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Research on the Influencing Factors of College Students' Deep Meaningful Learning in Blended Learning Mode

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Abstract

This study examines the factors that impact deep and meaningful learning in blended learning environments and their connections. The sample included 397 college students from a university in Sichuan Province, selected through random sampling. Data was collected using a questionnaire based on Bandura's ternary interaction theory, encompassing learners, helpers, environment, and interaction dimensions. The following text should be remembered: "Hypotheses were developed based on existing literature, and a survey with established scales was created. Quantitative analysis was conducted using SPSS and AMOS software. The mean, standard deviation, Variance, skewness, and kurtosis values were within reasonable ranges. The model's latent variables showed strong convergent validity, with standardized factor loadings (SFL) ranging from 0.807 to 0.965, average Variance extracted (AVE) from 0.697 to 0.946, and composite reliability (CR) from 0.919 to 0.946. Model fit indices indicated acceptable fit (CMIN/DF: 2.303, NFI: 0.966, CFI: 0.980, RMSEA: 0.058, RMR: 0.008, PNFI: 0.789). The study optimized the model through path analysis, culminating in the final structural equation model (SEM)." Findings indicate (1) Learner, environmental, and interaction factors positively influence deep meaningful learning, while helper factors show a negative correlation; (2) learner, interaction, and helper factors mediate the environment's impact on deep, meaningful learning; and (3) environmental factors hold the most significant sway over helper factors, followed by interaction and learner factors. Helpers wield significant influence over learners, enhancing deep understanding. These insights guide effective, deep, meaningful learning strategies in blended learning.

Keywords: Deep Meaningful Learning, Blended Learning Mode, College Student

1. Introduction

Industry 4.0 demands individuals with deep, meaningful learning capabilities. At the 2013 Hannover Messe, Industry 4.0 demanded individuals with deep, meaningful learning capabilities. At the 2013 Hannover Messe, the German Federal Ministry of Education and Research and the Federal Ministry of Economics and Technology published "Safeguarding the Future of German Manufacturing: Suggestions for implementing the 'Industry 4.0' Strategy." This publication integrated emerging technologies such as the Internet, big data, cloud computing, and the Internet of Things into industrial production, establishing interconnected resources, information, goods, and man-machine systems [1]. Consequently, it ushered in a new era of intelligence supported by an integrated intelligent platform and facilitated the transition from traditional "manufacturing" to "intelligent manufacturing." As a result, the demand for labor shifted towards innovative, versatile, and skilled high-end professionals, significantly diminishing the need for low-skilled labor [2].

In May 2015, the Chinese State Council released a notice titled "Made in China 2025," recognizing the profound amalgamation of information technology and manufacturing as a catalyst for industrial transformation [3]. The document prioritized innovation-driven growth as the primary foundational policy and stressed enhancing innovation capabilities within the national manufacturing industry [4]. They emphasized the strategic requirement of improving the multi-level talent development system, mainly focusing on cultivating high-level professionals and urgently needed and scarce technical and innovative talents [5]. The goal of talent training transformed fostering individual literacy and cultivating compound talents [6]. As information technology advanced, the notion of school education also evolved

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from nurturing individuals who could adapt to automated production to fostering intelligent individuals capable of lifelong learning. The educational landscape shifted from semi-open vocational and general Education to embracing open lifelong learning and vocational Education rooted in general Education. This shift entailed a transition from a "teaching" paradigm to a "learning" paradigm, where the focus shifted to learner-centered approaches [7]. This necessitated proactive and efficient learning, enabling the leap of knowledge across disciplines and nurturing compound talents with innovative capabilities [8]. Alongside issuing pertinent policies by various governments, scholars from different nations continually explored educational reform.

