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An exploratory study of learning engagement and influential factors in a blended learning environment among higher vocational students

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Abstract

Effective adoption of blended learning necessitates the learning engagement of students to the best extent, but limited attention has been paid to the learning engagement of vocational colleges in previous studies. Thus, the present study aims to investigate students' learning engagement in a blended learning environment and explore the influential factors in vocational education. After collecting questionnaires from 392 vocational students at Guangxi Vocational University of Agriculture, this research employed independent samples t-tests, one-way ANOVA, and multiple regression analysis to perform the data analysis. The analysis results identified a high level of behavioral engagement but a low level of emotional engagement. In terms of group differences, gender, computer skills, hometown, and disciplinary background significantly influenced learning engagement, and notable positive correlations were also found between computer skills and cognitive engagement as well as behavioral engagement. Additionally, the multiple regression analysis revealed that teacher factors played a critical role in overall learning engagement, while resource and platform factors significantly promoted behavioral and cognitive engagement. Findings of this research contribute to the empirical evidence of learning engagement in vocational education and provide insights for improving blended learning courses tailored to vocational learners' characteristics.

Keywords: Behavioral engagement, Blended learning, Cognitive engagement, Emotional engagement, Higher vocational students, Learning engagement, Vocational education.

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Contents

Contribution of this paper to the literature

This study contributes to the existing literature by analyzing problems and challenges of blended learning engagement in the vocational education setting. Moreover, the research offers suggestions for promoting learning engagement in the blended learning environment, including strengthening teacher guidance, optimizing resources and platforms, implementing differentiated interventions, and reforming assessment systems.

1. Introduction

In recent years, researchers have started to recognize the critical role of learning engagement in the context of vocational education, as it directly affects skill acquisition (Chukwuedo, Mbagwu, & Ogbuanya, 2021; Jayalath & Esichaikul, 2022; Song & Lai, 2025). Given that courses in agricultural vocational colleges are practice-oriented and skills-driven, the modes of online learning and classroom participation also differ from those in universities. There are also some issues of "high registration and low completion" or cyber-loafing, which deviate from the expected outcomes of blended learning (Zhang et al., 2022). However, existing research mainly focuses on general universities or comprehensive vocational colleges, with limited attention to agricultural vocational colleges (Niittylahti, Annala, & Mäkinen, 2023). Therefore, it is essential to identify the problems and influential factors of learning engagement among vocational students and to seek targeted measures to sustain their engagement in blended learning.

To address the research gap, the present study intends to delve into students' learning engagement in a blended learning environment and explore the influential factors in vocational education. Findings of this research could enrich our understanding of existing problems and challenges of learning engagement in the vocational education setting, and also contribute to the empirical evidence on providing directions for improving current blended learning courses based on the characteristics of vocational learners. Hence, the following research questions will be addressed.

(1) What is the current status of learning engagement in the blended learning environment among higher vocational students?
(2) Are there differences in engagement across gender, major, hometown, and computer proficiency?
(3) What are the main factors influencing learning engagement?
(4) What strategies can enhance engagement and learning outcomes?

2. Literature Review

2.1. Blended Learning

Blended learning has been widely integrated into vocational education around the world (Jayalath & Esichaikul, 2022). As an innovative teaching mode, it leverages the advantages of face-to-face and online learning so that learners can engage in both synchronous and asynchronous activities (Pan, Yan, & Zhang, 2022; Shakeel, Al Mamun, & Haolader, 2023). Angwaomaodoko (2023) illustrated that blended learning offers both students and educators a holistic educational setting that integrates conventional classroom elements (such as textbooks) with modern technologies (including computers, mobile devices, and learning management systems). Moreover, blended learning has been adopted by educators across a wide range of disciplines, such as computer science, mathematics, mechanics, and language acquisition, to name a few (Ali, Khan, & Alouraini, 2023; Egara & Mosimege, 2024; Shakeel et al., 2023).

