Online-Journals.org

iJIM International Journal of Interactive Mobile Technologies

iJIM | eISSN: 1865-7923 | Vol. 19 No. 24 (2025) | OPEN ACCESS

https://doi.org/10.3991/ijim.v19i24.59475

PAPER

Teaching Effectiveness and Student Experience in University Interactive Learning Platforms Based on Mobile Technology

Yifei Zhang (✉)

Henan Polytechnic, Zhengzhou, China

zhangyf6014@163.com

ABSTRACT

This study was conducted to investigate the intrinsic mechanisms underlying the teaching effectiveness and student experience of university interactive learning platforms supported by mobile technology. Grounded in the technology acceptance model (TAM) and contextualized within mobile learning environments, the research introduced interactivity, compatibility, self-efficacy, subjective norm, and perceived enjoyment as external variables. An extended model was thereby constructed to reveal the complete causal pathway from platform characteristics to students' cognitive perceptions, behavioral intentions, and eventual learning outcomes. A questionnaire survey was administered to university students who had utilized such platforms, yielding 250 valid responses. Structural equation modeling (SEM) was performed using SmartPLS software, with reliability and validity tests as well as bootstrapping employed to verify the proposed hypotheses. The empirical findings confirmed all 14 hypotheses. External variables such as interactivity, compatibility, and self-efficacy were identified as key antecedents influencing perceived usefulness and perceived ease of use. The core TAM pathway (perceived ease of use → perceived usefulness → attitude toward use → behavioral intention → actual use) received strong empirical support. Ultimately, actual use was found to exert a direct and significant positive effect on both student satisfaction and learning outcomes. The results demonstrated that the pedagogical value of mobile interactive platforms is realized through the process of students' technology acceptance. This study not only provides empirical evidence for the application and extension of TAM in the field of educational technology but also offers theoretical and practical implications for university administrators in optimizing digital education strategies, for educators in designing effective interactive learning activities, and for platform developers in enhancing system design.

KEYWORDS

mobile learning, interactive learning platform, technology acceptance model (TAM), teaching effectiveness, student experience, structural equation modeling (SEM)

Zhang, Y. (2025). Teaching Effectiveness and Student Experience in University Interactive Learning Platforms Based on Mobile Technology. *International Journal of Interactive Mobile Technologies (iJIM)*, 19(24), pp. 104–119. https://doi.org/10.3991/ijim.v19i24.59475

Article submitted 2025-09-12. Revision uploaded 2025-11-02. Final acceptance 2025-11-02.

1 INTRODUCTION

With the rapid development of mobile Internet technologies [1, 2] and the widespread adoption of smart devices [3, 4], higher education has been undergoing a profound process of digital transformation [5–7]. Against this backdrop, various university interactive learning platforms have emerged, characterized by their immediacy, interactivity, and ubiquity [8]. These platforms have created unprecedented opportunities to transcend the spatial and temporal constraints of traditional classroom instruction and to reconstruct a student-centered teaching paradigm. However, in practical implementation, the introduction of such platforms has not always resulted in a notable improvement in teaching quality. Their actual effectiveness has been inconsistent, and many platforms have faced the dilemma of being developed but underutilized or used yet ineffective [9]. This raises a fundamental question: beyond technological feasibility, what factors determine students' acceptance and sustained use of these platforms? Furthermore, how does such acceptance and use ultimately translate into measurable teaching effectiveness and enhanced student experience?

To address these questions systematically, the present study shifts the analytical focus from merely describing platform functionalities or superficial outcomes to examining the psychological mechanisms underlying students' adoption of new technologies. The classical TAM was adopted as the theoretical foundation, while the model was contextualized within the specific setting of mobile learning in higher education. An integrated research framework was constructed, encompassing not only the core psychological constructs of perceived usefulness, perceived ease of use, and attitude toward use, but also incorporating key external variables such as interactivity, compatibility, and perceived enjoyment. This comprehensive model was designed to elucidate the full causal pathway linking platform characteristics to students' cognitive perceptions, behavioral intentions, actual usage behaviors, and, ultimately, learning satisfaction and academic performance.

The objectives of this study were threefold. First, to accurately identify the key factors and intrinsic relationships that drive students' adoption of mobile interactive learning platforms. Second, to clarify the causal relationship between platform usage behaviors and final educational outcomes. Finally, to provide robust theoretical foundations and practical guidance for university administrators in optimizing digital education policies, for instructors in designing effective interactive teaching activities, and for platform developers in enhancing system functionality and user experience.

2 CONCEPTUAL DEFINITIONS

In this study, mobile learning is defined as a ubiquitous learning paradigm supported by portable devices such as smartphones and tablets, in combination with wireless network technologies. This mode of learning enables learners to engage in educational activities anytime and anywhere. Its core characteristics lie in mobility, contextuality, and fragmented access. The term "university interactive learning platform" specifically refers to a professional application system constructed on the basis of mobile technology and deeply integrated into the instructional process of university courses. Its primary aim is to facilitate real-time and multidimensional interactions among teaching participants as well as between participants and learning content. Such a platform is not merely a channel for information dissemination but also serves as a pivotal medium for constructing collaborative and inquiry-based learning environments. From an application perspective, the platform has evolved from an early, single-function model primarily assisting in content delivery to a hybrid instructional hub that supports a wide range of synchronous, asynchronous, and personalized learning activities. Synchronous interactions include real-time classroom functions such as live comments, voting, and group collaboration; asynchronous activities include forum-based discussions and peer assessments; while personalized learning is enabled through data-driven recommendation systems that provide adaptive learning resources and exercises tailored to individual learner progress.