In January 2020, the World Economic Forum unveiled a report titled "The School of the Future: Defining a New Education Model for the Fourth Industrial Revolution." This report presented a global framework encompassing eight essential attributes: global citizenship skills, innovation and creativity skills, technology skills, interpersonal skills, accessible and inclusive learning, problem-based collaborative learning, personalized and self-paced learning, and lifelong and student-driven learning [9]. The development of information technology has ensured the transformation of Education. With the development of communication technology, information dissemination has entered the era of big data [10]. The Computing Community Coalition published a report in 2008, "Big Data Computing: Creating Revolutionary Breakthrough Business," describing the context of data-driven research. Exploring the technologies needed to solve Big Data problems and the challenges faced is a critical topic today. According to a detailed report published by McKinsey, a world-renowned consulting firm, the impact, key technologies, and application areas of Big Data have been analyzed in depth. It is widely recognized that Big Data has the 3V characteristics of volume, variety, and real-time nature [11], and its value is crucial [12], the big data should have authenticity [13]. According to the 50th Statistical Report on China's Internet Development, as of June 2022, the number of Internet users in China reached 1.051 billion, and the Internet penetration rate reached 74.4%. The scale of instant messaging users is as high as 1.027 billion, the scale of online video (including short video) users has reached 995 million, and the scale of online news users has reached 788 million. This massive scale of users has driven the rapid development of information but also brought about the trend of information overload and fragmentation [14].

2. Literature Review

2.1. Bended Learning

Blended learning is an instructional method that combines conventional face-to-face teaching with online learning elements [15]. This educational approach offers students a flexible and personalized learning experience by integrating the advantages of in-person interaction and Internet resources [16]. Blended learning provides a dynamic environment where students can actively engage with course materials, collaborate with their peers, and receive individualized instructor feedback, enhancing the overall quality of their education experience [17].

2.2. Deep Meaningful Learning

Deep meaningful learning is a concept that focuses on promoting a deep understanding of the subject matter, as opposed to surface-level memorization of facts. It involves engaging students in critical thinking, problem-solving, and application of knowledge to real-world situation [18]. Deep, Meaningful Learning goes beyond surface-level learning by encouraging students to connect new information with their existing knowledge and experiences, fostering a deeper understanding of the subject matter [18]. The current research on Deep Meaningful Learning suggests that it positively impacts students' academic achievement, motivation, and engagement in the learning process [19]. The research indicates that students who engage in deep, meaningful learning are more likely to demonstrate higher levels of critical thinking skills, problem-solving abilities, and retention of information compared to those who engage in surface-level learning [20].

2.3. Influences on Deep Meaningful Learning in a Blended Learning Mode

Research on the factors influencing deep, meaningful learning and their relationships is receiving extensive attention and exploration. Research has shown that the educational environment, including the physical and human aspects, plays a significant role in students' achievement, satisfaction, and success [21]. This environment includes the shared perceptions of students and, sometimes, teachers within that setting. The physical environment of a classroom, such as the layout, seating arrangement, and availability of resources, can significantly impact students' engagement and learning outcomes [22]. A positive learning environment can enhance teachers' motivation, job satisfaction, and effectiveness in the classroom [23]. The environment can also impact teachers' instructional strategies and ability to create opportunities for deep and meaningful learning [24]. When the learning environment is supportive, inclusive, and conducive to active participation and collaboration, students are more likely to process information deeply, critically analyze concepts, and connect new and existing knowledge [25].

Additionally, a positive learning environment can foster a sense of autonomy and self-direction in students, promoting their intrinsic motivation to learn and explore new ideas [26]. The interaction between learners and the learning environment is a crucial aspect that influences the depth and meaningfulness of the learning experience [27]. Suppose learners perceive the learning environment as supportive, respectful, and inclusive. In that case, they are more likely to actively participate in discussions, ask questions, and seek additional resources to deepen their understanding [28]. Research has shown that individual factors, such as students' learning interests and self-efficacy, play a significant role in engaging in deep, meaningful learning in a blended learning mode [29]. Students with a high level of interest in the subject matter and who believe in their ability to succeed are more likely to engage in deep processing, seek out additional resources, and actively participate in discussions and activities [30]. Learners' factors, such as their level of motivation, prior knowledge, and learning strategies, also influence their engagement in profound, meaningful learning [31]. Interaction significantly promotes deep, meaningful learning in a blended learning mode [32].

