THE RELATIONSHIPS OF EDUCATIONAL TECHNOLOGY USE AND STUDENT ENGAGEMENT WITH LEARNING OUTCOMES IN BLENDED LEARNING AMONG UNIVERSITY STUDENTS IN QINGDAO CITY, SHANDONG PROVINCE, CHINA

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ABSTRACT
This research aimed at examining the relationships of educational technology use and student engagement with learning outcomes in blended learning among university students in Qingdao City, Shandong Province, China. A quantitative research approach was employed, and a structured questionnaire was administered to collect data from full-time undergraduates enrolled in blended learning courses at six private undergraduate universities in Qingdao City. A total of 400 valid questionnaires were used for the analysis. Descriptive statistics and multiple regression analysis were employed for data analysis. The results of a single comprehensive regression model indicated that student engagement significantly and positively predicted learning outcomes, with cognitive engagement being the strongest unique predictor, and that educational technology use also contributed significantly, with perceived usefulness and perceived ease of use as significant unique predictors, whereas usage frequency was not uniquely predictive; the six dimensions jointly explained 37.8 per cent of the variance in learning outcomes. Supplementary analyses disaggregating learning outcomes into cognitive, skills and affective dimensions further revealed differential predictive patterns, such as the specific role of perceived ease of use in fostering skills outcomes. This study concludes with theoretical and practical implications for blended course design and recommendations for future research.

Keywords: Educational Technology Use, Student Engagement, Learning Outcomes, Blended Learning, University Students

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INTRODUCTION

Blended learning, which combines traditional face-to-face instruction with online learning, has become a key direction of teaching reform in higher education because it breaks through the constraints of time and space and provides students with a more flexible and personalised learning experience (Garrison & Vaughan, 2008). During the COVID-19 pandemic, higher education institutions worldwide shifted to online teaching on a massive scale, which led to the unprecedented adoption of blended learning models and made their advantages in teaching effectiveness, learning flexibility and resource sharing increasingly apparent (Bozkurt et al., 2020). In China, the Ministry of Education has explicitly promoted the deep integration of information technology with teaching and learning and the innovation of educational models through the Education Informatization 2.0 Action Plan (Ministry of Education, 2018).

Garrison and Vaughan (2008) defined blended learning as the thoughtful integration of classroom face-to-face learning experiences with online learning experiences, and emphasised that the core value of blended learning lies in redesigning the teaching process rather than simply adding technology to traditional instruction. A well-designed blended course typically integrates self-paced online learning of core knowledge with interactive face-to-face activities such as discussion, group work and problem solving. In such a setting, blended-learning effectiveness depends not only on technical resources but also on how students use technology and how actively they participate in learning activities.

Shandong Province is one of China's most populous and educationally significant provinces, with 156 general higher education institutions and more than 2.6 million students enrolled in undergraduate and vocational associate programmes (Shandong Provincial Department of Education, 2024). Qingdao, a major coastal city in the province, has 13 general undergraduate institutions (7 public and 6 private) with approximately 300 000 full-time undergraduates (Qingdao Municipal Bureau of Education, 2023). Local private universities in Qingdao have actively carried out blended-learning reforms and deployed mainstream online teaching platforms.

Nevertheless, blended-learning implementation still faces practical challenges. Simply providing educational technology resources cannot guarantee improved learning outcomes; improper technology application may create heavy cognitive load and reduce student motivation (Mayer, 2021). Moreover, insufficient student engagement and poor self-regulation often lead to unsatisfactory blended-learning performance (Rasheed et al., 2020).

Existing literature has separately explored educational-technology use and student engagement, yet few empirical studies place both predictors within one analytical framework, especially for Chinese private undergraduate contexts. Therefore this study sets three objectives: (1) to describe the current levels of educational-technology use, student engagement and learning outcomes among undergraduates in six private universities of Qingdao; (2) to examine the influence of educational-technology use on blended-learning learning outcomes; (3) to examine the influence of student engagement on blended-learning learning outcomes. Two core research hypotheses are proposed accordingly.

H1: Educational technology use has a significant positive influence on learning outcomes in blended learning among university students in Qingdao City, Shandong Province, China. H2: Student engagement has a significant positive influence on learning outcomes in blended learning among university students in Qingdao City, Shandong Province, China.

