Bulletin of Electrical Engineering and Informatics
Vol. 15, No. 2, April 2026, pp. 1743~1755
ISSN: 2302-9285, DOI: 10.11591/eei.v15i2.10322

The role of technology acceptance model in evaluating educational games for higher education

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Article Info

Article history:

Received Mar 22, 2025
Revised Jan 28, 2026
Accepted Feb 22, 2026

Keywords:

Educational games
Higher education
Instructional design
Systematic review
Technology acceptance model

ABSTRACT

This systematic review investigates the application of the technology acceptance model (TAM) in evaluating the acceptance of educational games within higher education. Educational games have become prominent tools for enhancing learning outcomes through interactive and engaging experiences. Guided by TAM, this review analyzes how key constructs (perceived ease of use (PEOU), perceived usefulness (PU), attitude toward use (ATU), behavioral intention (BI), and perceived enjoyment (PE) influence students' acceptance of educational games. Using preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines, relevant studies published between 2020 and 2024 were systematically identified from Scopus and Web of Science (WoS) databases, with 20 empirical studies meeting the inclusion criteria. The synthesis reveals that PU and PEOU are the most significant predictors of acceptance, while hedonic factors such as enjoyment and flow enhance engagement and sustained use. Key challenges include technical limitations, cultural misalignment, inconsistent TAM extensions, and a lack of longitudinal evidence. The review highlights the need for context-aware and inclusive design approaches that integrate both cognitive and affective factors. Overall, the findings position TAM not only as an evaluative framework but also as a design-oriented model for developing effective, engaging, and pedagogically grounded educational games in higher education.

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1. INTRODUCTION

Educational games have emerged as powerful tools in higher education, offering interactive and engaging ways to enhance learning outcomes [1]. By leveraging gamification principles, these games create immersive experiences that motivate and engage students more effectively than traditional methods [2]. As technology evolves, the integration of educational games into curricula has become increasingly prevalent, driven by advances in digital technology [3] and the growing recognition of active learning benefits [4]. This trend underscores their potential to transform higher education by making learning more dynamic and accessible.

Recent systematic reviews and meta-analyses published between 2020 and 2024 have examined the effectiveness and motivational impact of digital and game-based learning across diverse educational settings [1], [2], [5]-[9]. These studies generally report positive effects on engagement and achievement but reveal

limited theoretical integration between motivational constructs and technology acceptance models. Most existing reviews have focused on learning outcomes or motivation rather than the mechanisms underlying learners' acceptance of educational games. However, there remains a need for a synthesis that specifically examines how technology acceptance model (TAM) constructs, including perceived usefulness (PU), ease of use, and enjoyment-related variables, explain acceptance across disciplines and learning contexts. The present review addresses this gap by systematically analyzing TAM-based studies of educational games in higher education.

To understand the impact of educational games, it is essential to consider the frameworks that evaluate technology acceptance. The TAM, developed by Davis [10], suggests that perceived ease of use (PEOU) and PU are the primary determinants of users' acceptance of technology. Over the years, TAM has evolved through several versions to better capture the complexities of technology acceptance by incorporating additional determinants such as social influence, cognitive instrumental processes, computer self-efficacy, and computer playfulness [11], [12]. The unified theory of acceptance and use of technology (UTAUT), developed by Venkatesh *et al*. [13], combines elements from eight prominent models, including TAM, to provide a comprehensive understanding of technology acceptance. UTAUT2, an extension of UTAUT, includes additional constructs like hedonic motivation, price value, and habit to better explain consumer technology acceptance and use [14]. By examining these frameworks, we can gain insights into how students interact with educational games and what factors influence their acceptance and continued use.

This systematic literature review aims to explore the role of TAM in evaluating the acceptance of educational games in higher education. Specifically, it seeks to address the following research questions: i) what are the TAM constructs used to evaluate the acceptance of educational games?, ii) what factors influence the acceptance of educational games among higher education students?, and iii) what are the challenges to the acceptance of educational games in higher education?. By synthesizing existing research, this review will contribute to the understanding of how TAM can be applied to evaluate educational games, offering insights for educators, game designers, and policymakers.

While several studies have applied TAM to specific educational game implementations, few have systematically synthesized its application across multiple disciplines, platforms, and cultural contexts. This review uniquely integrates findings from diverse domains, including science, technology, engineering, and mathematics (STEM), language learning, business, health, and computing, to identify how TAM constructs operate in different pedagogical and technological settings. By incorporating hedonic and experiential factors such as perceived enjoyment and flow, the review advances TAM beyond its traditional cognitive focus and demonstrates its adaptability for analyzing interactive, game-based learning environments. The synthesis also bridges theoretical and design perspectives, offering an extended TAM framework (TAM+flow) and discipline-specific design recommendations that link acceptance constructs to actionable game development principles. Collectively, this positions the review as a comprehensive reference for understanding and applying TAM in the context of educational games in higher education.