The mode of blended learning offers flexible access to online learning resources, along with opportunities for interactions beyond classrooms with the support of technological tools, learning management systems, gamification, flipped classrooms, or Massive Open Online Courses (MOOCs) (Chen, Jalaludin, & Rasul, 2024). It combines the strengths of conventional and online learning to guarantee the teachers' guiding role and the students' initiative in the learning process, thereby leading to better learning outcomes (Müller & Mildenberger, 2021). When it comes to vocational education, the application of blended learning focuses on equipping vocational students with practical knowledge related to real-world scenarios, specific skills, and competencies for future workplaces, which can bridge the gap between formal vocational education and the demands of the labor market (Song & Lai, 2025).

2.2. Learning Engagement

Learning engagement refers to the quality of physical and psychological efforts that students make to achieve expected learning outcomes (Halverson & Graham, 2019). It is a consensus among researchers that learning engagement can be categorized into behavioral, cognitive, and emotional dimensions (Fredricks, Blumenfeld, & Paris, 2004; Heo, Bonk, & Doo, 2022). Specifically, behavioral engagement represents the quantity and quality of active participation in learning activities, while cognitive engagement refers to the use of cognitive and metacognitive strategies (Fredricks et al., 2004). In addition, emotional engagement illustrates students' emotional and psychological involvement with academic tasks (Kim, Cho, Kim, & Kim, 2023).

Effective adoption of blended learning necessitates the efforts students dedicate to their studies or their learning engagement (Heo et al., 2022). Previous studies indicate that learning engagement can be influenced by perceived ease of use of online platforms, instructional design, teacher support, and learners' self-regulated learning abilities and motivation (Almaiah, Al-Khasawneh, & Althunibat, 2020; Jiang, Hu, & Feng, 2025; Kintu, Zhu, & Kagambe, 2017; Liao, Zhang, Yang, & Fei, 2023; Su, Zou, Wang, & Kohnke, 2024). For example, Liao et al. (2023) carried out a thirteen-week longitudinal study and identified that contextual factors, such as teacher support and instructional design, had positive effects on cognitive and emotional engagement, while co-regulated learning was shown to be closely connected with emotional engagement. Therefore, more empirical studies are essential to further investigate specific dimensions of learning engagement in the blended learning environment.

3. Research Methodology

3.1. Participants

Participants were selected from 20,000 vocational students at Guangxi Vocational University of Agriculture, and their majors covered several disciplines such as Agricultural Engineering, Humanities and Arts, and Economics and Management. For data analysis, these majors were categorized into two broad groups: Humanities and Social

Sciences, and Science and Engineering. Based on a stratified random sampling method, researchers conducted random sampling within each major. The present study followed the empirical sample size formula of Israel (1992) and it was expected to include at least 392 participants according to the 95% confidence level with a 5% margin of error. Therefore, 400 students were invited to complete the survey. After data cleaning, excluding missing values, outliers, and inconsistencies, 392 valid responses remained, with a response rate of 98%. Table 1 presents the demographic data for this study, including gender, hometown, fields of study, and computer proficiency.

Table 1. Demographic characteristics of participants (N = 392).

Variables	Category	N	%
Gender	Male	200	51.0
	Female	192	49.0
Hometown	Rural area	285	72.7
	Urban area	107	27.3
Fields of study	Humanities and social sciences	191	48.7
	Science and engineering	201	51.3
Computer proficiency	None	31	7.9
	Basic	126	32.1
	Proficient	174	44.4
	Mastery	61	15.6
Total		392	100

3.2. Instruments

The survey consisted of three parts, namely, the demographic survey, the Learning Engagement Scale, and the Factors Influencing Learning Engagement Scale. In the first section, demographic information was collected, including gender, hometown, fields of study, and computer proficiency. The second section assessed learning engagement with the 14-item scale developed by Luo (2019). Learning engagement was measured using a 5-point Likert scale (1 = "strongly disagree", 5 = "strongly agree"). The Learning Engagement Scale was classified into dimensions of behavioral, cognitive, and emotional engagement. The third section measured factors influencing learning engagement using the 24-item five-point scale developed by Jiang (2019). There are five dimensions, including teacher factors, learning resource factors, learning platform factors, learning assessment factors, and student factors. All factors were measured using a 5-point Likert scale (1 = "No influence" to 5 = "Very strong influence"), with higher scores indicating stronger positive effects on learning engagement.