The distinctive advantages of such platforms are directly linked to student experience and the research focus of this study. The anytime-anywhere accessibility eliminates temporal and spatial barriers, enhancing learning flexibility and convenience—serving as the foundation for perceived ease of use within TAM. Personalized services, which adapt to individual learners' progress and needs, greatly improve learning relevance and autonomy, thereby contributing to perceived usefulness. Furthermore, a high degree of interactivity reshapes the traditional classroom power structure by granting students greater discourse authority and a stronger sense of participation, which represents not only the platform's core value but also a crucial external variable influencing attitude toward use and behavioral intention. Nevertheless, the application of mobile interactive learning platforms also faces several challenges. From a technological standpoint, issues such as network instability and device heterogeneity may reduce perceived ease of use. From a pedagogical perspective, if interaction design becomes superficial or misaligned with instructional objectives, a decline in perceived usefulness may occur, leading to cognitive overload and engagement fatigue among students. Moreover, factors such as the digital divide, privacy concerns, and the high level of self-regulation required from students constitute potential barriers that can negatively affect teaching effectiveness and student satisfaction. These challenges underscore the necessity of conducting a systematic analysis and empirical validation through an extended TAM framework.

3 RESEARCH MODEL AND HYPOTHESIS DEVELOPMENT

The theoretical foundation of this study was established upon the TAM proposed by Davis [10, 11], with critical extensions introduced to accommodate the specific context of mobile learning in higher education. The structural framework of the extended TAM is illustrated in Figure 1. The model retains the five core constructs of TAM [12, 13], each of which has been precisely conceptualized in accordance with the present research context. Perceived ease of use refers to the degree to which students believe that using the mobile interactive learning platform requires minimal physical and cognitive effort. A platform with an intuitive interface, clear functionalities, and user-friendly design is expected to directly reduce the barriers to learning engagement. Perceived usefulness denotes the extent to which students believe that the use of the platform enhances their learning performance, such as by facilitating deeper comprehension of course content, improving learning efficiency, or achieving better academic results. These two constructs constitute the fundamental belief system driving technology acceptance. Attitude toward use represents the students' overall positive or negative affective evaluation of using the platform, shaped jointly by perceived usefulness and perceived ease of use. Behavioral intention reflects students' subjective willingness and commitment to continue and frequently use the platform in future learning activities, serving as a psychological precursor to actual behavior. Finally, actual use functions as the key behavioral variable in the model. Rather than being treated as an abstract concept, it has been operationalized through specific measurable indicators such as login frequency, number of discussion participations, and completion rate of online assessments. These quantifiable data points form a robust empirical bridge linking students' behavioral patterns to ultimate teaching effectiveness.

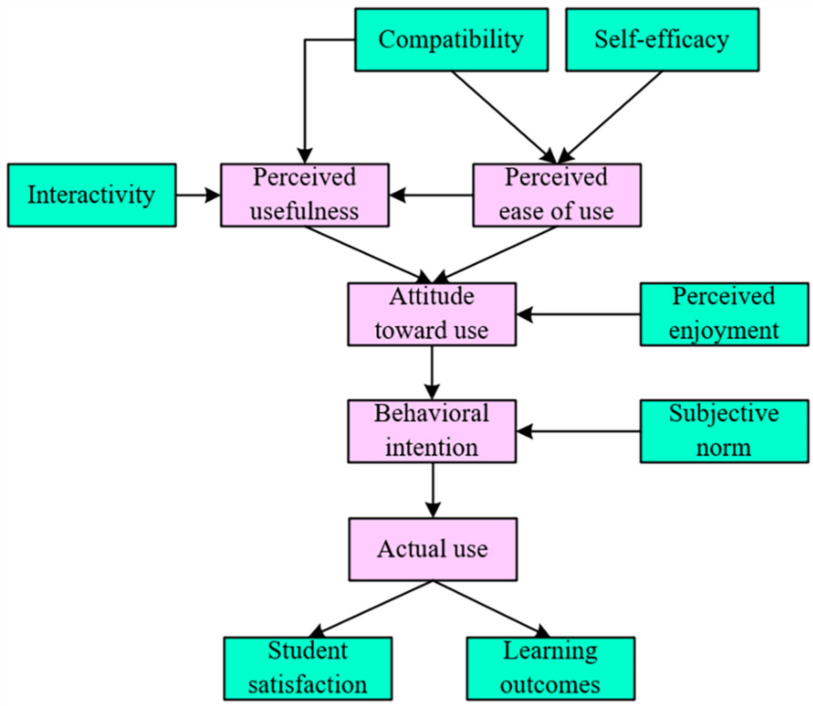

Fig. 1. Structural framework of the extended TAM

Given the limitations of the classical TAM in explaining context-specific phenomena, five external variables closely associated with mobile interactive learning were incorporated into the extended framework. Interactivity serves as the core of the platform, encompassing instructional interaction between students and instructors, social interaction among students, and cognitive interaction between students and learning content. A high level of interactivity is expected to directly enhance both perceived usefulness and perceived ease of use. Compatibility, derived from the Diffusion of Innovations Theory, refers to the degree to which the platform's mode of use aligns with students' existing learning habits, course requirements, and personal values. A highly compatible platform can be seamlessly integrated into students' learning processes, thereby improving both their perceptions of ease of use and usefulness. Self-efficacy, a central construct in Social Cognitive Theory, denotes the degree of confidence students possess in their ability to successfully use the platform to accomplish learning tasks. This confidence forms the psychological foundation for overcoming initial technological barriers and developing a strong perception of ease of use. Subjective norm, originating from the Theory of Reasoned Action, represents the perceived social pressure exerted by significant others who believe that the student should or should not use the platform. This social influence exerts a direct effect on students' behavioral intention. Perceived enjoyment emphasizes the platform's intrinsic motivational function. A platform that features engaging design, stimulating interactive forms, and elements that evoke curiosity can directly foster a positive attitude toward use among students.