Several theoretical models have been developed to explain technology acceptance and motivational behavior in learning contexts. The TAM [10], [12] focuses on cognitive beliefs, PU and PEOU, as primary determinants of attitude toward use (ATU) and behavioral intention (BI). The UTAUT [13] and its extension UTAUT [14] incorporate additional variables such as social influence, facilitating conditions, and hedonic motivation. While UTAUT offers broader explanatory power, it is better suited to organizational or consumer technology adoption, where external moderators (e.g., voluntariness and experience) are central.

Other motivational frameworks, such as expectancy–value theory (EVT) [15] and self-determination theory (SDT) [16], [17], emphasize affective and motivational factors underlying learning behaviors. Although both frameworks provide valuable insights into motivation, they lack the structural focus on usability and perceived performance benefits that characterize TAM. Consequently, TAM remains particularly suitable for evaluating educational games, as it integrates both utilitarian (PU and PEOU) and affective (enjoyment and flow) dimensions of acceptance. This balance allows researchers to capture how students' perceptions of usefulness, ease of use, and enjoyment collectively predict engagement and sustained BI in interactive, game-based learning environments.

2. METHOD

This section outlines the technique for collecting articles on the evaluation of educational games implemented in higher education settings guided by TAM. The study employs a systematic analysis approach to critically examine, evaluate, and synthesize complex concepts and produce original research. Following preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines, the process included stages of identification, screening, eligibility, and exclusion as shown in Figure 1.

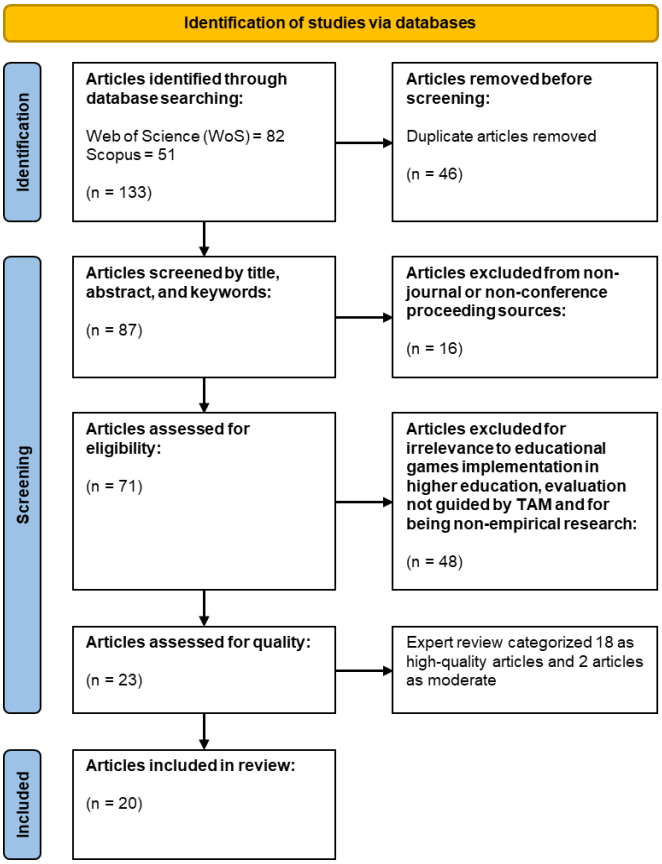

Figure 1. PRISMA systematic review adapted from Page *et al*. [18]

2.1. Identification phase

The identification phase constituted the first stage of this systematic review. Web of Science (WoS) and Scopus were selected as the primary databases due to their extensive coverage of peer-reviewed research in educational technology and game-based learning. Search strategies combined TAM–related terms with educational game–related keywords across titles, abstracts, and keywords. Boolean operators and controlled vocabulary were applied where available.

To ensure comprehensive coverage, backward and forward citation tracking was conducted for all included studies, and reference lists of relevant reviews and meta-analyses were screened. The complete search strings are presented in Table 1. Duplicate records were automatically removed prior to screening. In line with PRISMA recommendations, this review is bounded by a predefined search window (2020–2024). Newer studies published after 2024 are acknowledged narratively but fall outside the systematic scope.