This study selects full-time undergraduates taking blended courses from six local private universities and adopts questionnaire-based quantitative research. Theoretically, it combines the Technology Acceptance Model and student-engagement multidimensional framework for the Chinese private-university blended-learning scenario. Practically, it offers empirical evidence for university teachers, course designers and administrators to optimise blended-teaching arrangements.

For this paper, educational technology use means students' perceptions and actual usage frequency of online learning platforms and digital learning tools (Davis,1989). Student engagement covers behavioural, cognitive and emotional investment in learning activities (Fredricks et al., 2004). Learning outcomes include cognitive, skill-based and affective gains, following Bloom's educational-objective taxonomy (Bloom,1956).

LITERATURE REVIEWS

Educational Technology Use and Learning Outcomes

Educational technology use refers to students' use of technological tools, such as online learning platforms, digital resources and collaboration tools, during the learning process (Garrison & Vaughan, 2008; Mayer, 2021). According to the Technology Acceptance Model proposed by Davis (1989), perceived usefulness and perceived ease of use are the two core determinants of users' acceptance and usage behaviour towards information technology. Later extensions such as the Unified Theory of Acceptance and Use of Technology further emphasise performance expectations, effort expectations, social influence and facilitating conditions (Venkatesh et al., 2003). In addition, the Technological Pedagogical Content Knowledge framework emphasises that the effective application of educational technology requires the integration of technological knowledge, pedagogical knowledge and subject content knowledge (Mishra & Koehler, 2006). In blended learning contexts, students who believe that educational technology tools are useful and easy to use are more likely to adopt and persistently use these tools, which may in turn support better learning outcomes. Empirical research supports this view. Islam (2016), using a structural equation modelling approach, found that the use of e-learning systems was significantly and positively associated with students' learning outcomes, with the impact of perceived usefulness being stronger than that of perceived ease of use. Broadbent and Poon (2015) reported that the effective use of technological tools, combined with appropriate learning strategies, supports autonomous, collaborative and deep learning and thereby contributes to academic achievement. Vo, Zhu and Diep (2017), in a meta-analysis of blended learning in higher education, found that blended learning produced a significant, moderately positive effect on students' course performance compared with traditional instruction. However, technology use alone does not guarantee better learning outcomes; Mayer (2021) cautioned that inappropriate use of technology may result in excessive cognitive load, distraction and reduced motivation, and Selwyn (2016) similarly reminded that technology is not automatically good for education and that its educational value depends on how it is designed and used. Therefore, this study proposes the following hypothesis:

H1: Educational technology use has a significant positive influence on learning outcomes in blended learning among university students in Qingdao City, Shandong Province, China.

Student Engagement and Learning Outcomes

Student engagement refers to the degree to which students invest themselves behaviourally, cognitively and emotionally in learning activities, and is conceptualised as a multidimensional construct comprising behavioural engagement, cognitive engagement and emotional engagement (Fredricks et al., 2004). Trowler (2010) pointed out that student engagement encompasses not only participation in classroom learning but also involvement in extracurricular activities, teacher-student interactions and peer collaboration, while Sinatra et al. (2015) emphasised that engagement results from the interaction between cognitive, emotional and behavioural factors. Self-Determination Theory further explains that behavioural motivation is driven by the fundamental psychological needs for autonomy, competence and relatedness, and that a teaching environment supporting these needs can promote student engagement (Deci & Ryan, 2000). A large body of research confirms that student engagement is one of the most important factors influencing learning outcomes. Kuh (2003) found that student engagement was significantly and positively correlated with

academic performance, satisfaction with learning and personal development among university students. Carini et al. (2006) reported a moderate positive correlation between student engagement and learning outcomes across different disciplines, year groups and school types. In blended learning contexts, the role of student engagement is even more pronounced; Rasheed et al. (2020) indicated that low student engagement and weak self-regulation are important factors affecting the success of blended learning, and that students with high levels of engagement are better able to utilise the advantages of blended learning. Martin and Borup (2022) reported that online discussion tools can promote students' cognitive and affective outcomes, although their effectiveness depends on the design of discussion topics, instructor involvement and the quality of peer interaction. Recent regional studies also support the importance of context in online engagement (Wut et al., 2024). Therefore, this study proposes the following hypothesis:

H2: Student engagement has a significant positive influence on learning outcomes in blended learning among university students in Qingdao City, Shandong Province, China.

