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Article

A Case Study on the Effects of Blended Learning on College Students' Learning Motivation and Learning Outcomes ——Using the Zhihuishu Online Learning Platform as a Case

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Abstract: With the development of online education platforms, college students have widely engaged in blended teaching that combines online tools with face-to-face classes. Although research on online courses has surged, case studies focused on how college students actually use online platforms remain limited. Using Zhihuishu as a case, this study collected 289 questionnaires (270 valid users of the platform) and applied descriptive statistics, structural equation modeling (SEM), and chain mediation analysis to examine blended-learning motivation for using the platform, patterns of use and perceived experience, and how these relate to learning outcomes, including the differential roles of intrinsic and extrinsic motivation. Findings indicate a clear differentiation in learning motivations: career development needs are the strongest driver, while the extrinsic motive of "studying under pressure" exhibits marked polarization. Regarding outcomes, knowledge transfer is rated highest, whereas perceived improvements in comprehensive competencies are lowest and strongly polarized. SEM shows that better user experience significantly boosts learning outcomes; by contrast, the direct effect of platform usage on outcomes is insignificant, suggesting that merely adding features does not translate into gains. The chain mediation test further shows that extrinsic motivation increases platform use but does not form an effective transmission chain; intrinsic motivation, however, improves outcomes directly. Based on the statistics, we recommend strengthening career-oriented drivers by adding case-based resources; designing more engaging interactions to motivate passive learners; and prioritizing user-experience optimization to convert motivation into achievement.

Keywords: Blended learning; Learning motivation; Learning outcomes; Structural equation modeling; Zhihuishu platform

1. Introduction

With the rapid development of information technology, online learning platforms have multiplied and were widely adopted during the pandemic. Blended learning that integrates online and offline teaching has gradually become a major model in education. It combines traditional face-to-face instruction with online learning to enhance students' experience and outcomes through flexible modalities and depends heavily on feature-complete smart-teaching platforms. Internationally, Sakai and Google Classroom are widely used; in China, Zhihuishu Zhidao, Rain Classroom, Chaoxing, UMU, ClassIn, and Lanmo are common. Despite different emphases, these platforms typically include core modules such as: course resource management micro-lectures, PPTs, test banks and so on; process support (pre-class previews, in-class bullet comments/submissions/quizzes, post-class assignments and tests); behavior tracking (progress monitoring, attendance, participation analytics); and assessment/feedback (auto-grading, data-driven learning analytics reports, and peer assessment).

A substantial body of empirical research suggests such platforms positively affect learning. In theory-based courses, Zhihuishu-supported blended teaching significantly improved pharmacognosy students' final grades and recognition of the course; in college English translation, Rain Classroom combined with a divided/flipped class outperformed traditional models by enhancing grades and critical thinking. In practice-oriented training, UMU's instant feedback and formative assessment improved vocational students' collaborative learning and skill mastery. By integrating resources and interaction, these platforms optimize the student-centered learning loop and promote self-directed, deeper learning.

However, several critical gaps remain:

a. Unclear transmission mechanism between platform uses and outcomes: most studies focus on macro results while overlooking mediating paths such as motivation, cognitive strategies, and user experience.

b. Insufficient support for experimental/skills courses: in some laboratory courses, platform use failed to raise experimental grades, highlighting weak design alignment with hands-on practice.

c. Lack of discipline-specific adaptation: many studies focus on language or general-education courses; rigorous cases in STEM remain scarce, and platform features rarely reflect disciplinary characteristics—despite our sample being predominantly STEM majors.

d. Neglect of intrinsic-motivation mechanisms: platforms often rely on external incentives or pressure, but research on converting such pressures into intrinsic motivation is lacking, leaving passive learners disengaged.

This study investigates how online-platform use in blended learning influences college students' motivation and learning outcomes, focusing on Zhihuishu. By analyzing the relationships between students' motivation during platform use and their outcomes, we provide theoretical guidance for optimizing online-platform design and blended-learning models.