Table 1. Search strategy used in this study

Database	Search string/strategy
WoS	Topic search (TS): (“Technology Acceptance Model” OR TAM) AND (“educational game*” OR “serious game*” OR “game-based learning” OR “gamified learning” OR “instructional game*”) AND (higher education OR university OR college). Filters: Document types=Article OR Proceedings Paper; Language= English.
Scopus	TITLE-ABS-KEY: (“Technology Acceptance Model” OR TAM) AND (“educational game*” OR “digital game-based learning” OR “serious game*” OR “gamified learning” OR “game-enhanced learning”) AND (higher education OR university OR college). Filters: Year=2020–2024; Language=English; Source type=Journal OR Conference Proceeding.
Citation tracking	Manual backward and forward citation searches were conducted using WoS and Scopus “Cited Reference Search” functions. Additional relevant studies were identified through reference lists of meta-analyses and recent reviews.
Controlled vocabulary	Applied where available: *“Computer-Assisted Instruction,” “Game-Based Learning,” “Educational Technology,” “User Acceptance of Technology.”*

2.2. Screening phase

Following identification, 46 duplicate records were removed, leaving 87 unique articles. After excluding non-English publications and non-journal or non-conference papers, 71 articles remained for

screening. Studies were excluded if they did not examine educational games in higher education, did not employ the TAM as an evaluative framework, or lacked empirical data. Based on the inclusion and exclusion criteria shown in Table 2, 23 studies were retained for quality assessment.

Table 2. Inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
Published between 2020 and 2024	Published before 2020 and after 2024
Journal articles and conference proceedings	Books, book chapters, posters, and short papers
Written in English	Non-English publications
Empirical studies on educational games in higher education using TAM	Studies not involving educational games, higher education, or TAM
Empirical research	Non-empirical studies

Quality appraisal was conducted independently by two reviewers using a rubric adapted from Petticrew and Roberts [19], assessing five criteria: i) research objectives, ii) study design, iii) sample adequacy, iv) measurement validity, and v) analytical rigor (Table 3). Each criterion was rated on a three-point scale, and only studies classified as high or moderate quality were retained. Inter-rater agreement was substantial (Cohen's κ=0.74), according to Landis and Koch [20], with disagreements resolved through consensus. Following this process, 20 studies (18 high quality and 2 moderate quality) were included in the final synthesis. The screening and quality assessment workflow is summarized in Figure 2, and article-level evaluations are reported in Table 4.

Table 3. Quality assessment rubric for included studies (adapted from Petticrew and Roberts [19])

Criterion	High (3)	Moderate (2)	Low (1)
Clarity of research objectives	Research objectives are explicitly stated, directly relevant to TAM and educational games, and logically guide the study design.	Research objectives are partially stated or relevant to TAM is implied but not fully explicit.	No clear research objectives or relevance to TAM is apparent.
Appropriateness of study design	Study design (e.g., survey, experiment, and mixed methods) is well-justified, suitable for objectives, and robustly implemented.	Study design is adequate but lacks strong justification or detail.	Study design is inappropriate, unclear, or poorly aligned with objectives.
Sample adequacy and representativeness	Large, diverse, and representative sample clearly described and appropriate for target population.	Adequate sample size but limited diversity or unclear representativeness.	Very small or convenience sample with poor or missing description.
Validity and reliability of measures	Validated TAM instruments or measures; reliability (e.g., Cronbach's alpha) reported; adaptation process clearly explained.	Measures partially validated or adapted with limited justification; reliability reported for some constructs.	No evidence of validation or reliability; measures unclear or ad hoc.
Rigor of data analysis and reporting	Appropriate analysis methods applied; assumptions checked; results clearly linked to research questions; and limitations acknowledged.	Basic analysis appropriate but with limited detail or incomplete reporting of assumptions and limitations.	Inappropriate or insufficient analysis; results poorly reported or not linked to questions.

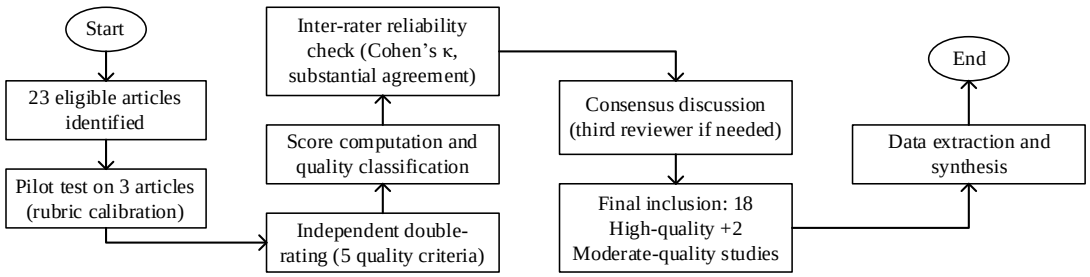

Figure 2. Workflow of the screening and quality assessment procedures

2.3. Included phase

This systematic review focused on empirical studies evaluating the acceptance of educational games in higher education using the TAM. Based on the inclusion criteria (Table 2), 20 studies indexed in WoS and Scopus were included in the final synthesis.