The model's dependent variables—teaching effectiveness and student experience—were operationalized as two measurable constructs. Student satisfaction is defined as a purely subjective experience and affective response, representing an overall evaluation of students' satisfaction and enjoyment derived from learning through the mobile platform. Learning outcomes, on the other hand, constitute a more objective result variable that can be assessed in two ways: (a) through students' self-reported perceived learning gains, and (b) when possible, by incorporating objective indicators such as final course grades, project scores, or other academic performance measures. This dual approach enables a more comprehensive evaluation of the platform's substantive impact on students' knowledge acquisition and skill development.

Based on the constructed research model, a series of structured hypotheses were formulated. The hypothesis framework begins with the influence of external variables on the core constructs of the TAM:

- H1: Interactivity exerts a significant positive effect on perceived usefulness.
- H2: Interactivity exerts a significant positive effect on perceived ease of use.
- H3: Compatibility exerts a significant positive effect on perceived usefulness.
- H4: Compatibility exerts a significant positive effect on perceived ease of use.
- H5: Self-efficacy exerts a significant positive effect on perceived ease of use.
- H6: Subjective norm exerts a significant positive effect on behavioral intention.
- H7: Perceived enjoyment exerts a significant positive effect on attitude toward use.

Subsequently, the hypotheses follow the intrinsic pathways of the classical TAM:

- H8: Perceived ease of use exerts a significant positive effect on perceived usefulness.
- H9: Perceived ease of use exerts a significant positive effect on attitude toward use.
- H10: Perceived usefulness exerts a significant positive effect on attitude toward use.
- H11: Attitude toward use exerts a significant positive effect on behavioral intention.
- H12: Behavioral intention exerts a significant positive effect on actual use.

Finally, all causal chains converge on the ultimate focus of this study—teaching effectiveness:

- H13: Actual use exerts a significant positive effect on student satisfaction.
- H14: Actual use exerts a significant positive effect on learning outcomes.

This comprehensive hypothesis framework forms a logically cohesive empirical research loop that progresses from why acceptance occurs, to how acceptance develops, and finally to what outcomes acceptance produces. It is intended to deeply reveal the intrinsic mechanisms through which mobile interactive learning platforms enhance teaching effectiveness and optimize student experience.

4 RESEARCH DESIGN AND METHODS

4.1 Research design

A quantitative research design based primarily on the questionnaire survey method [14] was adopted to empirically test the extended TAM developed in this study. To ensure the reliability and validity of the measurement instrument, the questionnaire items corresponding to the core TAM constructs—perceived usefulness, perceived ease of use, attitude toward use, behavioral intention, and actual use—as well as the external variables—interactivity, compatibility, self-efficacy, subjective norm, and perceived enjoyment—were primarily adapted from established scales published in both domestic and international research. Appropriate modifications in wording were made to fit the specific context of university mobile interactive learning platforms. For instance, the general term "the system" in previous scales was replaced with "the university interactive learning platform used in this course." The final section of the questionnaire focused on the dependent variables, incorporating items measuring student satisfaction and learning outcomes. The latter included both a self-reported learning gain scale and an optional entry for objective academic performance indicators. All latent variable items were measured using a five-point Likert scale [15], ranging from 1 (strongly disagree) to 5 (strongly agree). Prior to large-scale distribution, a pilot study was conducted with a small group of students. Interviews and preliminary data analysis were performed to refine the clarity and contextual appropriateness of the items. The final version of the questionnaire, optimized through this process, was then employed for formal data collection. Table 1 presents the specific measurement items corresponding to each construct in the formal questionnaire.

Table 1. Variable measurement items of the formal questionnaire

Latent Variable	Measurement Items (Simplified Codes; Full Sentences used in the Actual Questionnaire)
PU	PU1: Using the platform helps me master course content more effectively.
	PU2: Using the platform improves my learning efficiency.
	PU3: Using the platform contributes to the improvement of my course performance.
PEU	PEU1: Learning how to use the platform is easy for me.
	PEU2: The platform interface is clear, and its operation is simple and intuitive.
	PEU3: I can proficiently use the platform to complete various learning tasks.
INT	INT1: The platform allows convenient communication and questioning with instructors.
	INT2: The platform allows convenient discussion and collaboration with peers.
	INT3: The interactive features of the platform enhance my understanding of course content.
COM	COM1: Using the platform aligns with my usual learning habits.
	COM2: The platform's functions meet the learning requirements of this course well.
	COM3: Engaging in course interaction through the mobile platform is an appropriate learning approach.

