade Levels (N = 74)

Target Population Category	Frequency (f)	Percentage (%)
Junior High School (JHS) Cohorts	44	59.5%
Elementary & Primary School Learners	19	25.6%
Senior High School (SHS) Cohorts	9	12.2%
Exceptional & Special Education Learners	2	2.7%
Total	74	100.0%

The research landscape displays a stark concentration at the Junior High School level (59.5%), particularly Grade 7 algebra, where GBL is deployed as a strategic tool to ease the transitional jump to symbolic mathematics, reduce subject anxiety, and boost self-efficacy; for instance, Sipin and Tan [42], targeted math anxiety, Tambis and Potot [43], facilitated algebraic translation, and Mabuti [44], demonstrated that game-driven self-efficacy gains directly correlated with achievement improvements ($r = 0.435$). Primary and elementary learners represent the second largest demographic (25.6%), focusing on early numeric fluidity and spatial intuition to prevent math aversion, as seen in Relox *et al.* [45], Grade 1 place-value tool (driving a 58% proficiency gain) and Faustino *et al.* [46], Grade 4 volume visualization app. Senior High School cohorts (12.2%) target specialized strands like statistics and general mathematics through offline-capable apps Lalogo [47], though studies like Gonowon [48], warn of a "gamification paradox" where overly dense mechanics induce cognitive burnout in high-stakes environments. Finally, exceptional and SPED learners (2.7%) represent a critical equity micro-cohort, exemplified by Supangan *et al.* [34], specialized app for ADHD learners and Samonte [30], multi-sensory FSL-integrated platform for speech and hearing-impaired students in statistics.

Citation Patterns and Institutional Collaboration Networks

To map the institutional infrastructure and academic collaboration networks driving Philippine GBL research in mathematics education, co-authorship data was analyzed using VOSviewer (v1.6.20) [10]. The resulting network structure highlights the structural boundaries and regional

distribution of the local research community.

Bibliometric co-authorship mapping reveals a highly fragmented research landscape characterized by isolated team clusters, author pairs, and independent researchers. The largest connected co-author component comprises a maximum of only five individuals, proving that research collaboration is predominantly small-scale and confined to internal school-level teams or provincial pairs without broad national networks. Despite this overall decentralization, several active research clusters emerge across specific domains: the Lanuza cluster (focusing on modular distance learning and Lesson Study frameworks), the Maurat and Samonte networks (prioritizing software engineering and inclusive education platforms integrating Filipino Sign Language and speech recognition for SPED learners), and scattered localized teams evaluating primary 3D geometry tools and senior high track modules. The prevalence of isolated, floating co-authorship nodes confirms that local GBL research is largely driven by bottom-up, individual teacher initiatives; establishing cross-institutional and inter-regional research alliances remains a critical prerequisite for building a unified national research agenda in mathematics education.

Citation Patterns and Institutional Distribution

Macroscopic analysis of citation behaviors and institutional origins across the 74 reviewed studies reveals a dual-track citation model and a decentralized academic infrastructure

Table 9

Institutional Sectors Engaged in Game-Based Learning Research in the Philippines

Institutional Sector	Frequency(f)	Percentage (%)
Department of Education (K-12 Schools)	27	36.49%
Private Higher Educational Institutions	24	32.43%
State Universities and Colleges	23	31.08%
Total	74	100%

Citation patterns follow a dual-track structure: theoretical grounding relies on Western educational models (constructivism [23, 24], Kolb's experiential learning [25], Deci & Ryan's self-determination theory [26], and technical software engineering benchmarks (ADDIE, Waterfall, ISO/IEC 25010), whereas contextual urgency is driven by domestic policy frameworks (DepEd MELCs, DOST-SEI/MATHTED statistics, and PISA/TIMSS diagnostics [3]). Institutionally, research output is evenly distributed across DepEd basic schools (36.49%), private technical universities (32.43%), and regional state colleges (31.08%), with no single institution contributing more than three publications. Private HEIs like De La Salle University and Mapúa University focus heavily on digital software architectures and usability engineering, while DepEd practitioners at local schools like Olongapo City National High School execute localized action research to address division-level numeracy gaps. This balanced yet isolated institutional distribution confirms that Philippine GBL research stems from independent, bottom-up teacher initiatives rather than a

coordinated national agenda.