2. Materials and Methods

Blended learning combines the strengths of face-to-face instruction and online learning to provide flexible, personalized experiences. Garrison & Kanuka (2004) and Graham (2012) emphasize integration of synchronous and asynchronous modes, enabling autonomy while maintaining interaction with teachers and peers. Motivation—intrinsic and extrinsic per Self-Determination Theory (Ryan & Deci, 2020)—is pivotal. Empirical work shows intrinsic motivation is more predictive of achievement in blended environments. Peng & Fu (2021), using SEM with EFL students, found intrinsic motivation had stronger effects on outcomes; Radulović et al. (2023) and Shoukat et al. (2024) similarly reported gains in interest, persistence, and self-regulation under blended learning.

Learning motivation is a key determinant of achievement in blended environments. According to Self-Determination Theory, motivation can be intrinsic or extrinsic. Evidence shows intrinsic motivation exerts stronger effects on outcomes when autonomy is encouraged. Peng & Fu used SEM to model the links among motivation and outcomes in Chinese EFL contexts and found intrinsic motivation more influential. Studies in physics education and comparative experiments further confirm that blended learning enhances motivation and achievement, especially for previously lower-performing students. Blended learning not only raises motivation but also improves academic outcomes—exam performance, language proficiency, and soft skills such as confidence and persistence. Quasi-experimental and experimental studies according to Ghazizadeh & Fatemipour（2017）and Shih (2010) showed significant improvements in listening, speaking, reading, and writing. Meanwhile, Lim & Morris (2009) and Nortvig et al. (2018) found that learner self-management, platform usability, and instructional quality are critical determinants of success.

Ghazizadeh & Fatemipour (2017) and Shih (2010) used pre/post experimental designs with language tests and questionnaires, confirming that blended learning significantly enhances L2 skills. Peng & Fu (2021) also found that blended learning facilitates application abilities through more personalized feedback and resources during self-regulated study.

Table 1. Summary of Literature

Author (Year)	Method Type	Sample Type	Instruments	Findings
Peng & Fu (2021)	SEM modeling	Undergraduate English course	Questionnaire; AMOS	Learning motivation—especially intrinsic—correlates strongly with outcomes; blended learning significantly improves language ability.
Shoukat et al. (2024)	Experimental vs Control Group	University students	Control group; questionnaire; grade analysis	Experimental group outperformed control in motivation and grades; BL positively affects intrinsic motivation and self-efficacy.
Radulović et al. (2023)	Mixed methods (quantitative + qualitative)	High school students	Likert questionnaire; open-ended items	BL increases interest, persistence, and self-regulation.
Islam (2018)	Quasi-experimental design	High school / college students	Questionnaire; grade comparison	Experimental students surpassed traditional group in motivation, self-study, and grades; BL promotes learning initiative.
Ghazizadeh & Fatemipour (2017)	Pre-/post-test experimental design	Undergraduate English course	Language tests; Likert questionnaire	Students' L2 listening/speaking/reading/writing improved markedly; BL outperforms traditional instruction.
Shih (2010)	Action research	College presentation course	Learning logs; interviews; scales	BL enhanced students' speaking confidence and participation; timely online feedback from teachers is crucial.

Shoukat et al. (2024)	Regression and path analysis	University students (multiple disciplines)	Questionnaire; SPSS analysis	Course satisfaction and platform interactivity correlate positively with motivation; mediation through motivation is evident.

The success of blended learning also depends on learner characteristics and platform features. Lim & Morris (2009) found that prior online learning experience and self-management significantly affect outcomes—students with higher platform fluency and self-regulation perform better. Teacher quality is likewise crucial: facilitating online discussion, giving timely feedback, and designing engaging activities substantially enhance motivation and achievement (Nortvig et al., 2018).

3. Research Framework

To assess reliability, we computed Cronbach's α; we also ran KMO and Bartlett's tests to confirm adequate correlations among items within each dimension, thereby supporting factor analysis and the credibility of results.