(Continued)

Table 1. Variable measurement items of the formal questionnaire *(Continued)*

Latent Variable	Measurement Items (Simplified Codes; Full Sentences used in the Actual Questionnaire)
SE	SE1: I am confident in my ability to use the platform to complete learning activities.
	SE2: Even without guidance, I am confident in learning how to use the platform independently.
	SE3: I am capable of resolving most technical issues encountered when using the platform.
SN	SN1: Peers who influence me believe that I should use the platform.
	SN2: The course instructor encourages and expects the use of the platform.
	SN3: The majority of my peers use the platform, which creates social pressure for me to do the same.
PEN	PEN1: I find learning through the platform to be enjoyable.
	PEN2: The interactive features of the platform (e.g., quizzes and live comments) are appealing to me.
	PEN3: When using the platform, I often become immersed and lose track of time.
AT	AT1: Using the platform for learning is a good idea.
	AT2: I like the way learning is conducted through the platform.
	AT3: Overall, I hold a positive and affirmative attitude toward using the platform.
BI	BI1: I am willing to continue using the platform in future learning activities.
	BI2: If possible, I intend to increase the frequency of my platform use.
	BI3: I will recommend the platform to other students.
AU	AU1: I frequently use the platform for course-related activities.
	AU2: I make extensive use of most core features provided by the platform.
	AU3: I actively participate on the platform rather than engaging passively.
SAT	SAT1: Overall, I am satisfied with my experience of using the platform.
	SAT2: Compared with my expectations, the platform provides a pleasant learning experience.
	SAT3: If possible, I would prefer instructors to continue using the platform in future courses.
LE	LE1: The platform has deepened my understanding of the core concepts of the course.
	LE2: The platform has improved my ability to analyze and solve course-related problems.
	LE3: The platform has enabled me to gain inspiration through increased interaction with instructors and peers.
	LE4 (optional): Please provide your (expected) final grade for this course.

Notes: PU indicates perceived usefulness; PEU indicates perceived ease of use; AT indicates attitude toward use; BI indicates behavioral intention; AU indicates actual use; INT indicates interactivity; COM indicates compatibility; SE indicates self-efficacy; SN indicates subjective norm; PEN indicates perceived enjoyment; SAT indicates student satisfaction; and LE indicates learning outcomes.

4.2 Data collection and sample characteristics

Table 2 presents the demographic characteristics and basic distribution of platform usage among the valid sample (N = 250). The data indicate a relatively balanced gender distribution, with juniors comprising the largest proportion by academic year. In terms of disciplinary background, students majoring in science and engineering, as well as in economics and management, constituted the majority, providing a suitable foundation for comparative analysis of experiential differences across academic domains. Regarding platform utilization, Chaoxing Learning App and Yuketang were identified as the two most frequently used platforms, collectively accounting for nearly 90% of the sample—demonstrating strong representativeness of mainstream university learning systems. In terms of usage behavior, 47.2% of students reported using the platform two to three times per week, while the vast majority (77.2%) spent less than 30 minutes per session. This pattern clearly illustrates the defining characteristic of mobile interactive learning platforms as "high-frequency but short-duration" tools that function primarily as supplementary teaching aids rather than immersive long-session environments. The detailed frequency and percentage data not only enhance the transparency and scientific rigor of the sample description but also provide a solid empirical foundation for subsequent subgroup comparisons—such as analyzing variations in student satisfaction across different usage frequencies—or for integrating them as control variables in the model analysis.

Table 2. Description of demographic variables (N = 250)

Variable Category	Option	Frequency	Percentage (%)	Variable Category	Option	Frequency	Percentage (%)
Gender	Male	112	44.8%	Primary platforms used	Chaoxing Learning App	145	58.0%
	Female	138	55.2%		Yuketang	73	29.2%
	Other	0	0.0%		Ketangpai	18	7.2%
Academic year	Freshman	48	19.2%		Zhihuishu	9	3.6%
	Sophomore	67	26.8%		Others	5	2.0%
	Junior	82	32.8%	Average weekly usage frequency	Almost daily	35	14.0%
	Senior	43	17.2%		2–3 times per week	118	47.2%
	Postgraduate or above	10	4.0%		Once per week	65	26.0%
Discipline category	Science and engineering	95	38.0%		Once every two weeks	25	10.0%
	Economics and management	63	25.2%		Once per month or less	7	2.8%
	Humanities and social sciences	58	23.2%	Typical duration per session	Within 15 minutes	88	35.2%
	Arts and physical education	22	8.8%		15–30 minutes	105	42.0%
	Medical sciences	12	4.8%		30 minutes–1 hour	45	18.0%
	Other	0	0.0%		Over 1 hour	12	4.8%

4.3 Model evaluation

To rigorously validate the extended TAM developed in this study and to test the proposed hypotheses, a systematic quantitative analytical procedure was implemented. Initially, the appropriateness of the collected questionnaire data was examined. The Kaiser–Meyer–Olkin (KMO) measure yielded a value of 0.923, and the Bartlett's Test of Sphericity reached a high level of significance ($p < 0.001$). These results indicated strong correlations among the variables, confirming that the data were highly suitable for factor analysis. Subsequently, SmartPLS 3.3.9 software [16] was employed as the principal analytical tool. This choice was based on its robust capability to handle complex models and its strong emphasis on theoretical prediction, aligning precisely with the study's objective of explaining and predicting students' adoption behavior and instructional effectiveness.

The model evaluation was conducted in two stages. In the first stage, the reliability and validity of the measurement model were systematically assessed through indicators such as composite reliability (CR), factor loadings, and average variance extracted (AVE), ensuring the accuracy and consistency of latent variable measurement. Based on this foundation, the second stage involved significance testing of the path coefficients within the structural model by applying the bootstrapping resampling method with 5,000 iterations. This procedure enabled the formulation of objective and statistically robust conclusions regarding all research hypotheses proposed earlier.