Learning Outcomes in Higher Education

Learning outcomes refer to the knowledge, skills, attitudes and competencies that students are expected to acquire after completing a course or programme. In his taxonomy of educational objectives, Bloom (1956) categorised learning outcomes into three domains, namely the cognitive, affective and psychomotor domains, and subdivided each domain into ordered levels, which provides a classic framework for defining and assessing learning outcomes. In 2001, Anderson and Krathwohl revised Bloom's taxonomy and reorganised the cognitive domain into six levels, namely recall, understanding, application, analysis, evaluation and creation, placing greater emphasis on higher-order thinking skills (Anderson & Krathwohl, 2001). In their training evaluation model, Kirkpatrick and Kirkpatrick (2006) further categorised learning outcomes into four levels, namely reaction, learning, behaviour and results, emphasising the multidimensional and developmental nature of learning outcomes. Following this literature, the present study measures learning outcomes in three dimensions: cognitive learning outcomes, which refer to students' understanding and mastery of course content and their higher-order thinking ability; skills learning outcomes, which refer to the improvement of practical and operational skills; and affective learning outcomes, which refer to learning attitudes and learning satisfaction.

Related Research and Research Gap

A number of empirical studies have examined the factors influencing learning outcomes in technology-enhanced and blended learning. Alfalah (2023) investigated the factors influencing students' adoption and use of mobile learning management systems and found that perceived ease of use was a major factor shaping students' attitudes towards learning management systems, which in turn affected their actual usage behaviour. Deng and Yang (2025) explored the impact of online education on student engagement in higher education in the post-COVID-19 period and found that the three dimensions of engagement are interconnected and mutually influential. Sun (2025) found that perceived teacher emotional support significantly predicted university students' online learning engagement through the mediating role of academic burnout. Although these studies provide valuable evidence, most of them examined educational technology use and student engagement separately, and few have systematically compared the relative contributions of the two predictors to learning outcomes within a single framework in the Chinese private university context. The present study addresses this gap by testing the influence of educational technology use and student engagement on learning outcomes simultaneously in blended learning among university students in Qingdao City.

Based on the literature review, the conceptual framework of this study is illustrated in Figure 1. The framework comprises three core variables: educational technology use, which serves as the first independent variable; student engagement, which serves as the second independent

variable; and learning outcomes, which serves as the dependent variable. Educational technology use is measured across three dimensions, namely perceived usefulness, perceived ease of use and frequency of technology use; student engagement is measured across three dimensions, namely behavioural engagement, cognitive engagement and emotional engagement; and learning outcomes are measured across three dimensions, namely cognitive, skills and affective outcomes, based on Bloom's taxonomy of educational objectives (Bloom, 1956). According to the framework, educational technology use and student engagement are hypothesised to have significant positive influences on learning outcomes, which are represented by the two arrows labelled H1 and H2 in Figure 1.

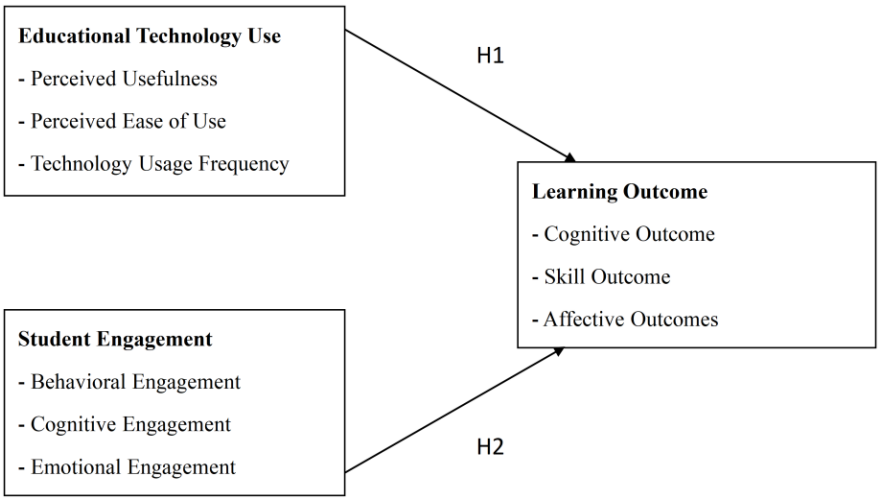


Figure 1 Conceptual Framework adapted from Davis (1989), Fredricks et al. (2004) and Bloom (1956)