Table 2 and 3 display the reliability and validity of questionnaires for this research. For example, the Cronbach's α for the overall learning engagement scale was 0.893, with all sub-dimensions exceeding 0.70, indicating high reliability. Similarly, Table 3 shows that Cronbach's α for the influential factors scale was 0.726, with all sub-dimensions above 0.70, and particularly high reliability for teacher factors and learning assessment factors ($\alpha > 0.90$). Additionally, values of KMO were above 0.70, and Bartlett's tests were significant ($p < 0.001$). Therefore, these two scales are adequate for further analysis of learning engagement and its influential factors.

Table 2. Reliability and validity of the learning engagement scale.

Variables	Number of items	Cronbach's α	KMO	Bartlett p
Learning engagement	14	0.893	0.899	0.000
Behavioral engagement	5	0.734	0.753	0.000
Cognitive engagement	5	0.875	0.828	0.000
Emotional engagement	4	0.746	0.706	0.000

Table 3. Reliability and validity of the factors influencing the learning engagement scale.

Variables	Number of items	Cronbach's α	KMO	Bartlett p
Overall	24	0.726	0.727	0.000
Student factors	8	0.820	0.711	0.000
Teacher factors	5	0.914	0.802	0.000
Learning resource factors	5	0.777	0.703	0.000
Learning platform factors	3	0.825	0.710	0.000
Learning assessment factors	3	0.905	0.702	0.000

3.3. Data Collection and Analysis

Ethical approval and consent were obtained from the relevant institutions and participants, respectively. The questionnaires were distributed online via Wenjuanxing, a widely used platform for data collection in China. Four hundred students from Guangxi Vocational University of Agriculture were invited to anonymously complete the survey and had the right to withdraw from the study at any time. Finally, researchers confirmed that 392 valid responses remained after data cleaning.

Data were analyzed using the Statistical Package for the Social Sciences (SPSS 23.0). Descriptive analysis was first conducted to describe the current status of learning engagement, its sub-dimensions, and influential factors among vocational college students. The data were also checked to ensure they met the assumptions of normality and homogeneity of variance. Subsequently, the study adopted independent samples t-tests to examine group differences based on gender, hometown, and fields of study. Then, a one-way ANOVA was conducted to assess the relationships between different levels of computer proficiency and learning engagement. Finally, the multiple regression approach was adopted to explore the influential factors of learning engagement and its different dimensions.

4. Results

4.1. Descriptive Statistics

The results of descriptive statistics can be found in Table 4. Accordingly, the mean value of overall learning engagement (M= 3.06, SD = 0.39) is slightly above the medium level, indicating that the learning engagement of vocational college students still has room for improvement in the blended learning setting. With regard to each dimension, behavioral engagement had the highest scores (M= 3.20, SD=0.43), followed by cognitive engagement (M= 3.04, SD=0.55) and emotional engagement (M= 2.91, SD=0.37). In other words, students demonstrated the strongest engagement in behavioral aspects, whereas the level of emotional engagement was the lowest.

Table 4. Descriptive statistics of learning engagement.

Dimensions	Number of Items	Mean	SD	Min.	Max.
Learning engagement	14	3.06	0.39	1.79	3.79
Behavioral engagement	5	3.20	0.43	1.80	4.00
Cognitive engagement	5	3.04	0.55	1.20	4.00
Emotional engagement	4	2.91	0.37	2.00	4.00

Note: N = 392.

4.2. Group Differences

4.2.1. Differences in Learning Engagement by Demographic Information

Table 5 summarizes the results of independent samples t-tests on gender differences. As shown in this table, female students reported significantly higher overall learning engagement (M = 3.10, SD = 0.35) than male students (M = 3.02, SD = 0.41). There was also statistical significance between male and female respondents (t = -2.137, $p < 0.05$), indicating that gender had a modest effect on overall engagement. When it came to sub-dimensions, behavioral engagement of female learners (M = 3.26, SD = 0.40) was significantly higher than that of male counterparts (M = 3.15, SD = 0.43) (t = -2.554, $p < 0.05$). However, no significant difference was observed in terms of cognitive engagement (p = 0.113) and emotional engagement between different genders (p = 0.211).

Table 5. Independent samples t-tests based on gender difference.