Furthermore, interaction in a blended learning mode also provides opportunities for collaborative learning and developing critical social skills [31]. Research has shown that student-to-student interactions in a blended learning mode can effectively facilitate deep and meaningful learning [34]. Teachers and teaching assistants can use instructional strategies like small group discussions, collaborative projects, and online forums to promote student-to-student interaction and engagement [35]. Their leadership style, level of support, and instructional approach can impact students' readiness for change and innovative work behavior [20]. Teachers and teaching assistants who are supportive, motivating, and promote a positive learning environment can inspire students to actively engage in deep, meaningful learning [36]. Additionally, teachers and teaching assistants are vital in promoting active learning strategies and self-directed and adaptive learning, critical components of deep, meaningful learning in a blended learning mode [37].

3. Methodology

3.1. Research Background

In recent years, integrating traditional face-to-face instruction with online learning activities, known as blended learning, has emerged as a unique educational approach. Blended learning offers students the advantages of synchronous and asynchronous interactions, providing greater flexibility and access to course materials. Meanwhile, deep learning strives to foster profound comprehension and meaningful engagement with subject knowledge by cultivating critical thinking skills and problem-solving abilities that can be applied in real-world scenarios. By combining these two approaches, learners can construct their knowledge more effectively. This study examines the factors significantly influencing deep, meaningful learning within a blended learning mode. It will explore whether these factors interact with each other and assess the effectiveness of their impact.

3.2. Participant

The research object selected for this study was a university in Sichuan Province, China, with 46,951 undergraduate students. The sample size was calculated using random sampling based on the assumption of finite aggregate formula, and a questionnaire survey was conducted on 397 college students to study the influencing factors of deep, meaningful learning under the blended learning mode.

3.3. Instrument

A questionnaire was developed based on the Likert scale - "In the Blended Learning Mode, Deep Learning Influencing Factors Questionnaire, "- containing five rating scales. Four level 1 dimensions were designed: learner, helper, environment, and interaction. 18 level 2 dimensions included self-efficacy, metacognitive ability, course perception, interest in learning, satisfaction, instructor professional competence and support, helper professional competence and support, teacher-student relationship, resource environment, virtual environment, classroom climate, student-student interaction, teacher-student interaction, content interaction, deep meaningful learning motivation, deep meaningful learning strategies, deep The questionnaire was constructed based on the Maturity Scale, which was based on 18 secondary dimensions, including deep meaning learning motivation, deep meaning learning strategies, deep meaning learning inputs, profound meaning learning outcomes. The questionnaire was constructed based on the maturity scale.

3.4. Research Design

This study aims to identify the influencing factors of deep, meaningful learning in the blended learning mode and the interrelationship between the influencing factors. This study adopts a questionnaire survey method and quantitative research method based on the ternary interaction theory; the theoretical model of the influencing factors of deep, meaningful learning ability is constructed from the influence of four influencing factors, namely, learner, helper, interaction, and environment, on deep, meaningful learning as well as the relationship between the variables.

Based on the literature research, the following hypotheses are put forward on the influencing factors of deep, meaningful learning and the interrelationships among the factors: H1: Environmental factors have a positive influence on learner factors; H2: Environmental factors have a positive influence on interaction factors; H3: Environmental factors have a positive influence on helper factors; H4: Environmental factors have a positive influence on deep meaningful learning; H5: Learner factors have a positive influence on interaction factors; H6: Learner factors have a positive influence on deep meaningful learning; H7: Interaction factors have a positive influence on deeper meaningful learning; H8: Helper factors have a positive influence on interaction factors; H9: Helper factors have a positive influence on learner factors; H10: Helper factors have a positive influence on deep meaningful learning. Based on the research hypotheses, a theoretical model of the factors influencing deep, meaningful learning was constructed, as shown in figure 1.