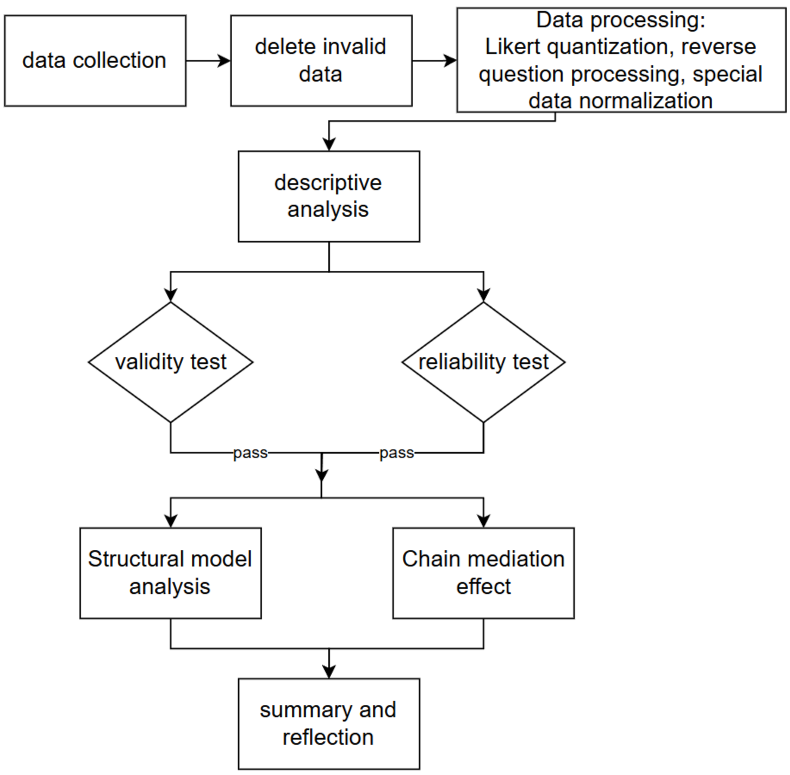

Figure 1. Research Framework

4. Data Collection and Analysis Results

4.1. Data Collection

We adopted a quantitative approach using an online questionnaire to investigate how blended learning affects college students' motivation and outcomes, and the relationships between them. The instrument covered four parts—background information, learning motivation, knowledge/achievement, and difficulties & suggestions—rated on five-point Likert scales. No personal identifiers were collected; only major, platform usage, and experience were recorded.

The sample comprised 289 undergraduates and recent graduates, with 270 valid users of Zhihuishu. Participants were students from one university across grades and majors. Informed consent was obtained, and the survey was distributed online to ensure breadth and representativeness.

The questionnaire consisted of four sections:

Table 2. Questionnaire Design

No.	Category	Question Details
1	Basic Information	1. Major (discipline)
2		2. Have you used the Zhihuishu platform?
3		3. Typical learning mode when using Zhihuishu is:
4		4. The interface of Zhihuishu is very user-friendly.
5	Learning motivation	I use Zhihuishu to enhance my knowledge and abilities, not merely for grades.
6		2. My use of Zhihuishu is entirely due to pressure from school and instructors.
7		3. Resources on Zhihuishu help lay a solid foundation for my future career development.
8		4. I adopt flipped-classroom activities to raise my interest and participation.
9		5. I expect such platforms to help me achieve higher grades.
10	Learning outcomes	1. The SPOC-based flipped model on Zhihuishu greatly improves my comprehensive competencies, for example, time management ability, thinking ability, etc.
11		2. I agree and like the flipped classroom teaching model based on SPOC based on Smart Tree and am willing to continue to implement the current teaching model.
12		3. By using similar platforms to study, my test scores have been improved.
13		4. By using similar platforms to learn, my understanding of course content has become more in-depth.
14		5. The Zhidao Smart Tree Platform allows me to participate more actively in the learning process and continue to make progress in learning.
15		6. The Zhidao Smart Tree Platform allows me to apply the knowledge I have learned to actual scenarios or other disciplines
16	Suggestions for Improvement	1. In the Zhihuishu-based SPOC flipped model, your biggest difficulty is:
17		2. Which aspects of Zhihuishu should be improved to better support the SPOC flipped model?
18		3. What improvements would you like instructors to make in the SPOC flipped model?

