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Blended Learning Engagement Evaluation System for University in China

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Abstract: This study uses the Delphi approach to create an evaluation system for blended learning, analyzing aspects affecting online learning. Educational institutions and decision-makers can use the system's three key dimensions and indicators to examine scientifically.Purposive sampling chose 17 Chinese university specialists for the study. With significant blended learning and learning engagement knowledge, the sample size met research objectives. Both face-to-face and telephone interviews provided deep insights into critical concerns. Experts reached a high level of agreement on evaluation indicators (α =.939,.849,.911, with average values above 4). The average Coefficient of Variation score was.167, α =.851, showing high reliability. The review prompted indicator system changes. Experts disagree with the signs "Autonomous Time", "Habit", "Self encouragement", "Force", "Reward" and others, thus we should erase them. Additionally, "video learning time" and "learning Tool Use" average 3.82 and 3.71. Both standard deviations and coefficient of variation are below 1, indicating consistency. The indicators suggest substantial expert consensus, with standard deviations below 1. Each indicator has a coefficient of variation below.25, indicating strong standard alignment.

Keywords: Blended Learning, Learning Engagement, Delphi, Evaluation System.

1. INTRODUCTION

Rapid advancements in technology and artificial intelligence are driving the emergence of blended learning, a pedagogical approach that seamlessly integrates online and offline elements within the classroom setting. Blended learning is transforming the education revolution, enhancing student engagement. Despite high enthusiasm, active participation in learning activities is lower compared to traditional classroom settings, highlighting the need for more effective and engaging learning environments. Blended learning in classrooms enhances student engagement by combining digital curriculum with traditional instruction. This study investigates the effects of blended learning on students' engagement in unprivileged classrooms. Data was collected through classroom observations and interviews with teachers. Results showed that blended learning environments positively impact students' engagement, regardless of gender, over nine weeks. This suggests that blended learning can positively impact classroom learning, even in schools with limited technological infrastructure (Kundu, A., & Bej, T., 2020).

Despite significant strides in understanding the factors influencing and strategies to enhance student engagement in blended learning, there still needs to be a research gap concerning the composition, types, and assessment of student engagement within this innovative approach. Consequently, there needs to be a mature analytical model for student engagement in blended learning to ensure further advancements in this field of study. Addressing this gap becomes a matter of utmost significance, necessitating the urgent establishment of a comprehensive evaluation indicator system to assess student learning engagement in blended learning environments through applied research. By creating such an evaluation system, educators and researchers can gain valuable insights into the intricacies of student engagement, fostering a better understanding of learners' levels of engagement. Recent advancements in technology and globalization have led to the development of blended learning (BL) formats, which have been proven to improve student satisfaction and performance. However, the relationship between satisfaction and improved performance remains unclear. To enhance student satisfaction and success, instructors should maintain personal connections, use collaborative active learning strategies, and align learning

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activities with objectives (Lane, S., Hoang, J., Leighton, J., & Rissanen, A., 2021).

This would enable more effective assessments and contribute to the promotion of heightened student involvement in blended learning environments. As a result, this comprehensive approach holds the potential to optimize the learning experience for students and enhance their academic performance. Building upon the definitions proposed by researchers, this study engaged higher education professionals through consultations and discussions tailored to the specific conditions of higher education institutions. The goal was to create an evaluation system for measuring student engagement in blended learning.

2. LITERATURE REVIEW

Concept of Learning Engagement

Student learning engagement has evolved significantly over time, with significant impacts on learning outcomes. It involves the investment of students' physical and mental energies in learning activities, integrating cognitive and behavioral efforts. Identified three dimensions: emotional, behavioral, and cognitive. Emotional and cognitive engagement have significant impacts on learning outcomes. Digital technologies have positive effects on student engagement in higher education. Implementing these technologies encourages constructive and interactive learning activities, resulting in improved learning outcomes. A study of 381 students found that when technologies are used, students engage in both passive and active activities, enhancing their learning experience (Wekerle, C., Daumiller, M., & Kollar, I., 2020).