1. Reliability and validity

Table 3. Reliability and convergent validity analysis of variables

Latent Variable	Cronbach's α	CR	AVE	Latent Variable	Cronbach's α	CR	AVE
Perceived usefulness	0.891	0.931	0.818	Perceived enjoyment	0.893	0.933	0.821
Perceived ease of use	0.902	0.937	0.832	Attitude toward use	0.908	0.941	0.840
Interactivity	0.885	0.926	0.807	Behavioral intention	0.882	0.925	0.804
Compatibility	0.869	0.917	0.787	Actual use	0.871	0.919	0.790
Self-efficacy	0.874	0.921	0.795	Student satisfaction	0.897	0.936	0.829
Subjective norm	0.846	0.904	0.756	Learning outcomes	0.868	0.916	0.785

The results presented in Tables 3 and 4 jointly demonstrate the reliability and validity of the measurement model. As shown in Table 3, all latent constructs exhibited Cronbach's α and CR values exceeding the recommended threshold of 0.70, confirming the internal consistency of the measurement scale. Similarly, AVE for each construct surpassed 0.50, providing strong evidence of convergent validity, indicating that the observed items effectively converged on their respective latent variables. Table 4 further assessed discriminant validity. The results indicated that the square root of AVE for each latent variable exceeded the Pearson correlation coefficients between that variable and any other construct. This finding provides compelling support for the discriminant validity of the measurement model, signifying that while moderate correlations existed among constructs, they remained statistically distinct and conceptually independent, thereby establishing a solid foundation for subsequent structural model analysis and hypothesis testing.

Table 4. Pearson correlation coefficients and square roots of AVE values

Variable	PU	PEU	INT	COM	SE	SN	PEN	AT	BI	AU	SAT	LE
PU	0.904											
PEU	0.621	0.912										
INT	0.587	0.554	0.898									
COM	0.602	0.645	0.533	0.887								
SE	0.445	0.598	0.412	0.487	0.892							
SN	0.392	0.365	0.478	0.401	0.288	0.869						
PEN	0.512	0.523	0.612	0.495	0.376	0.445	0.906					
AT	0.674	0.587	0.589	0.578	0.451	0.423	0.665	0.917				
BI	0.632	0.554	0.545	0.562	0.433	0.512	0.587	0.724	0.898			
AU	0.598	0.523	0.521	0.534	0.409	0.487	0.554	0.645	0.701	0.889		
SAT	0.645	0.567	0.598	0.589	0.445	0.423	0.612	0.754	0.687	0.632	0.911	
LE	0.587	0.501	0.512	0.523	0.387	0.365	0.523	0.621	0.598	0.587	0.689	0.886

2. Outer loadings and cross-loadings

Table 5. Matrix of outer loadings and cross-loadings for each construct

Item	PU	PEU	INT	COM	SE	SN	PEN	AT	BI	AU	SAT	LE
PU1	0.901	0.547	0.512	0.525	0.382	0.341	0.452	0.589	0.556	0.523	0.568	0.512
PU2	0.914	0.582	0.531	0.554	0.401	0.365	0.478	0.612	0.578	0.545	0.589	0.534
PU3	0.902	0.556	0.523	0.543	0.394	0.352	0.465	0.601	0.567	0.534	0.576	0.521
PEU1	0.541	0.908	0.487	0.567	0.523	0.321	0.465	0.512	0.489	0.456	0.501	0.443
PEU2	0.587	0.924	0.512	0.598	0.554	0.345	0.501	0.545	0.523	0.487	0.534	0.478
PEU3	0.565	0.905	0.498	0.589	0.567	0.332	0.487	0.523	0.501	0.465	0.512	0.456
INT1	0.512	0.478	0.895	0.465	0.365	0.412	0.534	0.512	0.476	0.454	0.523	0.465
INT2	0.523	0.501	0.901	0.478	0.378	0.423	0.556	0.534	0.498	0.476	0.545	0.487
INT3	0.534	0.512	0.898	0.487	0.387	0.432	0.567	0.556	0.523	0.501	0.556	0.498
COM1	0.534	0.589	0.465	0.892	0.432	0.354	0.432	0.512	0.512	0.487	0.523	0.476
COM2	0.556	0.612	0.487	0.901	0.445	0.376	0.465	0.545	0.545	0.523	0.556	0.501
COM3	0.543	0.598	0.476	0.887	0.423	0.365	0.445	0.534	0.534	0.512	0.545	0.487
SE1	0.398	0.543	0.365	0.432	0.889	0.243	0.321	0.398	0.387	0.365	0.398	0.343
SE2	0.412	0.567	0.378	0.445	0.901	0.265	0.343	0.412	0.401	0.387	0.423	0.365
SE3	0.387	0.556	0.354	0.423	0.887	0.232	0.332	0.387	0.376	0.354	0.412	0.354
SN1	0.345	0.321	0.412	0.354	0.232	0.865	0.376	0.365	0.445	0.432	0.365	0.321
SN2	0.365	0.332	0.432	0.376	0.254	0.878	0.401	0.387	0.476	0.465	0.387	0.343
SN3	0.354	0.343	0.423	0.365	0.243	0.865	0.387	0.376	0.465	0.454	0.376	0.332
PEN1	0.465	0.487	0.567	0.465	0.332	0.401	0.912	0.589	0.523	0.498	0.556	0.476

(Continued)

Table 5. Matrix of outer loadings and cross-loadings for each construct *(Continued)*