Table 4. Article checking table

Article ID	Paper title	Year	Paper quality by expert 1			Paper quality by expert 2			Remarks
			High	Moderate	Low	High	Moderate	Low	
A1	An interactive serious mobile game for supporting the learning of programming in JavaScript in the context of eco-friendly city management.	2020	✓			✓			
A2	Usefulness of digital serious games in engineering for diverse undergraduate students.	2022	✓			✓			
…A*n*	Enhancing learner satisfaction in simulation-based learning: the impact of learner characteristics and expectancy.	2023		✓			✓		Reliance on self-reported data

Following selection, a structured data extraction and coding process was conducted. A codebook was developed in alignment with the research questions and TAM constructs, capturing key study characteristics such as publication details, disciplinary context, participant profiles, game modality, TAM variables examined, and analytical methods. Two reviewers independently extracted data using a standardized template, with discrepancies resolved through discussion and, where necessary, consultation with a third reviewer.

To support cross-study comparison, studies were also coded for game genre, delivery modality, and key pedagogical design features identified through full-text analysis. The extracted data were synthesized in tabular form Table 5 and informed the narrative analysis presented in the results and discussion sections.

Table 5. Articles included for this review

Study	Year	Country	Context and game type/ modality	Sample	Key TAM variables	Key finding
[21]	2020	Taiwan	EFL writing; hybrid game	62 EFL students	PU, PEOU, ATU, BI, and flow	Flow predicted intention; reduced anxiety.
[22]	2020	Lithuania/Poland	Programming; mobile simulation	54 undergraduates	PU, PEOU, ATU, BI, and PE	Usefulness shaped attitudes and achievement.
[23]	2020	USA	Engineering; online simulation	132 students	PU, PEOU, ATU, and PE	Acceptance varied by gender and culture.
[24]	2021	Oman/Turkey	Programming; web/mobile	204 undergraduates	PU, PEOU, and BI	Core TAM relationships supported.
[25]	2021	Taiwan	EFL writing; hybrid game	62 learners	PU, PEOU, ATU, BI, and flow	Flow increased continuance intention.
[26]	2021	Philippines	Accounting; quiz/simulation	50 students	PU, PEOU, ATU, PE, and flow	Enjoyment and flow drove engagement.
[27]	2022	Hong Kong	Nursing; VR simulation	177 students	PU, PEOU, BI, and CSE	Ease of use predicted intention.
[28]	2022	Indonesia	IS (ERP); cloud simulation	93 students	PU, PEOU, and BI	Ease of use and social support mattered.
[29]	2022	Saudi/Malaysia	Programming; RPG coding	290 students	PU, PEOU, BI, and PE	Usefulness outweighed ease of use.
[30]	2022	Colombia	Entrepreneurship; board game	161 students	PE, EE, and satisfaction	Expectancy increased satisfaction.
[31]	2022	USA	Engineering; simulation	201 students	PU, PEOU, ATU, BI, and flow	Visualization improved; gamers favored usability.
[32]	2023	Taiwan	Excel; digital RPG	187 students	PU, PEOU, and flow	Game-based learning enhanced flow.
[33]	2023	Singapore	Marketing; team simulation	227 students	PE, EE, and satisfaction	Competition reduced satisfaction.
[34]	2023	Taiwan	Translation; mobile DGBL	68 learners	PU, PEOU, and BI	Motivation and outcomes improved.
[35]	2024	Türkiye	Civil Eng.; 3D WebGL	24 students	PU, PEOU, and usability	Usability enhanced acceptance.
[36]	2024	Spain/Portugal	CS; quiz collaboration	166 students	PU, PEOU, and ATU	Teamwork and competence improved.
[37]	2024	China	Innovation Mgmt.; simulation	872 students	PU, PEOU, and ATU	Self-regulation strengthened TAM.
[38]	2024	Indonesia	Arabic; web DGBL	180 learners	PU, PEOU, and BI	Usefulness dominated acceptance.
[39]	2024	South Africa	STEM; teacher education	255 pre-service teachers	PU, PEOU, and BI	Engagement enhanced usefulness.
[40]	2024	Malaysia/Indonesia	FinTech; 3D quest	200 students	PU, PEOU, and flow	NPCs improved flow and continuance.

3. RESULTS AND DISCUSSION

3.1. Constructs of technology acceptance model

The reviewed studies examined core TAM constructs, including PEOU, PU, ATU, BI, and perceived enjoyment (PE). Although flow experience is not a traditional TAM construct, several studies incorporated it as an experiential factor influencing acceptance. Collectively, these constructs shape students' engagement with and acceptance of educational games across higher education contexts.

Across the reviewed literature, PEOU and PU emerged as foundational determinants of acceptance. Studies consistently showed that when educational games were intuitive and clearly supported learning objectives, students developed more favorable attitudes and stronger intentions to continue use [21], [22]. ATU and BI were closely linked to these cognitive evaluations, reinforcing the interconnected structure of TAM and highlighting the central role of usability and perceived instructional value in shaping acceptance [23], [41].