RESEARCH METHODOLOGY

In response to the research objectives, this study adopted a quantitative research approach using a questionnaire survey, which was considered appropriate because the study aimed to examine the levels of the key variables and the relationships among them in a large population. The population of the study consisted of full-time undergraduates enrolled in blended learning courses at six private undergraduate universities in Qingdao City, Shandong Province, China, with a total enrolment of approximately 90,000 students. The sample size of 400 respondents was determined following the sample size determination procedure of Yamane (1973), and the sample was selected using proportionate stratified sampling based on the enrolment of each university, as suggested by Kothari (2004). The research instrument was a structured questionnaire consisting of four parts: the first part collected demographic information; the second part measured educational technology use in terms of perceived usefulness, perceived ease of use and frequency of technology use, adapted from the Technology Acceptance Model (Davis, 1989); the third part measured student engagement in terms of behavioural, cognitive and emotional engagement, adapted from the student engagement framework of Fredricks et al. (2004); and the fourth part measured learning outcomes in terms of cognitive, skills and affective outcomes, developed in accordance with Bloom's taxonomy of educational objectives and its revised version (Bloom, 1956; Anderson & Krathwohl, 2001). The questionnaire contained a total of 42 items, and all items were rated on a five-point Likert scale, with the interpretation of mean scores following five levels, namely highest, high, medium, low and lowest. The questionnaire was reviewed by the supervisor and three experts to verify its content validity, and a pilot test was conducted with 30 undergraduates to examine its reliability using Cronbach's alpha. Questionnaires were distributed both online through the Wenjuanxing platform and in person in classrooms between March and September 2026; a total of 450

questionnaires were distributed, of which 412 were returned, and after screening 12 questionnaires were excluded as invalid, yielding 400 valid questionnaires (88.89 per cent) for data analysis. The study was conducted from March to September 2026, covering questionnaire development, expert validation, the pilot test and formal data collection. Prior to the survey, students were informed of the research objectives, the principles of confidentiality and voluntary participation, and their informed consent was obtained. The collected data were analysed using descriptive statistics, including frequency, percentage, mean and standard deviation. Consistent with the conceptual framework, a single comprehensive multiple regression model was estimated in which all six dimensions of educational technology use and student engagement (perceived usefulness, perceived ease of use, frequency of technology use, behavioural engagement, cognitive engagement and emotional engagement) were entered simultaneously as predictors of learning outcomes, so that the unique predictive contribution of each dimension could be isolated while controlling for the variance shared among the predictors. To further examine how the predictors differentially relate to each facet of the dependent variable, three supplementary regression models were estimated with cognitive, skills and affective learning outcomes as separate dependent variables. Tolerance and variance inflation factor (VIF) statistics were used to assess multicollinearity, and the two research hypotheses were tested at a significance level of 0.05) All statistical analyses were performed with jamovi (Version 2.7).

RESEARCH RESULTS

This section presents the findings of the data analysis, including the demographic characteristics of the respondents, the levels of the key variables, and the results of hypothesis testing. The results are reported in the following tables.

Respondents' Profiles

Table 1 Number and Percentage of General Information of Respondents

General information of respondent		Frequency	Percentage
Gender	Male	193	48.25
	Female	207	51.75
Year of Study	First year	87	21.75
	Second year	97	24.25
	Third year	111	27.75
	Fourth year	105	26.25
Major/Field of Study	Philosophy	44	11.00
	Economics	59	14.75
	Law	44	11.00
	Education	12	3.00
	Literature	7	1.75
	History	25	6.25
	Science	28	7.00
	Engineering	50	12.50
	Agriculture	43	10.75
	Medicine	41	10.25
	Management	33	8.25
	Art	14	3.50
Number of Blended Learning Courses	1 course	35	8.75
	2-3 courses	23	5.75
	4-5 courses	182	45.50
	More than 5 courses	160	40.00

General information of respondent		Frequency	Percentage
Average Time Spent on Online Learning Each Week	Less than 2 hours	67	16.75
	2-5 hours	44	11.00
	6-10 hours	143	35.75
	11-15 hours	99	24.75
	More than 15 hours	47	11.75
Total		**400**	**100.00**

Most respondents were female (51.75 %). Third-year students formed the largest year group (27.75 %). Participants covered all 12 academic disciplines; Economics (14.75 %) and Engineering (12.50 %) occupied the highest proportions. Most students took 4-5 blended-learning courses, and the largest group (35.75 %) spent 6-10 hours weekly on online-learning activities.