Item	PU	PEU	INT	COM	SE	SN	PEN	AT	BI	AU	SAT	LE
PEN2	0.478	0.501	0.578	0.478	0.343	0.412	0.908	0.601	0.534	0.512	0.567	0.487
PEN3	0.487	0.512	0.556	0.487	0.354	0.398	0.899	0.578	0.523	0.501	0.556	0.476
AT1	0.598	0.523	0.534	0.534	0.401	0.376	0.589	0.921	0.645	0.567	0.678	0.556
AT2	0.612	0.545	0.556	0.556	0.412	0.387	0.612	0.924	0.667	0.589	0.689	0.567
AT3	0.601	0.534	0.545	0.545	0.398	0.376	0.601	0.907	0.645	0.578	0.667	0.556
BI1	0.567	0.501	0.512	0.534	0.387	0.465	0.534	0.656	0.901	0.623	0.612	0.543
BI2	0.589	0.523	0.523	0.556	0.401	0.487	0.556	0.689	0.905	0.645	0.634	0.567
BI3	0.578	0.512	0.523	0.545	0.398	0.476	0.545	0.667	0.889	0.623	0.623	0.556
AU1	0.545	0.487	0.501	0.523	0.376	0.454	0.512	0.589	0.634	0.895	0.567	0.534
AU2	0.556	0.498	0.512	0.534	0.387	0.465	0.523	0.601	0.645	0.901	0.578	0.545
AU3	0.534	0.476	0.498	0.512	0.365	0.443	0.501	0.567	0.623	0.887	0.556	0.523
SAT1	0.589	0.534	0.556	0.556	0.412	0.387	0.578	0.689	0.623	0.578	0.918	0.612
SAT2	0.601	0.545	0.567	0.567	0.423	0.398	0.589	0.701	0.634	0.589	0.922	0.623
SAT3	0.578	0.523	0.556	0.556	0.401	0.376	0.567	0.678	0.612	0.567	0.907	0.601
LE1	0.534	0.476	0.487	0.512	0.354	0.332	0.487	0.556	0.556	0.545	0.612	0.891
LE2	0.523	0.465	0.476	0.501	0.343	0.321	0.476	0.545	0.545	0.534	0.601	0.889
LE3	0.512	0.454	0.465	0.487	0.332	0.310	0.465	0.534	0.534	0.523	0.589	0.887
LE4	0.498	0.443	0.454	0.476	0.321	0.298	0.454	0.523	0.523	0.512	0.578	0.878

Notes: PU indicates perceived usefulness; PEU indicates perceived ease of use; AT indicates attitude toward use; BI indicates behavioral intention; AU indicates actual use; INT indicates interactivity; COM indicates compatibility; SE indicates self-efficacy; SN indicates subjective norm; PEN indicates perceived enjoyment; SAT indicates student satisfaction; and LE indicates learning outcomes.

The cross-loading matrix presented in Table 5 provides the most detailed and compelling evidence of the discriminant validity of the measurement model. As shown in the table, all measurement items exhibited outer loadings on their designated latent constructs substantially higher than the recommended threshold of 0.70 and consistently greater than their cross-loadings on any other constructs. For instance, the items associated with perceived usefulness—namely PU1, PU2, and PU3—displayed loadings of 0.901, 0.914, and 0.902, respectively, on the PU construct, while their cross-loadings on other factors were considerably lower. This pattern was consistently observed across all measurement items, indicating that each item was most strongly associated with its theoretically assigned latent construct while being clearly differentiated from others. Such results provide robust empirical confirmation of the discriminant validity of the measurement model, demonstrating that each construct is unique and independently measured by its corresponding indicators, thereby ensuring the reliability and precision of the path coefficient testing results in the structural model analysis.

3. Structural model

Table 6 presents the path coefficients and significance testing results of the structural model, which were obtained through bootstrapping with 5,000 resamples. These results provide direct empirical answers to the core research questions of this study. The data indicate that all 14 hypotheses achieved statistical significance, with p-values less than 0.05. Specifically, the classical TAM pathways (H1–H5) were fully supported, reaffirming the theoretical stability of the model under mobile learning environments. Among them, the path from behavioral intention to actual use exhibited the highest coefficient ($\beta = 0.584$), suggesting that behavioral intention serves as the most direct antecedent of actual engagement behavior. The extended external variables demonstrated substantial explanatory power. Both interactivity and compatibility exerted significant positive effects on students' perceptions of perceived usefulness and perceived ease of use, with compatibility showing a particularly strong impact on ease of use ($\beta = 0.354$). This finding implies that the degree of alignment between the platform and existing learning processes is a crucial factor in reducing perceived barriers to adoption. In addition, perceived enjoyment was found to significantly influence attitude toward use ($\beta = 0.278$), highlighting the pivotal role of affective factors in technology acceptance. Finally, the model's key outcome paths revealed that actual use exerted strong positive effects on both student satisfaction ($\beta = 0.487$) and learning outcomes ($\beta = 0.412$). These results provide robust empirical evidence that mobile technology–based interactive learning platforms can effectively enhance instructional effectiveness and optimize the learning experience. Consequently, the findings substantiate the central objective of this study.

Table 6. Path coefficients and hypothesis testing results of the structural model

Hypothesis	Path Relationship	Path Coefficient (β)	t-Statistic	p-Value	Supported
H1	Perceived ease of use → perceived usefulness	0.421	8.912	0.000	Yes
H2	Perceived ease of use → attitude toward use	0.198	4.123	0.000	Yes
H3	Perceived usefulness → attitude toward use	0.387	7.845	0.000	Yes
H4	Attitude toward use → behavioral intention	0.532	12.156	0.000	Yes
H5	Behavioral intention → actual use	0.584	14.278	0.000	Yes
H6	Interactivity → perceived usefulness	0.245	5.234	0.000	Yes
H7	Interactivity → perceived ease of use	0.187	3.876	0.000	Yes
H8	Compatibility → perceived usefulness	0.268	5.789	0.000	Yes
H9	Compatibility → perceived ease of use	0.354	7.112	0.000	Yes
H10	Self-efficacy → perceived ease of use	0.296	6.345	0.000	Yes
H11	Subjective norm → behavioral intention	0.165	3.456	0.001	Yes
H12	Perceived enjoyment → attitude toward use	0.278	5.967	0.000	Yes

(Continued)

Table 6. Path coefficients and hypothesis testing results of the structural model *(Continued)*

Hypothesis	Path Relationship	Path Coefficient (β)	t-Statistic	p-Value	Supported
H13	Actual use → student satisfaction	0.487	10.892	0.000	Yes
H14	Actual use → learning outcomes	0.412	8.765	0.000	Yes

Notes: Bootstrapping with 5,000 resamples was employed; significance is achieved when the t-statistic is > 1.96 and the p-value is < 0.05.