Beyond cognitive factors, affective and experiential constructs contributed to acceptance in specific contexts. PE was found to amplify both PU and ease of use, while flow experience, characterized by immersive concentration and time distortion, was associated with sustained engagement, particularly in simulation-based and language-learning environments [21], [40]. These findings suggest that while PU and PEOU initiate acceptance, enjoyment and flow play a critical role in maintaining continued use beyond initial adoption.

As summarized in Table 6, PU and PEOU were the most frequently examined constructs across the 20 reviewed studies, followed by BI and PE. Flow appeared less frequently and was primarily associated with simulation-based and language-learning contexts, indicating a more selective integration of experiential factors within TAM-based educational game research.

Table 7 further illustrates how TAM constructs were distributed across disciplinary contexts. PU and PEOU dominated across all domains, whereas PE and flow were incorporated more selectively, particularly in immersive or narrative-driven learning environments. This pattern reflects a continued reliance on core TAM constructs despite growing evidence of the importance of affective and experiential factors in educational gaming. Consistent with recent meta-analyses [9], these findings indicate that while motivational effects are well established, acceptance mechanisms remain underexplored.

Table 6. Frequency of TAM constructs identified across reviewed studies

Construct	Definition	Number of studies (n=20)	Percentage (%)
PU	Belief that using the game enhances learning performance.	19	95
PEOU	Belief that the game is easy to use and navigate.	18	90
BI	Intention to continue using the educational game.	17	85
ATU	Positive or negative feelings toward using the game.	13	65
PE	Enjoyment and hedonic pleasure derived from gameplay.	12	60
Flow experience	Deep immersion or "state of flow" during gameplay.	8	40

Percentages are relative to the total number of reviewed studies (n=20).

Table 7. Mapping of TAM constructs across study contexts and disciplines

Study context/discipline	PEOU	PU	ATU	BI	PE	Flow	Notable features/observations
STEM (engineering, programming, and IT)	✔✔ ✔	✔✔ ✔	✔	✔✔	✔	✔ ✔	PU–PEOU dominant; flow in programming and simulations.
Language learning (EFL and translation)	✔✔	✔✔	✔✔ ✔	✔✔ ✔	✔✔ ✔	✔	Enjoyment and ATU dominant; narrative and cultural relevance.
Business and management	✔✔	✔✔ ✔	✔	✔✔ ✔	✔✔	—	PU and BI dominant; realism and performance focus.
Health and medical sciences	✔✔ ✔	✔✔ ✔	✔	✔✔	✔	✔ ✔	Flow and PEOU salient; simulation fidelity important.
Computing/ IT education	✔✔ ✔	✔✔ ✔	✔✔	✔✔ ✔	✔✔	✔	Strong PU–PEOU–BI links; enjoyment supportive.
General/cross-disciplinary studies	✔✔	✔✔	✔	✔✔	✔✔	—	core tam focus; limited flow or contextual enjoyment.

(✔=construct included; ✔✔=strong emphasis; and ✔✔✔=dominant construct in findings)

Building on these patterns, this review proposes an extended TAM+flow to better capture acceptance dynamics in educational gaming contexts. In this framework (Figure 3), PE enhances both PU

and ease of use, while flow experience reinforces enjoyment and directly influences BI. This integration reframes TAM as a cognitive–affective–experiential model, more closely aligned with the interactive and immersive nature of educational games and better suited to explaining sustained engagement and continued use.

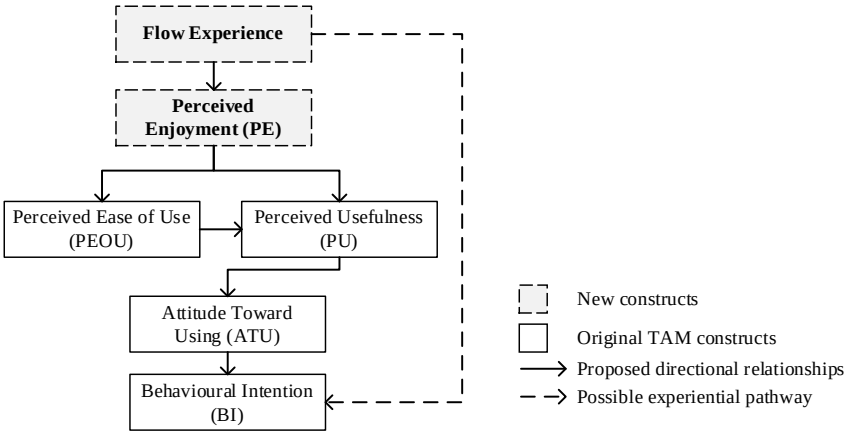

Figure 3. Extended (TAM+flow) for educational games

3.2. Factors influence the acceptance of educational games

Beyond core TAM constructs, the reviewed studies identified several contextual and design-related factors that shape students' acceptance of educational games. Instructional design emerged as a critical influence, particularly in relation to cognitive load management, feedback mechanisms, and engagement strategies. Well-designed instructional structures were shown to support sustained intention to use educational games, whereas poorly aligned or overly complex designs hindered acceptance [21]. Closely related to instructional design, technical reliability and usability were also essential, as system instability or usability issues negatively affected students' perceptions and willingness to engage.