Dimensions	Male		Female		*t*	*p*
	Mean	SD	Mean	SD		
Learning engagement	3.02	0.41	3.10	0.35	-2.137	0.033*
Behavioral engagement	3.15	0.43	3.26	0.40	-2.554	0.011*
Cognitive engagement	3.00	0.58	3.09	0.50	-1.590	0.113
Emotional engagement	2.89	0.37	2.94	0.36	-1.253	0.211

***Note:** Male(N=200), Female (N=192), *$p < 0.05$.

Table 6 outlines the results of independent samples t-tests that compare group differences based on hometown and fields of study. To illustrate, in terms of hometown, a significant statistical difference was observed between rural and urban learners ($p < 0.05$). Students from urban areas reported higher scores of learning engagement (M = 3.12, SD = 0.29) than rural students (M = 3.04, SD = 0.42). The value of effect size (Cohen's d = 0.21) is small according to the guidelines of the effect size (Cohen, 1988). In other words, hometown had a statistically significant but modest impact on learning engagement. Moreover, the difference in learning engagement was more pronounced across different fields of study ($p < 0.001$). Students majoring in Science and Engineering showed higher engagement (M = 3.15, SD = 0.36) than those in Humanities and Social Sciences (M = 2.97, SD = 0.39). A medium effect size (Cohen's d = 0.47) suggested that fields of study had a more substantial practical influence on learning engagement. Therefore, both hometown and fields of study had significant effects on overall learning engagement among higher vocational students.

Table 6. Independent samples t-tests based on hometown and fields of study.

	Category	N	M	SD	p (two-tailed)
Hometown	Rural	285	3.04	0.42	0.030*
	Urban	107	3.12	0.29	
Fields of study	Humanities and social sciences	191	2.97	0.39	0.000***
	Science and engineering	201	3.15	0.36	

Note: *$p < 0.05$, ***$p < 0.001$.

4.2.2. Differences in Learning Engagement and Its Dimensions by Computer Proficiency Level

The relationships between computer proficiency levels and learning engagement were examined using One-way ANOVA. Table 7 summarizes differences in learning engagement across four levels of computer proficiency. It is noted that the mean value of learning engagement increased with higher computer proficiency levels. Based on the One-way ANOVA results, there was a significant association between computer proficiency and overall learning engagement ($p < 0.001$). Significant statistical differences were also identified between computer proficiency and three sub-dimensions of learning engagement. However, this does not necessarily mean that better computer proficiency predicts higher learning engagement. According to Table 7, the "Proficient" group had the highest behavioral engagement (M = 3.47, SD = 0.23) and cognitive engagement (M = 3.39, SD = 0.21), but there was a slight decrease in these two dimensions among the "Mastery" group, which reflected their reduced interest in routine tasks. Furthermore, the mean value of emotional engagement demonstrated a consistent upward trend, with the highest score in the "Mastery" group (M = 3.03, SD = 0.28). Therefore, computer proficiency serves as a necessary foundation for enhancing engagement in blended learning, which indicates a positive impact of computer proficiency on learning engagement. However, the four groups of computer proficiency demonstrated minor fluctuations in behavioral, cognitive, and emotional engagement, suggesting that targeted teaching strategies should be adopted to further enhance engagement.

Table 7. Influence of computer proficiency on learning engagement and its dimensions (One-Way ANOVA).

Computer proficiency	N	Learning engagement M (SD)	Behavioral engagement M (SD)	Cognitive engagement M (SD)	Emotional engagement M (SD)
None	31	2.00 (0.14)	2.20 (0.16)	1.60 (0.28)	2.23 (0.15)
Basic	126	2.93 (0.15)	2.99 (0.16)	2.85 (0.22)	2.94 (0.18)
Proficient	174	3.30 (0.16)	3.47 (0.23)	3.39 (0.21)	2.97 (0.40)
Mastery	61	3.22 (0.16)	3.39 (0.30)	3.20 (0.24)	3.03 (0.28)
ANOVA p-value		<0.001	<0.001	<0.001	<0.001

Note: N = 392.