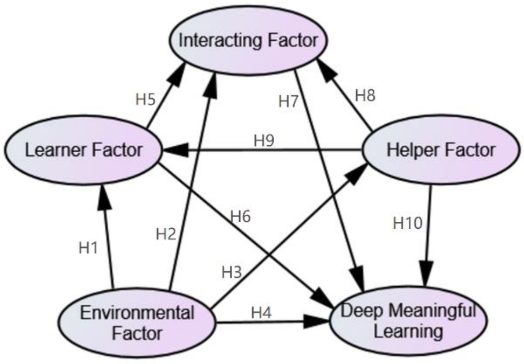

Figure 1. Theoretical framework diagram of profound, meaningful learning influences

The components of factors influencing deep, meaningful learning was scrutinized, and an open-ended questionnaire, "In the Blended Learning Mode, Deep Learning Influencing Factors Questionnaire Expert Evaluation Form," was developed for experts. An open-ended questionnaire, "Please remember the following text:

"In the blended learning mode, please fill out the Deep Learning Influencing Factors Questionnaire Expert Evaluation Form."," was created for the experts, and nine experts were invited to evaluate the questionnaire, including three experts in instructional design, three experts in educational technology, and three experts in assessment education. They all have the title of Associate Professor or above and have worked as Associate Professors for at least five years to solicit their opinions on the IOC (Index of Consistency of Program Objectives).

Based on the theoretical model of the influencing factors of deep meaningful learning in blended learning mode and the data collected from the questionnaire, the learner factors, helper factors, environmental factors, and interaction factors were classified as latent variables, and self-efficacy, metacognitive ability, course perception, learning interest, satisfaction, instructor professional competence and support, helper professional competence and support, teacher-student relationship, resource environment, and virtual environment, Classroom atmosphere, student-student interaction, teacher-student interaction, content interaction, deep meaningful learning motivation, deep meaningful learning strategy, deep meaningful learning input, and deep meaningful learning outcome were classified as observational variables and structural equation modeling was constructed based on the structure of the relationship between the variables as seen in figure 2.

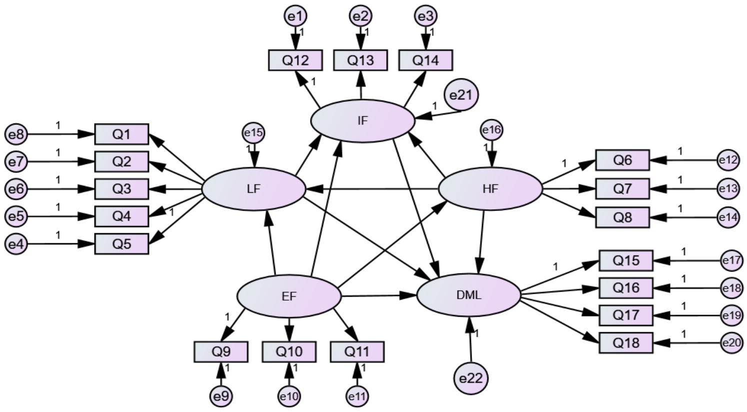

Figure 2. Deep meaningful learning influential factors structural equation modeling diagram

After the quantitative data from the questionnaires were coded, the study was subjected to a validated factor analysis (CFA) using AMOS software to assess the parameter estimation, convergent validity, and fitness metrics of the influencing factor model of the deep learning capability. The hypotheses were evaluated based on each variable's P-value and path coefficients, and the untenable hypotheses were deleted to obtain the final influence factor model diagram.

3.5. Data Collection and Analysis

They were recovering the results of the expert IOC assessment. The evaluation criteria were to revise items with scores below 0.5 and retain items with scores above or equal to 0.5. Before starting the formal survey, 30 university students were selected for pre-testing. The questionnaire dimensions were assessed to have Kaiser-Meyer-Olkin (KMO) values ranging from 0.7 to 0.891, Bartlett's test of sphericity with significance less than 0.001, and Cronbach's alpha data of 0.986, and the questionnaire was ready to be used for the formal test.

After the quantitative data from the questionnaires were coded, the study was subjected to a CFA using AMOS software to assess the parameter estimation, convergent validity, and fitness metrics of the influencing factor model of the deep learning capability. The hypotheses were evaluated based on each variable's P-value and path coefficients, and the untenable hypotheses were deleted to obtain the final influence factor model diagram. The specific validation parameter criteria are as follows:

3.5.1. Model Parameter Estimation

The probability of significance value must be P>0.05. If the P-value exceeds 0.05, the null hypothesis can be accepted, indicating that the hypothesized model can be fitted to the sample data. However, it should be noted that the chi-square value may increase when the sample size is more significant, resulting in a more negligible probability of significance value P. It is easy to reject the null hypothesis, which is the hypothesis that the model cannot be fitted to the sample data.