Understanding student engagement involves a multi-dimensional approach that considers learning emotions, cognition, and behavior. This shift from focusing on time investment to examining the interplay between quantity and quality of learning engagement signifies a comprehensive and multi-dimensional approach to student learning.The understanding of student learning engagement has gradually deepened in academia, shifting from a focus on learning duration to exploring the relationship between the quantity and quality of student learning engagement. Student learning engagement has evolved from a single-dimensional definition to a comprehensive concept composed of multiple dimensions. Currently, the most widely cited definition is the three-dimensional framework of learning engagement proposed by Fredricks et al., which includes behavioral engagement, cognitive engagement, and emotional engagement (Liu et al.; Q., 2021).

Research on Learning Engagement Assessment Indicators

Learning behaviors in the classroom are influenced by behavioral engagement, with various researchers exploring their composition and manifestations. Key dimensions include participation, persistence, avoidance, helplessness, discussions, and concentration. High engagement indicators include high levels of concentration, preference for challenging tasks, strong effort, and persistence. This understanding is crucial for constructing analytical frameworks in blended learning environments. Moreover, The study of learning engagement and behavioral assessment has been actively pursued by scholars, focusing on active participation, focus, and persistence in various aspects of teacher-student interaction. Understanding student behavioral engagement is crucial for a deeper understanding of learning. By assessing various dimensions, educators can optimize teaching methods, fostering active participation and enhancing learning outcomes. This knowledge enriches our understanding of student engagement and offers practical implications for effective educational strategies.

Concept of Blended Learning

Blended learning is a method of combining diverse technologies into traditional classroom teaching, enhancing the learning experience by combining online and face-to-face instruction. This approach allows learners to customize their learning based on their individual needs, resulting in a more active and enriched learning experience.Many universities have embraced blended learning, blending traditional face-to-face teaching with online learning. This approach provides students with greater flexibility and personalized learning experiences, allowing them to study at different times and locations while engaging with teachers and peers through online resources (Yang & Shang, 2020).

Analytic Hierarchy Process (AHP)

Analytic Hierarchy Process (AHP) was introduced by T.L. Saaty in the 1970s as a method for making decisions that involve multiple criteria, blending both quantitative and qualitative analysis (Yadav, R. 2021). By breaking down the decision problem into multiple tiers, a hierarchical arrangement is established, characterized by one-way hierarchical connections among these tiers. The Analytic Hierarchy Process (AHP) offers the significant advantage of integrating qualitative and quantitative analyses. Within the framework of AHP, attribute weights are determined by comparing the relative significance between two factors in pairwise fashion. Furthermore, the computed priority is considered valid only when the pairwise comparison matrix passes the consistency test. This matrix involves elements quantified on a numerical scale, based on the expertise and experience of Decision Makers (DMs). A notable advantage of using AHP is its ability to harmonize qualitative and quantitative criteria to produce a single score and establish a hierarchical decision structure (Yu, A., Jia, Z., Zhang, et al. ,2020).

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3. METHOD

This study describes the research methodology used in the Delphi technique to collect data. The research used quantitative, qualitative, and analytic hierarchy process methods.

Populations

A total of 17 experts from various universities in China participated in this study, selected using a purposive sampling method. All the experts had a background in education and possessed over five years of work experience, holding positions as assistant professors or higher. The researchers employed the purposive sampling approach to select these experts because of their extensive knowledge and experience in blended learning and learning engagement research. The study's sample size was determined using saturation criteria., ensuring that the number of participants was sufficient to fulfill the research objectives. Therefore, 17 respondents were chosen, and both face-to-face and telephone interviews were conducted. This carefully selected sample strategy enabled the researchers to gain profound insights into pertinent issues related to blended learning and learning engagement, resulting in representative and reliable research outcomes.