Each item used a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). Item 6 was reverse-scored (1 = strongly agree, 5 = strongly disagree). Intrinsic motivation comprised: Q1 (ability/knowledge enhancement), Q3 (career development), Q4 (interest). Extrinsic motivation comprised: Q2 (external pressure) and Q5 (grades). The multiple-choice item on learning modes was recoded into five binary variables (chosen = 1, otherwise 0) to compute platform usage intensity.

4.2. Descriptive Statistics

To evaluate ratings on motivation, knowledge mastery, and difficulties, we first computed descriptive statistics (means, SDs, medians). These provide an overview of attitudes and trends for later interpretation.

Table 3. Descriptive Statistics of Learning Motivation

Variable	Mean	SD	Median	Variance	Kurtosis	Skewness
1. I use Zhihuishu to enhance my knowledge and abilities, not merely for grades.	3.619	1.382	4	1.91	-1.002	-0.534
2. My use of Zhihuishu is entirely due to pressure from school and instructors.	2.526	1.455	2	2.116	-1.254	0.426
3. Resources on Zhihuishu help lay a solid foundation for my future career development.	3.996	1.323	5	1.751	-0.067	-1.109
4. I adopt flipped-classroom activities to raise my interest and participation.	3.811	1.343	4	1.804	-0.59	-0.838
5. I expect such platforms to help me achieve higher grades.	3.8	1.418	4	2.012	-0.69	-0.831

Motivations for using Zhihuishu showed clear differentiation. Intrinsic motives—enhancing knowledge/ability, supporting career development, and stimulating interest—averaged 3.81–4.00, whereas the "pressure-driven" item averaged only 2.53 (SD ≈ 1.46). Interestingly, the item "aiming for higher grades," though categorized as extrinsic, displayed a distribution similar to intrinsic motives (skew −0.831), suggesting that grade pursuit may have been internalized as a self-development goal. Career development was especially salient (mean ≈ 4.00), with 51.7% choosing "strongly agree." Notably, 34.6% endorsed "learning under pressure," versus 30.1% who disagreed, a polarization echoed by 61.59% reporting "difficulty sustaining attention during self-study."

Based on the above, we propose a dual optimization path:

a. Convert passive learners: For the 34.6% highly pressure-driven group, employ gamification and more engaging interaction, and provide practical resources so that external requirements are transformed into intrinsic drivers.

b. Strengthen career anchors: Display real-time alignment between learning progress and job skills on the home page and add industry case studies. Build a chain of "career goals → sense of competence → grades naturally follow," and augment job-related knowledge graphs and focus aids to align with students' internalized goals.

Table 4. Descriptive Statistics of Learning Outcomes

Variable	Mean	SD	Median	Variance	Kurtosis	Skewness
1. The SPOC-based flipped model on Zhihuishu greatly improves my comprehensive competencies (e.g., time-management, analytical thinking).	3.552	1.405	4	1.973	-1.119	-0.472
2. I approve of and like the Zhihuishu-based SPOC flipped	3.978	1.396	5	1.947	-0.212	-1.109

model and am willing to continue with it.						
3. Using such platforms has genuinely improved my exam scores.	4.026	1.309	5	1.713	-0.017	-1.131
4. Using such platforms has deepened my understanding of course content.	3.919	1.268	4	1.607	-0.539	-0.85
5. Zhihuishu enables me to participate more actively and keep progressing.	3.878	1.397	5	1.952	-0.504	-0.942
6. Zhihuishu helps me apply what I learn to real-world contexts or other subjects.	4.185	1.248	5	1.557	0.448	-1.327

All outcome dimensions were rated positively (means 3.55–4.19). Knowledge transfer (Item 6) received the highest endorsement, with 51.9% agreeing that the platform facilitates cross-context application; exam score improvement ranked second. Comprehensive competency (Item 1) scored lowest (mean 3.55; platykurtic distribution), indicating divergent views on gains in time management and thinking skills. All items were left-skewed (positive tilt), revealing overall favorable but polarized evaluations. For sustained willingness to continue using the model (Item 2), 54.3% strongly agreed while 18.7% disagreed—consistent with 15.22% reporting "no improvement in comprehensive skills."