3.5.2. Convergent Validity

Five values were used for assessment: standardized item reliability (STD), correlation sum of squares loading (SMC), 1-SMC, CR, and average variance extracted (AVE). First, STD and SMC values are standardized item reliabilities, with STD values greater than 0.7 being the ideal level and more significant than 0.6 being the acceptable range. SMC values greater than 0.5 are ideal, and more excellent than 0.36 is the acceptable range. Second, the CR value is a combination of the reliabilities of all measurement items and indicates the internal consistency of the construct, similar to Cronbach's alpha, the larger the CR value, the higher the internal consistency of the construct, and a value more excellent 0.7 is a more desirable criterion. Suggested that a CR value of 0.6 or higher is considered a criterion AVE is used to calculate the magnitude of the explanatory power of the Variance of the measured variables in the conceptualization; the higher the AVE value, the better the reliability of the conceptualization and the better the convergence, in general, more than 0.5 is the desirable range. More than 0.3 is the acceptable level.

3.5.3. Model Fitness Indicator

It is used to measure the optimization of each measurement model or structural model, including the bigger and better the CMIN (chi-square value), the smaller and better the DF (degree of freedom). The ratio of CMIN to DF is perfect between 0 and 3, and between 0 and 5 is an acceptable level; GFI (generalized fit index) is more significant than 0.8 as an acceptable range; AGFI (adjusted generalized fit index) is more significant than 0.9 as an acceptable range; and RMSEA (root-mean-square error approximation) is less than 0.08. By following the above specific validation parameter criteria, we can comprehensively assess the model's fit and validity, ensuring the consistency of the established model of influencing factors of profound learning ability with the actual data and providing reliable support for the scientific reliability of the research results.

4. Result and Discussion

4.1. Descriptive Data Statistic

SPSS27.0 software was used to process the collected formal survey data. A total of 414 questionnaires were sent out, and through data sorting, the final valid questionnaires were 391, with a recovery rate of 94.44%. These questionnaires were sorted out and analyzed to derive the mean, standard deviation, Variance, skewness, and kurtosis for the 18 indexes of the observed variables. The values of the variables are within reasonable limits, and the distributions are normally distributed.

4.2. Analysis Results

4.2.1. Assessment of model convergent validity

Convergent validity is an indicator used to assess whether the relationship between the latent variables and the observed variables in the measurement model is good, which reflects whether each observed variable in the measurement model effectively reflects the corresponding latent variable. According to the analysis of AMOS software, the Standardized Factor Loadings (SFL) between each observed variable and the corresponding latent variable ranged from 0.807 to 0.965, which were all greater than 0.5, and the explanatory power of the latent variable corresponding to the observed variable was high. AVE ranges from 0.697 to 0.840, which is greater than 0.5, indicating that the latent variables have higher explanatory power for their observed variables, and CR ranges from 0.919 to 0.946, which is greater than 0.7, indicating better internal consistency of the latent variables. Variables have better internal consistency. These results indicate that the model has good convergent validity and that the relationship between the observed and latent variables is more reliable.

Table 1. Latent variable AVE and CR values

	AVE	**CR**
EF	0.793	0.920
LF	0.697	0.920
HF	0.791	0.919
IF	0.840	0.940
DML	0.814	0.946

4.2.2. Quality of Model Fit and Fitness

In the absolute fitness index, the chi-square degrees of freedom ratio (CMIN/DF) are 2.303, which is favorable in the range of 1~3. The NFI value is 0.966, which is in the range of 0.9~1 and is in line with the index requirements. In the value-added fitness index, CFI represents the relative fit index of the model, which ranges from 0.9 to 1, and the closer to 1, the better the model fit. The CFI=0.980 in this scale meets the requirements of the index. RMSEA represents the standardized residuals' root mean square and square; a value of less than .05 means the model fit is good. A value of less than .08 means that the model fit is reasonable—the scale RMSEA=.058 indicates that the model fit of the scale is reasonable. RMR value is 0.008, and RMR indicates the mean square and square root of residuals; when RMR<0.050 and closer to 0, the better the fit, the RMR value of this scale is 0.008, which aligns with the index requirements. In the PNFI, PNFI refers to the index of the degree of model streamlining, with a value between 0.5 and 1, and a value close to 1 indicates that the degree of model streamlining is better. The scale validates that the model has a PNFI = 0.789, which meets the index requirements. As shown in the table 2.