4.3. Results of Key Factors Influencing Learning Engagement

4.3.1. Descriptive Statistics of Influential Factors

To investigate the key factors influencing learning engagement among higher vocational students in a blended learning environment, descriptive statistics of student factors, teacher factors, learning resource factors, learning platform factors, and learning assessment factors are outlined in Table 8. In general, the mean value of the overall influential factor score was 3.26 (SD = 0.15), suggesting that students generally perceived various factors as having a positive impact on their learning engagement. In terms of specific factors, teacher factors had the highest mean score (M = 3.91, SD = 0.31), followed by learning resource factors (M = 3.39, SD = 0.34) and student factors (M = 3.00, SD = 0.16), which constituted three primary predictors of learning engagement. By contrast, learning platform factors and learning assessment factors had relatively low mean values. Therefore, teacher factors exert the strongest positive influence, whereas learning platform and assessment factors represent clear weaknesses. Future initiatives should also be made to enhance platform functionality and refine assessment systems, alongside strengthening teacher guidance.

Table 8. Descriptive statistics of factors influencing students' learning engagement.

Dimensions	N	Min	Max	Mean	SD
Overall Influential Factors	392	2.79	3.63	3.26	0.15
Student factors	392	2.00	3.75	3.00	0.16
Teacher factors	392	3.00	4.60	3.91	0.31
Learning resource factors	392	2.60	4.00	3.39	0.34
Learning platform factors	392	2.00	4.00	2.96	0.37
Learning assessment factors	392	2.00	4.00	2.90	0.54

4.3.2. Correlation Analysis

Table 9 presents the results of the Pearson correlation analysis between the three dimensions of learning engagement and the five influential factors as follows. Teacher factors were positively correlated with behavioral engagement ($r = 0.17$, $p < 0.01$), cognitive engagement ($r = 0.16$, $p < 0.01$), and emotional engagement ($r = 0.39$, $p < 0.01$), indicating the crucial role of teachers in enhancing learning engagement. Resource factors demonstrated the strongest support for behavioral engagement ($r = 0.21$, $p < 0.01$) and emotional engagement ($r = 0.48$, $p < 0.01$). Student factors were weakly correlated with cognitive engagement ($r = 0.13$, $p < 0.05$). Platform factors showed moderate positive correlations with behavioral engagement ($r = 0.18$, $p < 0.01$) and cognitive engagement ($r = 0.17$, $p < 0.01$), but their effect was relatively limited. It is also noted that there was no correlation between assessment factors and the three dimensions of learning engagement ($p > 0.05$). These findings suggest a hierarchical pattern in the relationships between engagement dimensions and influential factors. In summary, teacher and resource factors serve as the primary positive drivers of student engagement, whereas platform factors exert a limited influence, and assessment factors exhibit weak or unstable effects. These findings provide targeted insights for optimizing blended learning environments.

Table 9. Pearson correlations between learning engagement and influential factors.

Dimensions	Student factors	Teacher factors	Resource factors	Platform factors	Assessment factors
Learning engagement	0.13**	0.14**	0.16**	0.18**	0.09^{ns}
Behavioral engagement	0.16**	0.17**	0.21**	0.18**	0.08^{ns}
Cognitive engagement	0.13*	0.16**	0.15**	0.17**	0.09^{ns}
Emotional engagement	0.08^{ns}	0.39**	0.48**	0.12^{ns}	0.19^{ns}

***Note:** N = 392; *p < 0.05, **p < 0.01, ns = not significant.

The correlations among behavioral, cognitive, and emotional engagement dimensions can be found in Table 10. As illustrated in this table, behavioral engagement and cognitive engagement were highly correlated ($r = 0.79$, $p < 0.01$) and exhibited strong correlations with learning engagement ($r = 0.89$ and $r = 0.94$, respectively, $p < 0.01$). However, emotional engagement shows a somewhat lower correlation with overall learning engagement ($r = 0.66$, $p < 0.01$).

Table 10. Correlations among dimensions of learning engagement.