Reliability of the Questionnaire

Table 2 Reliability of the Questionnaire (Cronbach's Alpha)

Variable and Dimension	Cronbach's Alpha
Educational Technology Use	
Perceived Usefulness	.830
Perceived Ease of Use	.843
Frequency of Technology Use	.800
Educational Technology Use (Total)	.828
Student Engagement	
Behavioural Engagement	.901
Cognitive Engagement	.811
Emotional Engagement	.815
Student Engagement (Total)	.878
Learning Outcomes	
Cognitive Learning Outcomes	.881
Skills Learning Outcomes	.853
Affective Learning Outcomes	.796
Learning Outcomes (Total)	.923

Note: Cronbach's alpha coefficients were computed from the 400 valid questionnaires.
All Cronbach's-alpha values exceeded 0.70, proving satisfactory reliability for every scale and dimension. Mean-score interpretation criteria: 4.21-5.00 = highest; 3.41-4.20 = high; 2.61-3.40 = medium; 1.81-2.60 = low; 1.00-1.80 = lowest.

Table 3 Mean and Standard Deviation of Educational Technology Use

Educational Technology Use	$\bar{X}$	SD	Level of opinion
Perceived Usefulness	3.71	.92	High
Perceived Ease of Use	3.69	.96	High
Frequency of Technology Use	3.82	.84	High
Total	3.74	.66	High

Table 3 displays the mean, standard deviation and interpretation of educational technology use. The overall level of educational-technology use among respondents was high ($\bar{X}$ = 3.74). Frequency of technology-use obtained the highest score among three dimensions.

Table 4 Mean and Standard Deviation of Student Engagement

Student Engagement	$\bar{X}$	SD	Level of opinion
Behavioural Engagement	3.68	.91	High
Cognitive Engagement	3.75	.87	High
Emotional Engagement	3.74	.89	High
Total	3.72	.67	High

As shown in Table 4, the overall level of student engagement was high ($\bar{X}$ = 3.72, SD = .67). Cognitive engagement received the highest mean score ($\bar{X}$ = 3.75, SD = .87), followed by emotional engagement ($\bar{X}$ = 3.74, SD = .89) and behavioural engagement ($\bar{X}$ = 3.68, SD = .91).

Table 5 Mean and Standard Deviation of Learning Outcomes

Learning Outcomes	$\bar{X}$	SD	Level of opinion
Cognitive Learning Outcomes	3.71	.91	High
Skills Learning Outcomes	3.76	.88	High
Affective Learning Outcomes	3.73	.88	High
Total	3.73	.65	High

Table 5 shows that learning outcomes were also rated at a high level overall ($\bar{X}$ = 3.73, SD = .65). Skills learning outcomes received the highest mean score ($\bar{X}$ = 3.76, SD = .88), followed by affective learning outcomes ($\bar{X}$ = 3.73, SD = .88) and cognitive learning outcomes ($\bar{X}$ = 3.71, SD = .91).

Hypothesis Testing

Table 6 Correlations of Educational Technology Use and Learning Outcomes

Variables	LO	PU	PEU	TUF
Learning Outcomes (LO)	-			
Perceived Usefulness (PU)	.405***	-		
Perceived Ease of Use (PEU)	.381***	.347***	-	
Frequency of Technology Use (TUF)	.312***	.255***	.266***	-

*** p < .001, ** p < .01, * p < .05

Table 7 Correlations of Student Engagement and Learning Outcomes

Variables	LO	BE	CE	EE
Learning Outcomes (LO)	-			
Behavioural Engagement (BE)	.419***	-		
Cognitive Engagement (CE)	.423***	.300***	-	
Emotional Engagement (EE)	.401***	.402***	.324***	-

*** p < .001, ** p < .01, * p < .05

The correlation analysis results showed that all three dimensions of educational technology use (with rs of .405, .381, and .312 respectively) and all three dimensions of student engagement (with rs of .419, .423, and .401 respectively) were significantly positively correlated with learning outcomes (all p < .001). The internal correlation coefficients among the predictive dimensions were at a moderate level (internal r for educational technology use = .255-.347, internal r for student engagement = .300-.402), indicating that although these two predictors were correlated, they captured different aspects of the blended learning experience.