Table 2. Indicators of quality of fit and fitness of structural equations

	CMIN/DF	NFI	CFI	RMSEA	RMR	PNFI
Value	2.303	0.966	0.980	0.058	0.008	0.789
Standard	≤3.000	≥0.900	≥0.900	≤0.050, ≤0.080	≤0.050	≥0.500
Findings	favorable	favorable	favorable	reasonably	favorable	favorable

4.2.3. Path Analysis and Scenario Evaluation

According to the path coefficient analysis of AMOS on the relevant influencing factors, the influencing factor that has the most significant impact on deeper meaning is the learner factor, with a path coefficient of 0.55 and a p-value of <0.05, which indicates that the influence of the learner factor on deeper meaning learning is positive. This is followed by environmental and interaction factors with path coefficients of 0.50 and 0.49, respectively, both with P-values <0.05, indicating that the influence of environmental and interaction factors on deep meaning learning is positive. The path coefficient of the learner assistant factor is -0.53, the P value < 0.05, and the absolute value of the Z value is more significant than 1.96, indicating that the learner assistant negatively influences deep, meaningful learning. The path coefficients for the environmental and learner-helper factors that affect the learner factor are 0.34 and 0.56, respectively, with p-values < 0.05, indicating that the environmental and learner-helper factors significantly affect the learner factor. The environment factor has the most significant influence on the interaction factor, with a path coefficient of 0.84 and a P value < 0.05, indicating that the environment factor positively and significantly influences the interaction factor. At the same time, the learner factor and helper factor do not significantly affect the interaction factor. The environmental factors have a significant effect on the helper factors. The direction is positive, and the path coefficient is 0.92. The specific values are shown in the table. According to the Z-value, the Z-value of the two paths LF→IF and HF→IF is less than 1.96. The P-value is more significant than 0.05, indicating the difference between the sample mean. The overall mean is insignificant, and the null hypothesis can be rejected at the 95% confidence level. at the same time, H5 and H8 are not considered valid.

Table 3. Path analysis and scenario evaluation data

Research Hypothesis	Trails	Path Factor	Estimate	SE	Z-value	p	Valid or not
H1	EF→LF	0.34	0.360	0.109	3.303	***	YES
H2	EF→IF	0.84	0.924	0.108	8.556	***	YES
H3	EF→HF	0.92	1.025	0.045	22.778	***	YES
H4	EF→DML	0.50	0.556	0.117	4.752	***	YES
H5	LF→IF	0.03	0.028	0.069	0.406	0.681	NO
H6	LF→DML	0.55	0.576	0.060	9.600	***	YES
H7	IF→DML	0.49	0.490	0.073	6.712	***	YES
H8	HF→IF	0.07	0.067	0.099	0.677	0.499	NO
H9	HF→LF	0.56	0.526	0.099	5.313	***	YES
H10	HF→DML	-0.53	-0.529	0.085	-6.224	***	YES

4.2.4. Final Structural Equation Model

After path optimization, the final structural equation model of the influencing factors of deep, meaningful learning is shown in figure 3.

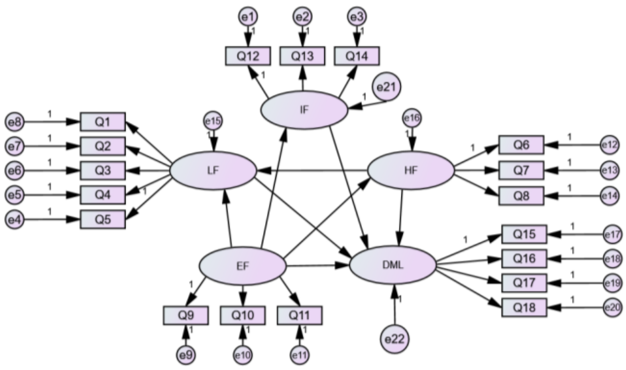

Figure 3. Structural equation modeling of influences on deep, meaningful learning

The study showed that student, environmental, and interaction factors positively affected deep-meaning learning in a blended learning model. The student factor has the most significant influence, followed by the environmental and interaction factors. At the same time, it was found that the helper factor had a negative direction of influence on deep, meaningful learning, which requires educators to be careful not to over-help learners but to guide learners to promote the formation of profound, meaningful learning ability. At the same time, this also emphasizes the development of learners' competence. In a blended learning environment, students must participate in learning, explore, and think actively. They should not rely entirely on the teaching of the helper but should exercise their initiative and actively participate in the learning process.