Data Collection

First Round:Brainstorming begins.The aim is to integrate the various elements of the evaluation system for blended learning engagement in higher education institutions. Through a semi-structured questionnaire, a basic framework for evaluating blended learning engagement was developed by 17 experts, resulting in the creation of Survey Questionnaire I.

Second Round:Expert Evaluation. Utilizing the Likert scale, 17 experts were invited to assess the viewpoints presented in Questionnaire I. The researchers measured values for each indicator item, including mean ($\bar{x}$), standard deviation (SD), and coefficient of variation (CV). Based on these measurement values and guided by principles of comprehensiveness, precision, scientific rigor, and procedural validity, as well as relevant theories of learning engagement, a preliminary assessment indicator system model for blended learning engagement was developed,Compile the obtained results into Questionnaire II for the next round of survey.

***Third Round*:**Re-Evaluation. 17 experts responded to Questionnaire II, and the data from the questionnaire were analyzed. Mean ($\bar{x}$), standard deviation (SD.), and Coefficient of Variation (CV)were calculated to establish an evaluation system for blended learning engagement evaluation. Based on the measurement outcomes of these indicators, Questionnaire III was formulated.

***Fourth Round*:** Resolved and Reported.Questionnaire III was employed to establish the feasibility of the content through the input of 17 experts, who expressed their responses using the options "yes," "no," or "unsure." These experts fully endorsed the viewpoints, concepts, strategies, and implementation details put forth by the research group.

Calculation of Indicator System Weights :The weights of the indicators are calculated by comparing the relative importance of two factors. Additionally, the calculated priority is deemed appropriate only when the pairwise comparison matrix passes the consistency test. The first-level indicators, second-level indicators belonging to the first-level indicators, and third-level indicators belonging to the second-level indicators are organized into judgments and form Questionnaire IV. Experts are invited to conduct pairwise comparisons of the judgments in Questionnaire IV and assign scores based on their importance. The average scores for each indicator item from the 17 experts are then computed, resulting in the values of the final judgment matrix. Using the weight calculation formula, the weights for each indicator item are determined, thus establishing a comprehensive evaluation indicator system.

Statistical Analysis

Questionnaire Analysis

Objective analysis of experts' revision opinions on evaluation indicators and criteria requires a statistical examination of their scoring data. Extensive research has established that judgments on expert scoring data rely on the mean for concentration, the standard deviation for dispersion, and the coefficient of variation for variability. The mean indicates the average evaluation of each indicator's importance by the experts, while the standard deviation measures the spread of experts' evaluations on a particular indicator item. The coefficient of variation, also known as the dispersion coefficient, represents the ratio of the standard deviation to the corresponding mean. A larger coefficient of variation signifies higher data dispersion, while a smaller coefficient of variation indicates lower data dispersion. During the process of revising indicators, indicators with higher mean values, smaller standard deviations, and smaller coefficients of variation are deemed more critical and should be retained. On the other hand, indicators with lower mean values, larger standard deviations, and larger coefficients of variation may warrant further consideration, including potential discarding or alternative treatment. Average and Standard Deviation of Professional Views on Learning Engagement Measures, Level of Opinions (1.00-1.49= Strongly Disagree, 1.50-2.49= Disagree, 2.50-3.49= Neutral, 3.50-4.49= Moderately Agree, 4.50-5.00= Strongly Agree). The standard deviation measures data dispersion from the mean, with values ranging from .000-.999 and greater than 1.000. The Coefficient of Variation is a statistical tool used to compare data variability across different datasets. Levels of the standard deviation , which is a measure of the dispersion of a set of data from its mean (Mishra, P.,

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Pandey, C. M., Singh, U., Gupta, A., Sahu, C., & Keshri, A.,2019), were as follows as (less spread apart data = .000- .999, spread apart data =1.000) Coefficient of Variation is a statistical measure used to calculate the relative degree of dispersion in a dataset. It is commonly employed to compare the variability between different datasets (Arachchige, C.N., Prendergast, L. A., & Staudte, R. G. , 2022).The formula to calculate the Coefficient of Variation is as follows:

$$CV = (SD. / \bar{x}) \times 100\%$$

Calculation of Indicator Weights

1) Establish the hierarchy: Based on the connections among the audit content and audit evaluation indicators, relevant indicator elements are grouped hierarchically.