Drawing on these findings and student suggestions, we propose three improvements:

a. Reinforce soft-skill development: embed time-management tools (e.g., Pomodoro planners) and thinking-skills modules in SPOC courses.

b. Consolidate advantages in transfer: build cross-disciplinary project banks to expand the 61.6% positive group.

c. Differentiated design: generate personalized diagnostic reports by integrating practice data and learning behaviors for learners with low outcomes, addressing difficulties in internalization and attention, and establishing a "mastery → capability → transfer" progression.

In the fourth part of the questionnaire, 270 valid users reported difficulties and suggestions for blended learning on Zhihuishu; a summary is shown below.

Table 5. Difficulties and Suggestions

Question	Option	Count	Share	Other
Biggest difficulty in the Zhihuishu-based SPOC flipped model	A. Difficulty maintaining attention during self-study	178	30.74%	Overly concise content; family distractions; lack of self-discipline; device desynchronization; mobile app inferior to web version
	B. Time-management difficulties in balancing tasks	179	30.92%	
	C. Difficulty internalizing knowledge	116	20.03%	
	D. Technical issues with Zhihuishu (lag, unfamiliarity with features, etc.)	106	18.31%	
	A. Add more high-quality learning resources	150	23.78%	Add more resources;

Areas for improvement in Zhihuishu to better support the SPOC flipped model	B. Optimize interactive functions for easier communication	159	25.20%	dual-screen video-PPT; improve entry page; more practice with timely feedback; study-time tracking and focus mode
	C. Improve the accuracy and usefulness of learning analytics	148	23.45%	
	D. Increase platform stability and reduce technical issues	174	27.58%	
Desired improvements instructors could make in the SPOC flipped model	A. Provide more detailed learning guidance	213	29.02%	Personalized resources & feedback; adjust workload; timely assignment feedback; use the platform for in-class interaction
	B. Increase diversity of in-class interactions	179	24.39%	
	C. Adjust pacing to fit different learning tempos	155	21.12%	
	D. Provide more targeted learning resources	187	25.48%	

4.3. Reliability and Validity Tests

To ensure reliability and consistency, we computed Cronbach's α for each scale (motivation, knowledge/outcomes). Higher α indicates greater internal consistency; values above 0.70 are generally acceptable. A low α would call for revisiting item design.

Table 6. Cronbach's α Results

Cronbach's α	**Standardized Cronbach's α**	**Items**	**Sample Size**
0.753	0.752	11	270

The overall Cronbach's α = 0.753, indicating acceptable internal consistency.

We then conducted KMO and Bartlett's tests. KMO values above 0.9 indicate excellent suitability for factor analysis; 0.8–0.9 good; 0.7–0.8 fair; 0.6–0.7 marginal; 0.5–0.6 poor; below 0.5 unacceptable. For Bartlett's test, $p < 0.05$ rejects the null hypothesis, indicating sufficient correlations for factor analysis.

Table 7. Validity Tests

KMO and Bartlett's Test		
KMO Value		0.95
Bartlett's Test of Sphericity	Approx. Chi-square	2522.073
	df	78
	p	0.00001

KMO = 0.95 and Bartlett's test p = 0.0001 indicate significant correlations among variables; factor analysis is appropriate.

4.4. Structural Equation Modeling (SEM) Analysis

4.4.1. Method Overview

SEM integrates factor analysis and path analysis to test structural relations among multiple variables, accommodating complex mediation, correcting measurement error, and evaluating overall fit via χ^2, CFI, RMSEA, etc. It is well-suited for verifying multi-level causal relationships in theoretical frameworks.

In the measurement model, a latent variable ξ relates to its observed indicators Y as:

$$Y = \Lambda_{\xi} \cdot \xi + \epsilon \qquad (4\text{-}1)$$

where
Y denotes observed indicators;
λ is the loading between the latent and indicators;
ξ is the latent variable;
ϵ the error term.