Research Directions and Policy Recommendations

Synthesizing empirical gaps across the 74 reviewed studies establishes a strategic roadmap to advance game-based learning (GBL) from an experimental intervention into a core instructional pathway. First, researchers must rebalance target demographics by expanding beyond the heavily saturated Junior High School bracket (59.5%; dominated by Grade 7) into under-represented cohorts, including early childhood kindergarten numeracy, Senior High School strands, and Special Education (2.7%), where assistive game environments tailored for exceptional learners remain critically scarce. Second, the embedded mathematical content must elevate beyond basic arithmetic drills and whole numbers toward higher-order conceptual domains, such as abstract algebraic structures, geometric proofs, calculus, and advanced inferential statistics. Third, methodological approaches must transition away from short-term pre-test/post-test quasi-experiments (55.4%) toward longitudinal design-based research and mixed-methods frameworks incorporating video observations and focus groups to evaluate long-term skill retention and problem-solving reasoning. Finally, future inquiries should leverage empirical data validating GBL as a primary teaching methodology such as Yumang [49], in Grade 7 algebra (Mean= 24.80 vs., Mean = 15.13), Jorda and De los Santos [50], in trigonometry (35.33% to 78.00%), and Buray and Alferez [51], in primary counting ($p < .001$) to transition interactive games into permanent, weekly classroom fixtures.

Actionable Educational Policy Recommendations

To operationalize these research directions, educational leaders and policy bodies must institute systemic policy updates across basic and higher education. First, the Department of Education (DepEd) and the Commission on Higher Education (CHED) should fund formal regional alliances linking public school practitioners (36.49% of output) with private university technical hubs (32.43%) to pair ISO/IEC 25010 software quality benchmarks with classroom-grounded pedagogy. Second, school administrators should officially embed verified GBL platforms into standard Weekly Lesson Logs and Strategic Intervention Material protocols, while formally integrating original GBL software design and validation into the Results-Based Performance Management System (RPMS) promotion metrics for public school teachers. Third, national policy guidelines must mandate offline-capable software architectures hosted on centralized repositories like the DepEd LRMS to bridge connectivity divides in remote divisions. Concurrently, curriculum designers must regulate gamified task density in Senior High School settings to mitigate the cognitive fatigue, task overload, and subject-specific anxiety documented in high-stakes learning environments.

5. CONCLUDING STATEMENTS

Based on the synthesis of empirical findings, game-based

learning (GBL) in Philippine mathematics education has gained strong academic momentum over the past decade, yet its publication landscape remains highly fragmented across multidisciplinary outlets rather than converging within specialized national journals. Local empirical inquiries are heavily performance-driven, prioritizing quantitative pre-test/post-test experimental designs that position GBL primarily as a downstream, supplementary tool for remedial drills and post-lecture enrichment rather than integrating game mechanics into core daily instruction. Structurally, the research ecosystem is decentralized and isolated, driven by independent teacher initiatives across public basic schools, state universities, and private institutions that rely on a dual-track citation model anchoring psychological and technical designs in Western frameworks while grounding practical urgency in Department of Education competencies and domestic diagnostic gaps. Ultimately, transitioning GBL into a permanent, equitable instructional fixture requires expanding beyond Junior High School algebra into early numeracy, Senior High School, and Special Education, establishing formal university K–12 research alliances, mandating offline-capable software architectures, and institutionalizing original GBL design within official teacher promotion systems.

6. Acknowledgements

The researchers extend its sincere appreciation to all the researchers and authors whose empirical studies comprised the analytical population of this review; their dedication to advancing game-based learning provided the foundational data that made this synthesis possible.

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