2) Construct the Importance Judgement Matrix: After establishing the hierarchy, judgment matrices are used to compare the relative importance of each element with respect to its superior indicator. A scale of 1 to 9 is used to measure the importance of each indicator(1=Equal importance, 3=Weak importance of one over another, 5=Essential or strong importance,7=Demonstrated importance,9=Absolute importance,2, 4, 6, and 8 represent intermediate values between the two adjacent judgments).

Table 1. The Importance Judgement Matrix

A	A1	A2	A3
A1	1	a_{12}	a_{13}
A2	$a_{21} = \frac{1}{a_{12}}$	1	a_{23}
A3	$a_{31} = \frac{1}{a_{13}}$	$a_{32} = \frac{1}{a_{23}}$	1

Note: If element A1 is more important than element A2, the value of A1/A2 is greater. In the case where element A1 is absolutely more important than element A2, the value of A1/A2 is 9. Conversely, if element A1 is relatively less important than element A2, then A1/A2 equals 1/9.

(3)Calculation of Evaluation Indicator Weights: The geometric mean of each row in the judgment matrix is computed using the Geometric Mean Method($\overline{w_i}$).

$$\overline{w_i} = \left(\prod_{j=1}^{n} a_{ij}\right)^{\frac{1}{n}} \quad i,j=1,2\ldots,n$$

In the formula, represents the element in the i-th row and j-th column of the original judgment matrix, n represents the number of indicators, represents the geometric mean of the i-th row of the original judgment matrix. The geometric mean values of each row are then normalized to obtain the characteristic vector:

$$w_i = \frac{\overline{w}_i}{\sum_{j=1}^{n} \overline{w_j}} \quad i,j=1,2\ldots,n$$

In the formula, represents the weight of the i-th indicator. To obtain the weight value of a specific evaluation indicator, it is necessary to multiply the weight of that indicator by the weight of its respective dimension, and then round the weight result. This process is repeated iteratively, resulting in the establishment of the weight system for the blended learning mode engagement evaluation indicator system.

(4)Consistency test: Consistency testing ensures valid conclusions amidst complex indicators. Pairwise comparisons may yield inconsistencies. CR < .1 assures sound weight results. For 2nd-order matrices, RI = 0, obviating the test.The calculation process is as follows:

$$\lambda max = \frac{1}{n} \sum_{k=1}^{n} \frac{(AW_i)}{w_i}$$

Substitute the calculated λmax value into the formula above to compute the consistency indicator value:

$$CI = \frac{(\lambda \max - n)}{(n-1)}$$

Finally, based on the average random consistency indicator value (RI) as shown in Table 3,the consistency assessment indicator CR is calculated using the formula:

$$CR = \frac{CI}{RI}$$

Table 2. Values for Average Random Consistency Index (RI) for Orders 1 to 11

n	2	3	4	5	6	7	8	9	10	11
RI	0	.58	.90	1.12	1.24	1.32	1.41	1.45	1.49	1.51

4. RESULTS AND DISCUSSION

The research consisted of a descriptive analysis as well as a significant assessment of the evaluation system for the amount of involvement in blended learning that was present in Chinese universities. Interviews and a synthesis of the data from the survey were used to produce a summary of the results. The evaluation index system for the level of involvement in blended learning at higher education institutions was successfully developed based on the expert judgment data and revised suggestions by making use of the Delphi technique and the Analytic Hierarchy Process (AHP) analysis. In the first round,