External and contextual factors further moderated acceptance across studies. Prior gaming experience, technical proficiency, gender, and cultural background influenced how students perceived and interacted with educational games. For example, Chennault and Villanueva [23] demonstrated that gender and race or ethnicity shaped learners' experiences in engineering game-based environments, with women of color facing greater navigation challenges due to limited prior exposure. Similarly, Aljuaid *et al*. [29] emphasized the importance of culturally responsive game design in fostering acceptance, suggesting that alignment with learners' cultural identities enhances both usability perceptions and engagement.

Several studies also highlighted the importance of examining acceptance over time. Long-term impact, defined as sustained engagement and continued learning benefits, remains underexplored in the current literature. Gayao *et al*. [26] and Chen and Tang [32] both called for longitudinal research to assess whether initial acceptance translates into durable learning outcomes and skill development. Comparative and longitudinal designs were further recommended to capture changes in acceptance as students become more familiar with game-based learning environments [31].

Across the reviewed studies, variations and conflicting findings regarding acceptance were frequently observed and appeared to be context-dependent rather than contradictory. While some studies reported strong positive relationships between PU and BI [22], [41], others found more nuanced responses influenced by sociocultural alignment or disciplinary focus [23], [32]. These patterns suggest that acceptance of educational games is shaped by interacting cognitive, affective, and contextual factors, underscoring the need to interpret TAM-based findings within specific disciplinary and cultural settings rather than assuming universal applicability.

3.3. Meta-synthesis of thematic and contextual patterns

A broader meta-synthesis of the reviewed studies revealed consistent contextual and theoretical patterns across regions and game types. Studies conducted in East and Southeast Asia (e.g., Taiwan, Malaysia, and China) frequently emphasized collective learning, cultural adaptation, and contextual alignment as key determinants of acceptance. These studies often incorporated culturally relevant narratives or localized game elements, highlighting the importance of PE and ATU within predominantly collectivist educational settings. In contrast, research from western and middle-eastern contexts (e.g., Lithuania, Saudi

Arabia, and Oman) placed greater emphasis on technical usability, interface quality, and performance expectancy, with PU and PEOU emerging as dominant predictors. Together, these findings indicate that cultural context moderates the relative salience of TAM constructs in educational-game acceptance.

Distinct patterns also emerged when studies were grouped by game type and technological modality. Simulation-based games in medical, business, and engineering education frequently foregrounded flow and BI, reflecting the importance of immersion, realism, and skill transfer. Quiz and puzzle-based games, commonly used in language learning and general education, relied more heavily on PE and motivational mechanisms supported by immediate feedback and reward structures. Mobile and web-based platforms emphasized PEOU due to accessibility considerations, whereas 3D and virtual-reality environments promoted flow and engagement through experiential immersion. These cross-contextual patterns are summarized in Table 8.

Table 8. Cross-contextual patterns in TAM-based educational game acceptance

Grouping dimension	Dominant TAM constructs	Key observations	Representative studies
East and southeast Asia	PE, ATU, and BI	Cultural adaptation and collective learning emphasized	[21], [29], [38]
Western and middle east	PU and PEOU	Focus on usability and performance expectancy	[22], [28], [30]
Simulation-based games	Flow, BI, and PU	Immersion and realism enhance engagement	[27], [33], [39]
Quiz/puzzle-based games	PE, ATU, and BI	Enjoyment and motivation driven by feedback	[21], [34], [37]
3D/VR platforms	Flow and PE	Experiential immersion and interaction	[27], [35], [38]
Mobile/web platforms	PEOU and PU	Accessibility and interface simplicity	[22], [28], [32]

Synthesizing across these clusters demonstrates that acceptance of educational games is multidimensional and context-sensitive. While PU and PEOU consistently predict intention to use, their influence varies according to disciplinary goals, cultural orientations, and game design characteristics. PE and flow, although less frequently examined, play a critical mediating role in sustaining engagement, particularly in immersive or creative learning contexts. Overall, this meta-synthesis highlights the need for context-aware design and evaluation frameworks that adapt TAM constructs to diverse educational environments.

3.4. Challenges to the acceptance of educational games

Across the reviewed studies, several recurring challenges constrain the acceptance and sustained use of educational games in higher education. These challenges span technical, pedagogical, cultural, and motivational dimensions, all of which shape learners' perceptions and BI.