Table 8 Comprehensive multiple regression analysis of the impact of educational technology use and student engagement on learning outcomes

Predictors	b	Std. Error	β	t	Sig.	Tolerance	VIF
(Constant)	1.214	.170	-	7.13***	.000	-	-
Perceived Usefulness	.145	.031	.205	4.64***	.000	.812	1.232
Perceived Ease of Use	.093	.030	.138	3.06**	.002	.783	1.277
Frequency of Technology Use	.044	.034	.057	1.28	.201	.804	1.244
Behavioural Engagement	.120	.033	.167	3.60***	.000	.735	1.361
Cognitive Engagement	.178	.032	.240	5.49***	.000	.832	1.202
Emotional Engagement	.097	.034	.132	2.84**	.005	.731	1.368
$R = .615$, $R^2 = .378$, Adj. $R^2 = .368$, SEE = .511, $F = 39.80$, Sig. = .000***							

*** $p < .001$, ** $p < .01$, * $p < .05$

Table 8 lists a single comprehensive regression model that incorporates all six dimensions simultaneously. This model has statistical significance, $F(6, 393) = 39.80$，$p < .001$， And explained the variance of 37.8% in the learning results (adjusted R^2=. 368). Cognitive engagement ($\beta = .240$, $p < .001$) and perceived usefulness ($\beta = .205$, $p < .001$) became the two strongest unique predictive factors, followed by behavioural engagement ($\beta = .167$, $p < .001$), perceived ease of use ($\beta = .138$, $p = .002$), and emotional engagement ($\beta = .132$, $p = .005$). After controlling for the dimensions of perception and engagement, the frequency of technology use is no longer a significant unique predictor (β=. 057, p=. 201), indicating that its complex correlation with learning outcomes is largely mediated through perceived usefulness and student engagement. The values of tolerance (. 731 -. 832) and variance inflation factor (VIF) (1.20-1.37) confirm the absence of multicollinearity. Therefore, H1 received partial support: perceived usefulness and perceived ease of use had a significant unique positive impact, while usage frequency did not. H2 is fully supported as all three input dimensions significantly and uniquely predict learning outcomes. Students' perception of technology and their level of investment are more important than their frequency of using technology; Relying solely on the quantity of technology cannot guarantee good results, and teaching integration and quality are equally important (Mayer, 2021).

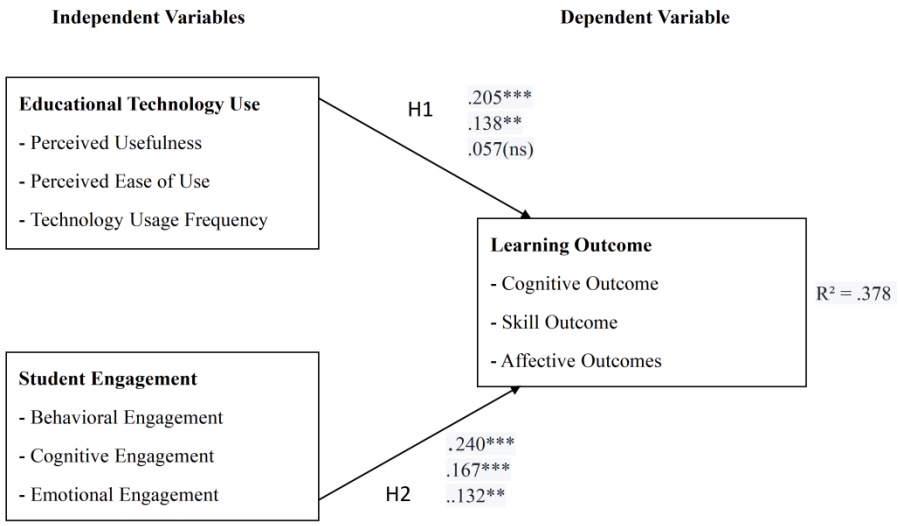
Table 9 Regression results of various dimensions of learning outcomes