The learner, interaction, and helper factors are all mediating variables that influence environmental factors on the ability to learn deep meaning. The environmental factors need to be carried to the learners, educators, and interaction sessions to facilitate the influence of environmental factors on deep, meaningful learning. In a blended learning environment, the quality and richness of learning resources, the reasonableness of instructional design, and the teacher's encouragement and guidance are all environmental factors, and the direct relationship between these factors and students' deep, meaningful learning may not be very significant. However, through interaction factors, these environmental factors can influence students' deep-meaning learning more effectively.

Between the latent variables, environmental factors positively affected learner and helper factors, with the most significant effect on helper factors. The helper factors have a positive effect on learner factors. The learner and learner-helper factors do not influence the interaction factor. Helper factors play an essential role in the teaching and learning process, positively influencing students' motivation, learning attitudes, and learning behaviors.

5. Conclusion

Based on the findings, to enhance the cultivation of deep, meaningful learning abilities in a blended learning model, we propose the following recommendations:

Balance Student and Educator Factors: Student factors exhibit the most significant influence on deep, meaningful learning. Educators should emphasize students' active engagement and exploration, encouraging independent thinking, problem identification, and solution skills. Additionally, educators should tailor teaching to individual students' needs, guiding them to actively participate in learning within the blended learning environment.

Optimize Interaction Design: Interaction factors play a crucial role in facilitating the impact of environmental factors on deep, meaningful learning. Educators should design interactive elements that promote collaborative learning and discussions among students, fostering the collision of thoughts to stimulate inspiration and enhance comprehension and mastery. Concurrently, active interaction and guidance from teachers can ignite students' interest and motivation for learning.

Avoid assistance: Research suggests excessive assistance may negatively impact deep, meaningful learning. Educators should be mindful of refraining from excessive intervention in students' learning processes. Instead, through guidance and motivation, educators can empower students to develop autonomous learning abilities through exploration. This requires a conscious effort to cultivate students' autonomy and problem-solving skills, offering moderate support to students.

Optimize Environmental Factors: Environmental factors need to be integrated into learners, educators, and interactive sessions. Educators should focus on delivering high-quality and diverse learning resources, thoughtfully designing instructional content and activities, and actively encouraging student participation. Through these enhancements, a learning environment conducive to deep, meaningful learning can be established.

Cultivate Learning Motivation: Educators should endeavor to stimulate students' interest and motivation for learning, encouraging them to engage in the learning process willingly. Encourage students to pursue deep understanding rather than merely surface knowledge acquisition, fostering enduring enthusiasm and self-driven learning.

In summary, these recommendations underscore that cultivating deep, meaningful learning abilities in a blended learning setting necessitates educators' attention to student autonomy, active involvement, interaction design optimization, balanced assistance, enhanced environmental factors, and motivation cultivation. These efforts collectively contribute to enhancing students' deep, meaningful learning capabilities.

6. Declarations

6.1. Author Contributions

Conceptualization: S.L., T.P., and T.S.; Methodology: S.L.; Software: S.L.; Validation: S.L., T.P., and T.S.; Formal Analysis: S.L., T.P., and T.S.; Investigation: S.L.; Resources: T.P.; Data Curation: T.S.; Writing Original Draft Preparation: S.L. and T.P.; Writing Review and Editing: S.L. and T.P.; Visualization: T.P.; All authors have read and agreed to the published version of the manuscript.

6.2. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

6.3. Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

6.4. Institutional Review Board Statement

Not applicable.

6.5. Informed Consent Statement

Not applicable.

6.6. Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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