The structural model describes relations among latent variables, e.g., the effect of learning motivation on platform usage: $\xi_1 \xi_2$

$$\xi_2 = \beta_1 \cdot \xi_1 + \zeta \qquad (4\text{-}2)$$

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The structural model describes relations among latent variables, e.g., the effect of learning motivation on platform usage: $\xi_1 \xi_2$

$$\xi_2 = \beta_1 \cdot \xi_1 + \zeta \qquad (4\text{-}2)$$

where:
ξ_2 is denotes the latent variable of platform usage,
β_1 is the path coefficient from motivation to platf$\xi_1$orm usage,ξ_2
ζ is the structural disturbance term.

We used SEM to examine the mechanism by which Zhihuishu usage affects outcomes. We jointly assessed measurement reliability/validity and estimated the chain of "motivation → usage → outcomes," using 5,000-sample bootstrap to test mediation; overall model-fit indices met conventional criteria.

4.4.2. Results

Table 8. SEM Results

Factor (Latent)	Indicator (Observed)	Unstandardized Coef.	Standardized Coef. (β)	SE	Z	p
User experience	Platform usage	0.005	0.015	0.025	0.207	0.836
Learning motivation	Platform usage	0.14	0.179	0.066	2.112	0.035
User experience	Learning outcomes	0.408	0.797	0.028	14.468	0.000
Learning motivation	Learning outcomes	0.067	0.058	0.05	1.334	0.182
Platform usage	Learning outcomes	0.092	0.063	0.066	1.399	0.162

The coefficients show heterogeneous effects. Learning motivation positively predicts platform usage (unstandardized $b = 0.14$, $\beta = 0.179$, $Z = 2.112$, $p = 0.035$). User experience powerfully predicts learning outcomes ($b = 0.408$, $\beta = 0.797$, $Z = 14.468$, $p < 0.001$). Other paths are not significant: experience → usage ($p = 0.836$), motivation → outcomes ($p = 0.182$), and usage → outcomes ($p = 0.162$).

Standardized coefficients indicate that user experience has a far larger effect on outcomes than other paths, underscoring its central role. Outcomes are driven primarily by experience, while usage acts only as a partial mediator between motivation and outcomes and shows no significant direct effect. All significant paths have Z > 1.96 with SEs 0.025–0.066, indicating precise estimates.

4.4.3. Discussion

Motivation's positive effect on blended-learning engagement suggests that students' desire for academic growth drives online platform usage more than grade pressure, consistent with general findings on intrinsic motivation and online participation.

The non-significant direct effect of platform usage implies that simply using more features does not ensure better outcomes; the quality of engagement—interaction, participation, time-on-task—likely matters more than breadth of use.

The strongest path from experience to outcomes indicates that usability and user-friendliness are crucial for improving achievements. This aligns with evidence that user experience is vital for participation and success in online environments, although reverse causality (successful students rating platforms higher) cannot be ruled out.

Platform usage serves as a partial mediator between motivation and outcomes but exerts no direct effect, implying that without a positive experience, increased usage alone is insufficient. Platforms should therefore enrich interactive features, provide timely grading/feedback, and improve UI/UX to foster meaningful engagement and deeper learning.

Platform usage indeed mediates between motivation and outcomes, but only partially and not as a direct driver. Students need to engage meaningfully, for example, through active use of resources and high-quality interaction—to realize gains. Platforms can improve UX via richer interaction, timely grading, and intrinsic-motivation features; instructors can adopt personalized strategies that encourage deep engagement.

Overall, the SEM results suggest that in blended environments, platform usability and user experience are the most important drivers of effectiveness. Without positive UX, simply expanding the number of functions is insufficient. Because UX directly affects performance and willingness to participate, platforms should actively optimize experience and resource accessibility.

4.5. Chain Mediation Analysis

4.5.1. Method Overview

Chain mediation refers to a process whereby an independent variable (X) affects a dependent variable (Y) through a sequence of mediators (M_1, M_2, …, M_k). We first estimate the total effect.

$$Y = cX + e_1 \qquad (4\text{-}3)$$

We then estimate the indirect effect via mediators and the direct effect with mediators included:

$$M = aX + e_2 \qquad (4\text{-}4)$$

$$Y = cH + X_n + e_3 \qquad (4\text{-}5)$$

Significant direct effects: a 1-unit increase in intrinsic motivation raises outcomes by 0.452; a 1-unit increase in extrinsic motivation raises outcomes by 0.112. Platform usage and user experience did not form an effective serial mediation chain; the key break is the non-significant path from intrinsic motivation to platform usage.