Technical and usability-related issues were among the most frequently reported barriers. Problems such as software instability, limited device compatibility, and unreliable internet connectivity disrupted gameplay and reduced satisfaction in multiple studies [21], [27], [28]. When systems were difficult to navigate or prone to technical failure, perceived ease of use and PU declined, underscoring the importance of stable, accessible, and user-friendly platforms for sustained adoption.

Pedagogical and design-related challenges also emerged consistently. Poorly structured games increased cognitive load or failed to sustain engagement, weakening both enjoyment and perceived learning value [21], [22], [24]. Several studies noted that once the novelty effect diminished, motivation declined if gameplay lacked adaptive progression, meaningful feedback, or alignment with course objectives. These findings highlight the importance of instructional scaffolding, dynamic feedback, and curriculum integration in supporting long-term engagement [23], [34].

Cultural relevance and inclusivity further influenced acceptance outcomes. Games that lacked culturally responsive narratives or contextual alignment were perceived as less engaging, particularly in multilingual or collectivist learning environments [21], [29], [38]. Gender and equity considerations were also evident, as learners with limited prior gaming experience, often women or students from underrepresented groups, encountered greater usability challenges and lower confidence [23]. These patterns emphasize the need for inclusive design approaches that accommodate diverse learner backgrounds and experiences.

Finally, broader structural and motivational challenges persist. Overreliance on extrinsic rewards risked undermining intrinsic motivation, while limited access to devices or stable connectivity exacerbated digital inequities across institutions [24], [39]. In addition, rapid advances in immersive and artificial intelligence-driven technologies suggest that acceptance constructs such as usefulness, ease of use, and enjoyment will continue to evolve. As a result, the present findings should be viewed as context- and time-sensitive, reinforcing the need for ongoing evaluation as educational-game technologies mature.

3.5. Methodological considerations and limitations

Beyond the thematic findings, several methodological limitations constrain the strength and generalizability of the reviewed evidence. Most studies relied primarily on self-reported survey data, increasing the risk of common method bias and potentially inflating relationships among TAM constructs. Sample characteristics also limited generalizability, as many studies involved small, single-institution cohorts concentrated in STEM or language-learning contexts.

Variation in the operationalization of the TAM further complicates cross-study comparison. While some studies examined only core TAM constructs (PU and PEOU), others incorporated selected extensions such as enjoyment, flow, or self-efficacy. This inconsistency reflects the model's adaptability but limits cumulative synthesis and comparability across disciplines and contexts. In addition, measurement instruments and cultural assumptions were often adapted without sufficient validation, potentially obscuring the experiences of learners from underrepresented or non-Western backgrounds.

These limitations highlight the need for more rigorous and coherent research designs. Future studies should adopt mixed-method and longitudinal approaches that combine self-report measures with behavioral, performance-based, and observational data. Greater attention to cultural sensitivity, inclusive sampling, and consistent TAM operationalization would strengthen the explanatory power and generalizability of acceptance research in educational gaming.

While these methodological challenges constrain interpretation, they also point to opportunities for improving both research practice and game design. The following sections translate the synthesized findings into empirically grounded design principles and discipline-specific recommendations.

Although this review followed PRISMA guidelines with a defined search window (2020–2024), several related studies published in 2025 have begun to explore emerging themes such as immersive XR environments and collaborative virtual learning spaces within educational game-like contexts. Recent TAM-based studies have examined students' acceptance of fully immersive VR simulators and collaborative VR environments in higher education, consistently reaffirming the central role of PU and ease of use in shaping behavioural intention [42], [43]. However, as these studies were published after the final search cut-off date, they were not included in the systematic synthesis.

3.6. Design principles derived from the review

Drawing on the synthesized findings, this review distills a set of actionable design principles to guide the development and evaluation of educational games in higher education. These principles operationalize core TAM constructs, PU, PEOU, PE, and BI, by linking them to concrete, pedagogically grounded design practices that support acceptance, engagement, and sustained use (Table 9). Together, they provide educators, instructional designers, and developers with a practical framework for creating inclusive and theoretically robust educational games, while supporting a design–theory feedback loop in which empirical evidence informs iterative game development.