Predictors	(CLO)b(SE)	β	(SLO)b(SE)	β	(ALO)b(SE)	β
(Constant)	1.028 (.267)***	-	1.344 (.264)***	-	1.331(.261)***	-
Perceived Usefulness	.179(.049)***	.180	.094 (.049)	.097	.160(.048)***	.167
Perceived Ease of Use	.062 (.048)	.065	.141 (.047)**	.153	.081 (.047)	.088
Frequency of Technology Use	.077 (.054)	.072	.033 (.053)	.031	.008(.053)	.007
Behavioural Engagement	.127 (.052)*	.127	.105 (.052)*	.108	.127(.051)*	.131
Cognitive Engagement	.155 (.051)**	.149	.199 (.050)***	.197	.186(.050)***	.186

Predictors	(CLO)b(SE)	β	(SLO)b(SE)	β	(ALO)b(SE)	β
Emotional Engagement	.121 (.053)*	.119	.076(.053)	.077	.085(.052)	.087
R^2	.217		.193		.197	
Adj. R^2	.205		.181		.185	
F	18.10***		15.70***		16.10***	

*p < .05, **p < .01, ***p < .001 (In the skills model, perceived usefulness was marginally significant, p = .055).

To break down the dependent variables of this aggregation, the same comprehensive model was estimated for cognitive, skill, and affective learning outcomes separately (Table 9). All three models have statistical significance and explain approximately one-fifth of the variance (R^2=. 217,. 193, and. 197, respectively); All p<. 001). This reveals three detailed patterns. Firstly, cognitive engagement and behavioural engagement were the only two predictors that contributed significantly to all three outcome dimensions, with cognitive engagement being the strongest predictor of skills learning outcomes (β = .197), consistent with its core role in deep learning activities. Secondly, perceived usefulness has a significant and unique contribution to cognitive outcomes (β=. 180) and emotional outcomes (β=. 167), but its contribution to skill outcomes is only at the marginal level (p=. 055), indicating that students primarily experience the usefulness of technology through better content mastery and a more positive learning attitude. Thirdly, perceived ease of use predicts skill learning outcomes (β=. 153, p=. 003), but has no predictive effect on cognitive or emotional outcomes, indicating that easy-to-use platforms primarily support the acquisition of practical and operational skills. In addition, behavioral engagement contributes to all three dimensions, while emotional engagement only reaches a significant level in cognitive outcomes (β=. 119, p=. 023), and frequency of use does not have unique predictive power for any specific dimension. These disaggregated results enable educators to more accurately locate instructional design interventions.
Figure 2 presents the finalized model of the study, in which the standardised regression coefficients are shown on the corresponding paths.



*** p < .001, ** p < .01, * p < .05, ns = not significant

Figure 2 Finalized Model

Table 10 Summary of Hypothesis Testing Results

Hypothesis	Result
H1: Educational technology use has a significant positive influence on learning outcomes in blended learning among university students in Qingdao City, Shandong Province, China.	Partial support
H2: Student engagement has a significant positive influence on learning outcomes in blended learning among university students in Qingdao City, Shandong Province, China.	Supported

From Table 10, it can be seen that the data partially supports H1 and fully supports H2) The use of educational technology has made significant contributions to learning outcomes through perceived usefulness and perceived ease of use, while student engagement has a significant positive impact on learning outcomes through all three dimensions, as reflected in blended learning among college students in Qingdao, Shandong Province, China.

DISCUSSION & CONCLUSION

Conclusion

In response to the three research questions, the study found that the levels of educational technology use, student engagement and learning outcomes among the sampled students were all high. Educational technology use contributed significantly to learning outcomes through perceived usefulness and perceived ease of use, thus partially supporting H1, and student engagement had a significant positive influence on learning outcomes, thus supporting H2) Therefore, both educational technology use and student engagement are significant predictors of learning outcomes in blended learning among university students in the six private undergraduate universities in Qingdao City, Shandong Province, China.