The chain-mediation test indicates a strong direct effect of intrinsic motivation on outcomes ($p < 0.001$), while the hypothesized "usage → experience → outcomes" route is not significant ($p > 0.05$). Extrinsic motivation promotes usage but fails to convert into substantive outcome gains, suggesting a design gap that weakens the translation of behavior into achievement.

The chain-mediation test shows a significant direct effect of intrinsic motivation on outcomes ($p < 0.001$), whereas the serial path "platform usage → user experience → outcomes" is non-significant. Although extrinsic motivation increases usage, it does not translate into outcome gains—indicating a disconnect between behavior and achievement in the current design.

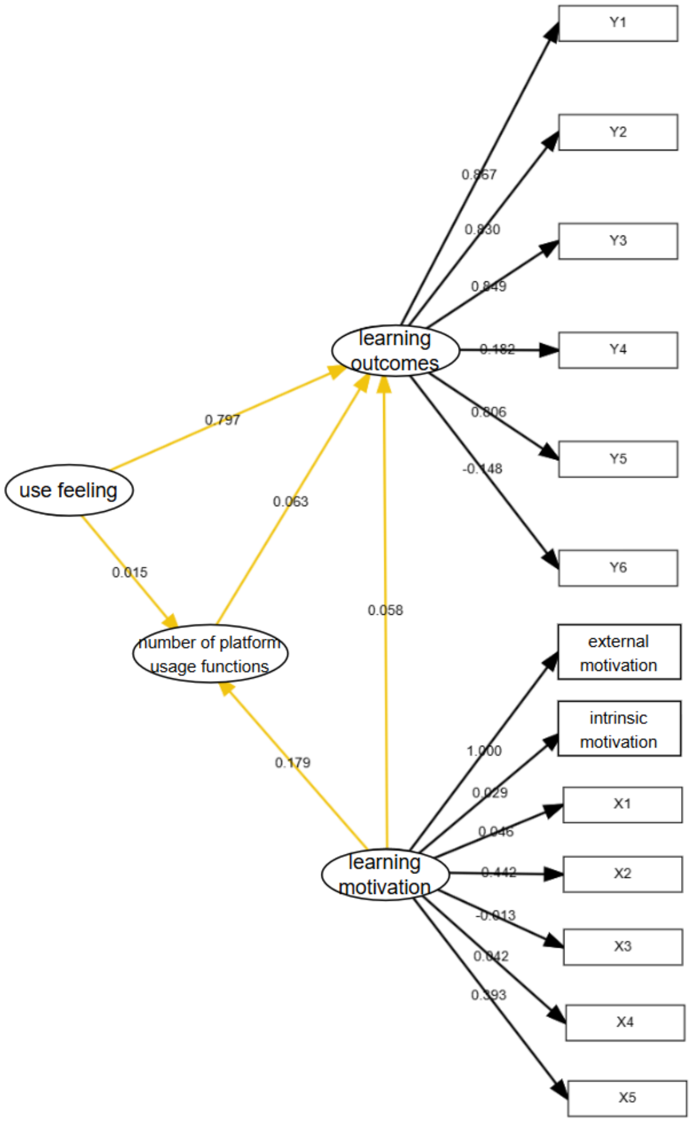

Figure 2. Structural Diagram

Table 9. Variable Definitions

Construct	Variable	Computation
Intrinsic motivation	X_{inside}	$(X_1 + X_3 + X_4)/3$
Extrinsic motivation	$X_{outside}$	$(X_2 + X_5)/2$
Platform usage	M_1	$\sum_{k=1}^{4} Behavior_k$
User experience	M_2	-
Learning outcomes	Y	$(Y_1 + Y_2 + Y_3 + Y + Y_5 + Y_6)/6$

4.5.3. Discussion

Both intrinsic and extrinsic motivations affect platform usage. Intrinsic motivation—reflecting interest and proactive engagement—encourages more varied use of online tools. Platforms should therefore cultivate intrinsic drivers via personalization and interactive learning.