Dimensions	Behavioral engagement	Cognitive engagement	Emotional engagement	Overall learning engagement
Behavioral engagement	—	0.79**	0.54**	0.89**
Cognitive engagement	0.79**	—	0.51**	0.94**
Emotional engagement	0.54**	0.51**	—	0.66**
Overall learning engagement	0.89**	0.94**	0.66**	—

***Note:** N = 392, *p < 0.05, **p < 0.01.

4.3.3. Regression Analysis

The approach of multiple regression analysis was adopted to further explore the predictive roles of five influential factors in learning engagement and its different dimensions among vocational college students. According to Table 11, the results demonstrated the disparity of different factors in terms of their influences on learning engagement and the three dimensions. Generally, learning resource factors ($\beta = 0.139$, $p < 0.01$) and platform factors ($\beta = 0.159$, $p < 0.01$) had significant positive effects on overall learning engagement, and the same pattern was observed between student factors and learning engagement ($\beta = 0.106$, $p < 0.05$). Besides, the model exhibited relatively low explanatory power ($R^2 = 0.072$, $F = 6.003$, $p < 0.001$).

When analyzing behavioral engagement, student factors ($\beta = 0.124$, $p = 0.012$), resource factors ($\beta = 0.198$, $p < 0.001$), and platform factors ($\beta = 0.157$, $p = 0.001$) were all significant positive predictors. The model's explanatory power ($R^2 = 0.096$, $F = 8.233$, $p < 0.001$) was slightly higher than that of the overall learning engagement model, indicating that behavioral engagement is more susceptible to both internal factors of learners and external learning conditions in vocational education. Regarding the cognitive engagement model, learning platform factors ($\beta = 0.154$, $p = 0.002$) were the most significant positive predictor, followed by resource factors ($\beta = 0.119$, $p = 0.020$) and student factors ($\beta = 0.108$, $p = 0.029$). The explanatory power of this model remained limited ($R^2 = 0.067$, $F = 5.505$, $p < 0.001$). In other words, cognitive engagement may be influenced by more complex factors, such as vocational skill development and metacognitive strategies. It is also noted that no significance was identified in the emotional engagement model ($R^2 = 0.012$, $F = 0.901$, $p = 0.480$), indicating that none of the five conventional predictors significantly explained variations in emotional engagement in this study.

Table 11. Multiple regression analysis of factors affecting blended learning engagement.

Dependent variable	Model fit (R, R^2, adjusted R^2)	ANOVA significance (F, p)	Significant predictors (Standardized β, p)
Learning engagement	$R = 0.269$, $R^2 = 0.072$, Adjusted $R^2 = 0.060$	$F(5, 386) = 6.003$, $p < 0.001$	Resource factors ($\beta = 0.139$, $p = 0.006$); Platform factors ($\beta = 0.159$, $p = 0.001$); Student factors ($\beta = 0.106$, $p = 0.033$)
Behavioral engagement	$R = 0.310$, $R^2 = 0.096$, Adjusted $R^2 = 0.085$	$F(5, 386) = 8.233$, $p < 0.001$	Student factors ($\beta = 0.124$, $p = 0.012$); Resource factors ($\beta = 0.198$, $p < 0.001$); Platform factors ($\beta = 0.157$, $p = 0.001$)
Cognitive engagement	$R = 0.258$, $R^2 = 0.067$, Adjusted $R^2 = 0.054$	$F(5, 386) = 5.505$, $p < 0.001$	Resource factors ($\beta = 0.119$, $p = 0.020$); Platform factors ($\beta = 0.154$, $p = 0.002$); Student factors ($\beta = 0.108$, $p = 0.029$)
Emotional engagement	$R = 0.107$, $R^2 = 0.012$, Adjusted $R^2 = -0.001$	$F(5, 386) = 0.901$, $p = 0.480$	None

Note: $N = 392$.

5. Discussion

5.1. Status of Learning Engagement in Blended Courses

In order to answer the first research question, this study found that higher vocational students demonstrated a moderately high level of overall learning engagement. Specifically, behavioral engagement was the highest dimension, followed by cognitive engagement, while emotional engagement was below average. A similar pattern was also observed in the study by Xu and Zhang (2022), which identified a high level of behavioral engagement among students in the context of blended learning. By contrast, Yang, Yuan, Tan, Wang, and Li (2021) reported that the middle school students had a high level of emotional engagement in their mathematical learning. These contradictory results can be attributed to the different student groups, and vocational students focus more on skill-based tasks and hands-on training due to the practice-oriented features of vocational education.