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we convened a brainstorming session to come up with the first evaluation criteria, and it was really successful. These standards are the result of combining the findings from a semi-structured questionnaire with applicable theories and previous research in the field. Following that, Questionnaire I was developed through discussion and collaboration with the specialists. In the second phase of the competition, the goal of the employment was to collect ratings from 17 specialists regarding preset criteria. After that, the SPSS software was used to perform an analysis on the data, and the findings are detailed in the following paragraphs:

Table 3. Statistics Containing Level 1 Indicators

N=17

Level 1 indicators	$\bar{x}$	SD.	CV.
Behavioral Engagement	4.23	.323	.076
Cognitive Engagement	4.02	.387	.096
Emotional Engagement	4.18	.314	.075

The average score of Coefficient of Variation was .108, α=.939, indicating strong reliability. The average scores for all three indicators are above 4, signifying a high level of consensus among the experts, reflecting their agreement. From a dispersion perspective, the standard deviations of the evaluation indicators are all less than 1, indicating that the opinions among the experts are closely clustered and consistent. Furthermore, each indicator's coefficient of variation is below .25, further reinforcing the notion of strong consensus and alignment regarding these indicators. Consequently, all three indicators can be retained.

Table 4. Statistics Regarding Level 2 Indicators

N=17

Level 2 indicators	$\bar{x}$	SD.	CV
Participate	4.41	.559	.127
Focus	3.88	.416	.107
Interaction	4.45	.31	.070
Persistence	3.94	.455	.115
Self-monitoring	4.32	.397	.092
Self-Management	3.88	.401	.103
Learning Strategies	3.91	.333	.085
Sense of Belonging	4.2	.459	.109
Emotional Attitudes	4.34	.431	.099
Internal Support	3.98	.253	.064
External Support	2.82	.585	.207

The average score of Coefficient of Variation was .079, α =.874, indicating strong reliability. The mean score for "External Support" is below 2.82, suggesting that the experts do not agree with this indicator. However, the mean scores for the rest of the indicators are above 3.5, and their standard deviations are all less than 1, indicating a high level of consensus and agreement among the experts. Additionally, the coefficient of variation for each indicator is below .25, signifying good data convergence and consistent expert opinions. Therefore, we will remove the "External Support"

indicator from the secondary indicators and replace "Internal Support" with "Emotional Regulation" based on expert feedback. The remaining indicators will be retained.

Table 5. Statistics Regarding Level 3 Indicators

N=17

Level 3 indicators	$\bar{x}$	SD.	CV
Number of logins to online platforms	4.41	.618	.140
Amount of online tasks completed	4.47	.717	.160
Number of class discussions	4.47	.624	.140
Video learning time	3.82	1.015	.266
Amount of class tasks completed	4.29	.588	.137
Peer interaction	4.53	.800	.177
Active interaction	4.47	.514	.115
Teacher-student interaction	4.35	.606	.139
Overcoming difficulties	4.18	.809	.194
Online task Persistence	4.41	.795	.180
Maintaining high engagement in class	4.47	.800	.179
Class learning time	2.41	.507	.210
Setting clear goals and requirements	4.41	.618	.140
Self-assessment and reflection	4.41	.795	.180
Use of learning tools	3.71	1.047	.282
Learning resource	4.18	.529	.127
Time management	4.24	.831	.196
Autonomous time	2.47	.514	.208
Cognitive strategies	4.35	.606	.139
Metacognitive strategies	4.47	.514	.115
Self-identity	4.47	.717	.160
Teacher-student identity	4.47	.624	.140
Habit	2.94	.429	.146
Interest	4.35	.786	.181
Sense of accomplishment	4.53	.514	.113
Learning motivation regulation	4.35	.702	.161
Emotion management	4.41	.507	.115
Self-encouragement	2.82	.529	.188
Coercion	2.76	.437	.158
Reward	2.59	.507	.196