4.5.2. Results

Table 10. Chain Mediation Results

Effect	Relation	Effect Size	SE	t	p	95% CI Lower	95% CI Upper
Direct effect	Intrinsic motivation ⇒ Learning outcomes	0.452	0.036	12.388	0.000	0.38	0.524
	Extrinsic motivation ⇒ Learning outcomes	0.112	0.045	2.459	0.015	0.022	0.201
Indirect path	Intrinsic motivation ⇒ Platform usage	0.024	0.029	0.836	0.404	-0.033	0.081
	Extrinsic motivation ⇒ Platform usage	0.139	0.057	2.448	0.015	0.027	0.25
	Intrinsic motivation ⇒ User experience	0.894	0.044	20.31	0.000	0.807	0.981
	Extrinsic motivation ⇒ User experience	-0.035	0.088	-0.396	0.692	-0.207	0.138
	Platform usage ⇒ User experience	-0.066	0.094	-0.708	0.479	-0.25	0.118
	Platform usage ⇒ Learning outcomes	0.056	0.049	1.149	0.251	-0.04	0.152
	User experience ⇒ Learning outcomes	0.079	0.032	2.499	0.013	0.017	0.142
Total effect	Intrinsic motivation ⇒ Learning outcomes	0.524	0.023	22.755	0.000	0.479	0.57
	Extrinsic motivation ⇒ Learning outcomes	0.116	0.045	2.556	0.011	0.027	0.205

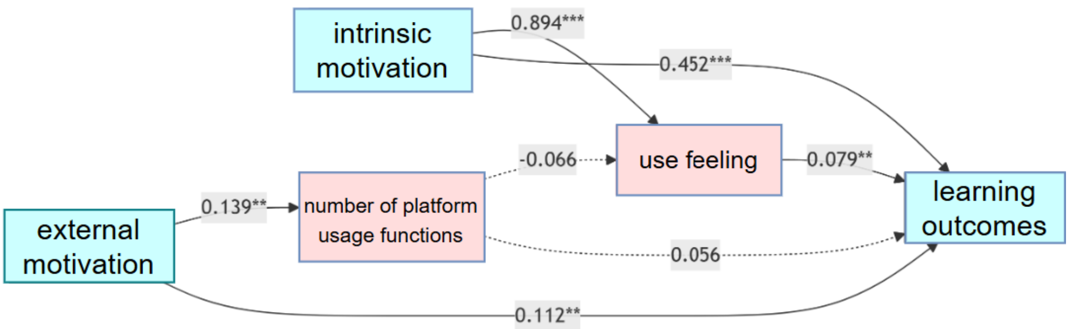

Figure 3. Chain-Mediation Model

Table 11. Legend

Style	Meaning
Solid line	Significant path ($p<0.05$)
Dashed line	Non-significant path ($p>0.05$)
Blue fill	Significant relation
Red fill	Non-significant node

Positive user experience, combined with active learning strategies, is associated with better outcomes. Blended courses should prioritize interaction and UX design (e.g., interface clarity, ease of use) to enhance satisfaction and achievement.

The non-significant usage → outcome path suggests that increasing the number of ways students use the platform is insufficient. Emphasis should be placed on content quality and interactive depth to drive learning gains.

Intrinsic motivation is the core driver of outcomes in Zhihuishu, operating mainly through a direct path. While extrinsic motivation increases usage, it does not translate into outcome improvements, indicating a break in behavioral conversion. Beyond motivational triggers, improvements in platform functionality, pedagogy, and student engagement are necessary.

Accordingly, we recommend enhancing interactivity and resource diversity; providing engaging modules to stimulate intrinsic motivation; focusing on UX to improve participation and satisfaction; and using personalized, interesting approaches to strengthen mixed online-offline experiences.

AUTHOR CONTRIBUTIONS

Xinyu Zhao: Conceptualization, Methodology, Data Collection, Formal Analysis, Investigation, Validation, Visualization, Writing - Original Draft, Writing - Review & Editing.

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CONFLICT OF INTEREST STATEMENT

The authors declare no competing interests.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

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