Discussion of the Findings

The findings of this study can be summarised as follows. In the single comprehensive regression model, the six dimensions of educational technology use and student engagement jointly explained 37.8 per cent of the variance in learning outcomes. Cognitive engagement was the strongest unique predictor ($\beta = .240$), followed by perceived usefulness ($\beta = .205$), behavioural engagement ($\beta = .167$), perceived ease of use ($\beta = .138$) and emotional engagement ($\beta = .132$), whereas usage frequency was not uniquely predictive once the other dimensions were controlled for. Student engagement, with cognitive engagement at its core, and the perceptual dimensions of educational technology use therefore both contribute distinct variance to learning outcomes. The disaggregated analyses further showed that cognitive engagement significantly predicted all three outcome dimensions, perceived ease of use uniquely fostered skills learning outcomes ($\beta = .153$), perceived usefulness contributed to cognitive and affective outcomes, and behavioural engagement contributed to all three dimensions, offering granular guidance for targeted instructional design.

These findings can be interpreted through the Technology Acceptance Model, which proposes that perceived usefulness and perceived ease of use are the core determinants of technology acceptance and usage behaviour (Davis, 1989). The finding that perceived usefulness was the strongest predictor among the three dimensions of educational technology use is consistent with Islam (2016), who found that the impact of perceived usefulness on learning outcomes was stronger than that of perceived ease of use, and with the meta-analytic evidence of Vo et al. (2017) that blended learning, when technology is integrated with sound pedagogical design, produces moderately positive effects on course performance. The finding that student engagement, especially cognitive engagement, significantly predicts learning outcomes is consistent with the multidimensional framework of Fredricks et al. (2004) and with the results of Kuh (2003) and Carini et al. (2006), who reported that engagement is significantly and

positively correlated with learning outcomes. The results also align with the view of Rasheed et al. (2020) that student engagement is a key factor affecting the success of blended learning, and with recent evidence that technology-enhanced learning can promote behavioural, cognitive and affective engagement (Bond & Bedenlier, 2019), that emotional factors such as teacher support predict online learning engagement (Sun, 2025), and that the three dimensions of engagement are interconnected and mutually influential (Deng & Yang, 2025).

Implications of the Study

Theoretically, this study extends the application of the Technology Acceptance Model and the multidimensional framework of student engagement to the blended learning context of private undergraduate universities in China. The results provide empirical evidence that educational technology use and student engagement jointly, but with different relative strengths, predict learning outcomes, supporting a dual-predictor framework in which technology-related perceptions and behaviours on the one hand, and behavioural, cognitive and emotional investment in learning on the other hand, both contribute to learning outcomes. By incorporating the two predictors within a single research framework, the study enriches theoretical research on the factors influencing learning outcomes in blended learning and provides empirical evidence from the Chinese higher education context.

Practically, the findings provide several actionable implications for lecturers, course designers and university administrators. First, given that perceived usefulness is the strongest predictor of learning outcomes, lecturers and course designers should select and design educational technology tools that are clearly useful for learning, such as platforms that facilitate lesson review, assignment submission and mastery of key course content, and should communicate the practical value of these tools to students. Second, because perceived ease of use also contributes significantly to learning outcomes, the interfaces and functions of online learning platforms should be kept user-friendly, and technical guidance and training should be provided to reduce the effort required to use the tools. Third, since student engagement, especially cognitive engagement, strongly predicts learning outcomes, blended courses should be designed to promote active participation, deep understanding and critical thinking through interactive activities, collaborative learning, timely feedback and appropriately challenging tasks. Fourth, university administrators should invest in reliable learning platforms and technical support, organise training on blended teaching and learning, and monitor and support student engagement in blended courses. Finally, students themselves can benefit from developing self-regulated learning strategies, such as planning and monitoring their online learning, and from actively participating in both online and face-to-face learning activities.

Limitations and Future Research

However, this study has some limitations that should be considered when interpreting the findings. The results were obtained from six private undergraduate universities in a single city in China, which limits the generalisability of the findings. Future research should therefore be conducted in a wider range of institutions, including public universities and universities in other cities and provinces, to examine whether the identified relationships hold across different contexts. Future studies could also include additional variables that may contribute to learning outcomes in blended learning, such as learning motivation, self-efficacy, perceived teacher support and course design quality, and could examine mediating and moderating mechanisms, for example, whether student engagement mediates the relationship between educational technology use and learning outcomes. In addition, future research is recommended to adopt mixed-methods designs incorporating qualitative techniques such as interviews, classroom observation and case studies, and longitudinal designs, and to complement self-reported outcomes with objective measures such as course grades, assessment performance and observed learning behaviours.

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