5 DISCUSSION

Through empirical testing based on the extended TAM, all 14 proposed hypotheses were statistically supported. This outcome provides strong evidence for the internal mechanism by which university interactive learning platforms are accepted by students and ultimately influence instructional effectiveness. The core findings indicate that external variables—namely interactivity, compatibility, and self-efficacy—serve as key antecedents driving the formation of perceived usefulness and perceived ease of use. These two central beliefs subsequently shape attitude toward use and behavioral intention, which are ultimately transformed into actual use behavior. The latter exerts a significant positive impact on student satisfaction and learning outcomes. This complete and empirically validated pathway demonstrates that the proposed model possesses strong explanatory and predictive power in understanding student behavior and learning experiences in mobile learning environments.

A deeper examination of the results reveals several important insights. First, the strong influence of interactivity on perceived usefulness ($\beta = 0.245$, $p < 0.001$) confirms that students do not perceive the platform merely as a digital repository of course materials but rather value its multidimensional interactive functions—real-time communication with instructors, collaborative inquiry with peers, and immersive engagement with learning content—all of which directly enhance learning efficiency and cognitive depth. Second, the significant effect of compatibility on perceived ease of use ($\beta = 0.354$, $p < 0.001$) proves particularly noteworthy. This finding suggests that when the platform's functional logic and operational flow are highly aligned with students' familiar classroom routines and task requirements, the technology itself becomes "invisible," allowing cognitive resources to be fully devoted to the learning process rather than tool manipulation. In addition, the positive impact of perceived enjoyment on attitude toward use ($\beta = 0.278$, $p < 0.001$) highlights that pedagogical designs integrating elements of gamification and interactive enjoyment can effectively stimulate intrinsic motivations. Finally, the direct influence of actual use on learning outcomes ($\beta = 0.412$, $p < 0.001$) represents the central conclusion of this study. This finding empirically verifies that mobile interactive learning platforms are not superficial technological innovations but rather effective tools capable of substantively enhancing students' mastery of knowledge and development of academic competencies through sustained and meaningful engagement.

From a theoretical perspective, this study successfully extends the application context of the classical TAM from general information technologies to a specific, interaction-centered mobile learning environment in higher education. By introducing two key variables—interactivity and compatibility—which are closely related to instructional practice, and empirically validating their roles as critical antecedents of the model's core beliefs, the theoretical connotation of TAM has been enriched and further developed. This advancement provides a more explanatory integrative framework for applying TAM within the field of educational technology.

Building upon these findings, several significant practical implications can be derived. For platform developers, priority should be given to the creation of products that emphasize deep interactivity and seamless compatibility with mainstream instructional processes. The design of user interfaces should aim to minimize operational barriers through intuitive functionality, while the incorporation of moderate enjoyment-oriented elements can enhance user engagement and retention. For front-line instructors, the effective activation of platform functions is essential. Interactive instructional activities should be deliberately designed around platform capabilities, and the perceived usefulness of platform use in achieving learning objectives should be explicitly communicated to students. Such instructional guidance can foster a more positive attitude toward use. For university administrators, the implementation of mobile interaction platforms should not be confined to the provision of robust technical support alone. Training initiatives should be organized for both faculty and students. These programs should focus on enhancing self-efficacy and demonstrating best practices in platform utilization to eliminate adoption barriers, thereby ensuring that technological investments can be effectively transformed into improvements in teaching quality.

6 CONCLUSION

Through the construction and validation of an extended TAM, the intrinsic mechanisms influencing both the instructional effectiveness and student experience of university interactive learning platforms were systematically revealed. The principal findings confirm that the success of such platforms does not merely depend on technological functionality but rather emerges from a continuous causal chain linking external driving factors, internal cognitive perceptions, and ultimate learning outcomes. Specifically, interactivity, compatibility, self-efficacy, and perceived enjoyment—as external variables—were found to significantly influence students' perceived usefulness and perceived ease of use. These two beliefs subsequently shape attitude toward use and behavioral intention, which in turn drive actual use behavior. This behavioral outcome exerts a direct and substantial positive effect on both student satisfaction and learning outcomes. From an empirical standpoint, these results verify that scientifically designed and effectively implemented mobile interactive platforms can serve as powerful instruments for enhancing the quality of higher education.

Despite the valuable insights yielded, several limitations remain, offering directions for future research. First, as the sample was primarily drawn from a limited number of universities, the issue of sample homogeneity may exist. Future investigations could expand the sampling scope to include institutions of different regions and types in order to enhance the generalizability of the findings. Second, as cross-sectional data were employed, the analysis reflects conditions at a single point in time, preventing the capture of dynamic changes in students' attitudes and learning outcomes. Longitudinal studies could therefore be conducted to examine the sustained effects of platform use. Third, the data were largely derived from self-reported measures, which may be influenced by social desirability bias. To strengthen the robustness of the conclusions, future research should incorporate objective behavioral data from platform back-end analytics—such as login logs, interaction frequencies, and content access trajectories—for triangulation. Finally, contextual factors such as teaching style and course type (e.g., theoretical versus practical courses) were not explicitly considered in the current model. Integrating these moderating variables would provide a more nuanced understanding of how mobile interactive platforms exert differentiated effects across varied instructional contexts.