Table 9. Design principles derived from the systematic review and their alignment with TAM constructs and intended learning outcomes

Design principle	Description	Linked TAM constructs	Intended outcome/impact
Adaptive feedback loops	Integrate real-time, performance-based feedback through hints, pacing adjustments, or scaffolded challenges to maintain optimal difficulty.	PEOU, PE, and flow	Sustains engagement and promotes continuous learning.
Culturally responsive mechanics	Incorporate culturally relevant narratives, visuals, and contexts that align with learners' identities and backgrounds.	PU and PE	Enhances PU and enjoyment, fostering inclusivity.
Intrinsic–extrinsic motivation balance	Combine intrinsic motivators (authentic problem-solving, curiosity, narrative immersion) with extrinsic rewards (points, badges).	ATU, BI, and PE	Promotes meaningful engagement without overreliance on superficial incentives.
Curriculum-integrated progression	Align game missions and objectives with course outcomes and assessment milestones.	PU and BI	Reinforces educational relevance and PU.
Accessible multi-platform design	Ensure games are device-agnostic and accessible to learners with varying abilities and technology access.	PEOU and PU	Expands equity and participation in game-based learning.
Longitudinal engagement features	Include achievement tracking, narrative continuity, or progress milestones that extend beyond a single session.	BI and PE	Sustains long-term motivation and behavioural intention.
Collaborative and social learning environments	Enable peer cooperation or competition through multiplayer or shared reflection activities.	PE, ATU, and BI	Strengthens enjoyment, motivation, and collective learning engagement.

3.7. Discipline-based clusters and context-specific design recommendations

Building on the general design principles, the reviewed studies reveal clear disciplinary variations in how TAM constructs influence educational-game acceptance. As summarized in Table 10, STEM and health disciplines emphasize PU, ease of use, and flow through technically precise and authentic simulations, whereas language-learning contexts rely more heavily on enjoyment, attitude, and cultural resonance. Business and computing domains prioritize realism, feedback, interactivity, and usability aligned with professional practice. These patterns confirm that TAM constructs operate differently across academic contexts, reinforcing the need for discipline-sensitive and context-aware design strategies rather than uniform implementation.

Table 10. Discipline-based clusters and corresponding design recommendations

Discipline cluster	Dominant TAM constructs	Key observations from studies	Specific design recommendations
STEM	PU, PEOU, and flow	Emphasis on problem-solving and conceptual understanding technical precision and challenge balance are crucial for PU.	- Integrate simulation-based challenges aligned with real-world problem contexts. - Provide adaptive feedback loops to scaffold complex reasoning. - Emphasize usability and technical reliability to sustain engagement.
Language learning (EFL/translation)	PE, ATU, and BI	Enjoyment, narrative immersion, and cultural relevance strongly affect motivation and sustained use.	- Incorporate story-driven and culturally localized content - Blend intrinsic and extrinsic motivators to maintain engagement - Enable peer interaction (e.g., cooperative dialogue or translation tasks).
Business and management (e.g., marketing, and entrepreneurship)	PU, BI, and PE	Learners emphasize realism, decision-making, and applicability to future professional contexts.	- Design scenario-based simulations mirroring workplace challenges - Use leader boards and performance analytics tied to authentic outcomes. - Encourage collaborative decision-making modules to reflect team-based work.
Health and medical sciences	PU, PEOU, and flow	Acceptance depends on clinical relevance, feedback accuracy, and perceived realism.	- Incorporate 3D or VR simulations for procedural practice - Ensure immediate corrective feedback for skills acquisition. - Simplify interfaces to minimize cognitive load.
Information technology and computing	PEOU, PU, and PE	Learners prioritize interactivity, immediate feedback, and gamified reinforcement of abstract concepts.	- Provide modular coding challenges or debugging quests. Include progress tracking and artificial intelligence-based adaptivity. - Use visual coding metaphors to enhance perceived ease of use.

4. CONCLUSION

This systematic review examined the application of the TAM in evaluating educational games in higher education. The findings confirm that TAM not only explains learners' acceptance but also serves as a design-oriented framework for enhancing engagement and learning outcomes. Across the reviewed studies, PU and PEOU consistently emerged as core predictors of acceptance, while PE and flow supported sustained engagement, particularly in immersive learning contexts.

The influence of TAM constructs varied across disciplines, cultural contexts, and technological modalities, highlighting the importance of context-aware and inclusive design approaches. Methodological limitations, including reliance on self-reported data, limited sample diversity, and inconsistent TAM operationalization, constrain cross-study comparability and point to the need for more rigorous research designs.

Future research should adopt longitudinal and mixed-method approaches to examine sustained use and learning outcomes, particularly in emerging contexts such as virtual and augmented reality and AI-enabled personalization. Overall, this review advances TAM from a descriptive acceptance model to a practical framework for designing inclusive, engaging, and pedagogically grounded educational games in higher education.

FUNDING INFORMATION

Authors state no funding involved.

AUTHOR CONTRIBUTIONS STATEMENT

This journal uses the Contributor Roles Taxonomy (CRediT) to recognize individual author contributions, reduce authorship disputes, and facilitate collaboration.

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
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O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

Authors state no conflict of interest.

DATA AVAILABILITY

The data supporting the findings of this study are derived from published studies cited in the reference list. No new datasets were generated or analyzed during the current study.

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