Moreover, the present study also demonstrated that the level of emotional and cognitive engagement among vocational learners still had room for improvement in the blended learning environment, which warrants attention from vocational educators. Henrie, Halverson, and Graham (2015) argued that the effectiveness of technology-supported learning was limited in promoting behavioral engagement, rather than cognitive or emotional engagement, due to a lack of contextualized design and feedback mechanisms. Previous studies also identified close connections between emotional and behavioral engagement (Yang et al., 2021). This can be interpreted by the broaden-and-build theory, which asserts that positive emotions could motivate approaching behaviors and in-depth cognitive learning (Fredrickson, 2001). Conversely, the behavioral and cognitive engagement of vocational learners might not be sustained when they have a limited level of emotional engagement (Sureda-Garcia, Jimenez-Lopez, Alvarez-Garcia, & Quintana-Murci, 2021). Therefore, learning activities must be deliberately designed based on the characteristics of vocational students, and competitive or project-based tasks can be introduced to enhance their behavioral, cognitive, and emotional engagement.

5.2. Group Differences in Learning Engagement

For the second research question, gender had a significant impact on overall engagement and behavioral engagement, with female students performing better than their male counterparts. Similarly, Sureda-Garcia et al. (2021) also identified gender differences in behavioral engagement among Spanish vocational learners and reported better learning engagement among girls than boys. Such results may be attributed to the characteristics of female groups with self-regulated learning capacity in various learning environments. Nevertheless, contradictory findings have also been observed in prior studies. For instance, Kara (2022) did not identify the difference in online learning engagement between male and female learners, indicating that other contextual factors, such as subjects, teacher support, or digital platforms, may also exert an influence on learning engagement in the blended courses. Therefore, it demands further analysis of contextual variables to provide a more nuanced understanding of blended learning engagement among higher vocational students.

Besides, students from urban areas and those majoring in science and engineering reported higher levels of engagement, which reflects the impact of resource accessibility and disciplinary characteristics. This corroborates a recent study of Ma, Xiao, and Liu (2024) that also observed striking differences between Chinese rural and urban

students in terms of their learning due to disparate family support and resource allocation (Ma et al., 2024). Moreover, Koo (2016) highlighted that the expansion of vocational education in China attracted many rural youths but failed to offer them sufficient opportunities for upward mobility, suggesting a mismatch in resource allocation for their learning. In addition, differences across fields of study indicated that STEM students exhibited higher engagement due to the better suitability of virtual simulation resources compared to their peers from the fields of humanities and social sciences. In a similar vein, Zheng, Zeng, Huang, and Sun (2024) also reported that students majoring in liberal arts demonstrated lower learning engagement than that of science students, which underscored the imbalanced distribution of both geographical and disciplinary groups. It is suggested that equitable access to educational resources remains a critical factor of student engagement in vocational education.

Finally, computer proficiency was strongly associated with blended learning engagement, with the "Proficient" group showing the highest level of engagement. This supports the view of Zhu and Hu (2022) who argued that digital literacy is a crucial foundation for blended learning, with computer skills serving as its core component that directly affects the quality of learning engagement. Similarly, Kara (2022) demonstrated that digital literacy constitutes a central predictor of technology acceptance and significantly influences learning engagement quality. Warschauer and Matuchniak (2010) also systematically explained how the digital divide affects learning outcomes through disparities in access to resources and digital skills. Bridging courses in digital skills prior to enrollment can help reduce this gap, consistent with Means, Toyama, Murphy, and Baki (2013) who concluded in their meta-analysis that technology support needs to be adapted to learners' digital readiness. The significant role of computer proficiency indicates that digital literacy training is critical for vocational learners, particularly those from rural areas.

5.3. Influential Factors of Learning Engagement

In response to the third research question, teacher factors, student factors, resource factors, platform factors, and assessment factors were analyzed based on the approach of multiple regression analysis. Above all, teacher-related factors were found to have the highest mean value, followed by learning resource factors, while learning platform and assessment factors had relatively lower mean values. Furthermore, the results of regression analysis indicated that resource, platform, and student factors significantly predicted the overall learning engagement of vocational students. Likewise, Liu and Li (2024) proposed and validated a model that recognized teacher presence, diverse resources in multi-modal forms, and relevant functions of learning platforms as critical factors influencing the effectiveness of blended learning. Additionally, the present study revealed that there was no significant relationship between teacher factors and learning engagement based on the regression analysis. Su et al. (2024) illustrated that teachers' feedback, hands-on experience, and clear instructions were closely correlated with learning engagement in the blended courses. Similarly, the five-stage model for online teaching proposed by Salmon (2012) accentuated teachers' support for learning through resource integration and interactive guidance, rather than only imparting knowledge or theories.