7 REFERENCES

[1] N. Sun and Y. Zang, "Innovative applications and teaching effectiveness analysis of interactive mobile technology in music education," *International Journal of Interactive Mobile Technologies*, vol. 19, no. 1, pp. 93–106, 2025. https://doi.org/10.3991/ijim.v19i01.53497

[2] M. S. Uddin, W. Slany, and K. J. Hasan, "On-device neural network for object train and recognition using mobile," *International Journal of Interactive Mobile Technologies (iJIM)*, vol. 18, no. 12, pp. 99–111, 2024. https://doi.org/10.3991/ijim.v18i12.47895

[3] S. Kryshtanovych, O. Inozemtseva, O. Voloshyna, I. Ostapiovska, and O. Dubrova, "Modeling the effective digitalization of the education management system in the context of sustainable development," *International Journal of Sustainable Development and Planning*, vol. 18, no. 5, pp. 1507–1514, 2023. https://doi.org/10.18280/ijsdp.180521

[4] A. A. Adegbenjo *et al.*, "Design and analysis of an automated IoT system for data flow optimization in higher education institutions," *Journal Européen des Systèmes Automatisés*, vol. 56, no. 5, pp. 889–897, 2023. https://doi.org/10.18280/jesa.560520

[5] V. Ducl, E. Çaro, and M. Kapllanaj, "Integrating ICT in vocational education and training: Expectations, challenges, and the path towards modernisation," *Journal of Research, Innovation and Technologies*, vol. 3, no. 2, pp. 109–118, 2024. https://doi.org/10.57017/jorit.v3.2(6).02

[6] J. Rosak-Szyrocka, "Engineering the future of higher education: A VOSviewer analysis of smart university trends in the digitalization and Industry 5.0 era," *Management Systems in Production Engineering*, vol. 33, no. 1, pp. 8–23, 2025. https://doi.org/10.2478/mspe-2025-0002

[7] M. Cristea, G. G. Noja, T. A. Găinaru, and C. D. Tălăban, "Digital transformation and its implications on educational quality: An empirical analysis within the European Union context," *Opportunities and Challenges in Sustainability*, vol. 2, no. 3, pp. 130–140, 2023. https://doi.org/10.56578/ocs020302

[8] G. H. Ma, "Modeling the influencing factors of EFL learners' online interactive learning: A grounded theory approach," *Chinese Journal of Applied Linguistics*, vol. 48, no. 3, pp. 401–424, 2025. https://doi.org/10.1515/CJAL-2025-0307

[9] P. Kruachottikul *et al.*, "Immersive learning environment platform: ChulaVerse's 3D interactive university," *Engineering Journal*, vol. 29, no. 7, pp. 17–33, 2025. https://doi.org/10.4186/ej.2025.29.7.17

[10] Y. K. Huang, J. K. Liang, and C. C. Lu, "Bus drivers' intention to accept level 4 autonomous buses in ethical dilemmas: An extended technology acceptance model," *Travel Behaviour and Society*, vol. 42, p. 101143, 2026. https://doi.org/10.1016/j.tbs.2025.101143

[11] V. S. Diwanji, "Should your brand hire virtual influencers? How realism and gender presentation shape trust and purchase intentions," *Journal of Retailing and Consumer Services*, vol. 88, p. 104491, 2026. https://doi.org/10.1016/j.jretconser.2025.104491

[12] S. M. Xu, C. K. Lo, M. H. Ling, and G. W. Chen, "Leveraging generative AI in a 3D scenario-based game for vocabulary acquisition and conversation practice: Insights from primary EFL educators through the technology acceptance model," *Cogent Education*, vol. 12, no. 1, p. 2560059, 2025. https://doi.org/10.1080/2331186X.2025.2560059

[13] M. Razzouki, S. B. Hammou, and M. Izenzal, "The adoption and effective use of artificial intelligence in Moroccan higher education: The moderating role of trust," *Cogent Education*, vol. 12, no. 1, p. 2553829, 2025. https://doi.org/10.1080/2331186X.2025.2553829

[14] S. Zhao *et al.,* "Research on key factors influencing public acceptance of nuclear facilities decommissioning projects," *Nuclear Engineering and Technology*, vol. 58, no. 1, p. 103885, 2026. https://doi.org/10.1016/j.net.2025.103885

[15] M. Rodríguez-Enríquez, D. Álvarez-García, S. Rodríguez-Alvarado, and M. Ares-Ferreirós, "Validation of a computerized version of Harter's social support scale in preadolescents and adolescents," *Revista de Psicología Clínica con Ninos y Adolescentes*, vol. 13, no. 1, pp. 33–42, 2026. https://doi.org/10.21134/rpcna.2026.13.1.3

[16] U. Ludigdo *et al.*, "A dual-theory approach to corporate social responsibility development: Upper echelons theory and religiosity-based ethics in Indonesian Muslim entrepreneurship," *Cogent Social Sciences*, vol. 11, no. 1, p. 2563037, 2025. https://doi.org/10.1080/23311886.2025.2563037

8 AUTHOR

Yifei Zhang graduated from Northwest A&F University in 2004 and works at the School of Economics and Management, Henan Polytechnic, Zhengzhou 45000, China. He is engaged in the research of business administration and has obtained Henan Province higher vocational education teaching ability competition first prize. He published "Foundation of Management" has been approved as a high-quality online open course for vocational education and continuing education in Henan Province (E-mail: zhangyf6014@163.com).