According to the multiple regression analysis, both student factors and platform factors emerged as the strongest predictors of behavioral and cognitive engagement. Similarly, Liao et al. (2023) elaborated that the self-regulated learning capacity was positively correlated with cognitive engagement in blended learning courses. In addition, Jiang et al. (2025) found that the perceived ease of use of online teaching platforms positively influences learning engagement, with self-efficacy serving as a mediating role. Zheng et al. (2024) also identified that the library environment has a significant impact on learning engagement. Moreover, it is also noted that emotional engagement showed no significant predictors in the regression model. However, Liao et al. (2023) illustrated that perceived teacher support contributed to enhancing emotional engagement of undergraduates who studied blended learning courses. In this case, potential factors such as teacher support or peer interaction warrant our attention in future research, and it is essential to provide vocational learners with high-quality and relevant resources and platforms, such as simulation videos and library resources, to support their blended learning engagement.

5.4. Suggestions for Promoting Blended Learning Engagement

This research offers several implications for suggestions and strategies to promote learning engagement among vocational learners in the context of blended learning. First, attention should be paid to group differences among vocational learners, and targeted measures can be taken to improve digital access for rural students, humanities and social science learners, and male students at vocational schools. In this case, educational equity can be guaranteed by enhancing engagement across diverse student populations. Second, due to the effect of teacher factors on learning engagement, it is essential to strengthen the role of teacher support in the blended courses, and vocational institutions are expected to organize training workshops to enhance teachers' competencies in online interaction and emotional communication. Third, improving learning platform functionality is pivotal in strengthening behavioral and cognitive engagement. Recommendations include optimizing interface design, simplifying operations, enhancing platform stability, and adding interactive features such as collaborative modules and AI-powered feedback tools. To reduce technical barriers, simplified guides and step-by-step instructions should be provided for vocational students with limited digital literacy skills. Fourth, the learning assessment should be reformed to promote diversified and formative evaluation practices, instead of relying heavily on summative assessment. In the blended learning setting, the learning process can also be assessed through platform resource usage, alongside problem-solving and creativity behaviors, so that timely feedback can be provided to encourage personalized learning strategies and sustained engagement. Finally, optimizing and enriching learning resources is also a critical step, with an emphasis on developing high-quality practical resources such as virtual training cases and skill demonstration videos tailored for vocational contexts. Structuring resources at different difficulty levels can further support students with weaker foundations, increasing accessibility, effectiveness, and active participation in blended learning. Additionally, integrating industry case studies and career guidance into teaching can strengthen the connection between learning content and professional requirements. This can enhance students' sense of learning identity and belonging, specifically improving the current weakness in emotional engagement.

6. Conclusion

This study focused on the analysis of learning engagement and its influential factors in a blended learning environment among vocational college learners. These findings contribute to the empirical evidence regarding existing problems and challenges of learning engagement in vocational education. More importantly, suggestions for promoting learning engagement in the blended learning environment were also offered, including strengthening teacher guidance, optimizing resources and platforms, implementing differentiated interventions for students, and reforming assessment systems. These strategies offer empirical support and practical pathways for enhancing the quality of digital teaching in vocational education and provide a reference for blended learning reforms in similar institutions.

It is also acknowledged that this research has several limitations. First, the sample was only collected from a vocational college in China, which might limit the generalizability of the findings. Future research could adopt a multi-region, multi-institution sampling approach, which would enhance the generalizability of the results by covering institutions across different regions. Second, the explanatory power of the regression models was limited, indicating the need to include additional variables, such as peer interaction and course-content alignment. Finally, the present study relied on self-reported questionnaires and quantitative analysis to explore the issue of learning engagement in the blended learning environment. Future research could collect diversified sources of data or employ qualitative analysis to provide targeted strategies for optimizing blended learning environments.

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