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The average score of Coefficient of Variation was .167, α =.851, indicating strong reliability. Based on the evaluation, adjustments have been made to the indicator system. The indicators "Autonomous Time", "Habit", "Self encouragement", "Force", "Reward" and other indicators are 2.47,2.94, 2.82, 2.76and 2.59 points, all lower than 3.5 points, indicating that experts do not agree with the indicator items, so we need to delete these five items. In addition, the average values of the "video learning time" and "learning Tool Use" indicators are 3.82, 3.71 , which is higher than 3.5 points, but the standard deviations are both greater than 1, and the coefficients of variation are both greater than .25, indicating that although experts agree with their opinions, they are highly controversial. , expert opinions are not unified. According to expert opinions, we need to correct this indicator before we can keep it, otherwise we need to delete it. Therefore, we convert the indicator into "The amount of video played per unit time" and "Learning environment adjustment" before proceeding to the next step. round of evaluation. Based on the feedback from experts, blended learning should also pay attention to inspections in the classroom, so we also need to add indicators "classroom attendance"and"Classroom performance" to the secondary indicators. Combined with the goal of cultivating students in colleges and universities, "Interdisciplinary Thinking and Associations" is added. On the other hand, except for the above-mentioned failed indicators, the average values of other indicators are above 3.5, their standard deviations are all less than 1, and the coefficients of variation of these indicators are all less than 0.25 , indicating that the data has good convergence and the experts' opinions are consistent, so they can be retained. These modifications aim to enhance the accuracy and relevance of the evaluation system. In the third round, after necessary adjustments, the primary indicators were unanimously agreed upon by the experts in Questionnaire I. Therefore, in Questionnaire II, there is no need to score the primary indicators. Questionnaire II underwent expert evaluation within a strict framework of the educational research paradigm. The results are as follows:

Table 6. Statistics Regarding Level 4 Indicators

N=17

Level 4 Indicators	$\bar{x}$	SD.	CV.
Participate	4.41	.712	.161
Focus	4.35	.702	.161
Interaction	4.53	.624	.138
Persistence	4.41	.618	.140
Self-monitoring	4.65	.606	.130
Self-Management	4.47	.624	.140
Learning Strategies	4.53	.624	.138
Sense of Belonging	4.71	.588	.125
Emotional Attitudes	4.41	.618	.140
Emotion management	4.71	.470	.100

The average score of Coefficient of Variation was .137, α =.849, indicating strong reliability. The indicators demonstrate a high level of consensus and concentration among the experts. All indicators have mean scores above 4, and their standard deviations are below 1, indicating that the expert opinions are concentrated. Furthermore, all coefficients of variation are below .25, reflecting the consistency and convergence of the indicator system. Therefore, this evaluation indicator system can be considered effective and reliable.

Table 7. Statistics Regarding Level 5 Indicators

N=17

Level 5 Indicators	$\bar{x}$	SD.	CV.
Number of logins to online platforms	4.18	.529	.127
Amount of online tasks completed	4.29	.849	.198

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Level 5 Indicators	$\bar{x}$	SD.	CV.
Number of class discussions	4.29	.588	.137
Classroom Attendance Rate	4.35	.606	.139
Video Quantity per Unit Time	4.35	.862	.198
Video learning time	4.18	.636	.152
Amount of class tasks completed	4.59	.618	.135
Peer interaction	4.53	.624	.138
Active interaction	4.35	.606	.139
Teacher-student interaction	4.59	.795	.173
Overcoming difficulties	4.41	.618	.140
Online Task Persistence	4.41	.618	.140
Maintaining high engagement in class	4.35	.702	.161
Setting clear goals and requirements	4.41	.795	.180
Self-assessment and reflection	4.29	.588	.137
Use of learning tools	4.65	.493	.106
Logic and Critical Thinking	4.41	.618	.140
Creative Thinking and Problem Solving	4.06	.748	.184
Interdisciplinary Thinking and Associations	4.12	.697	.169
Summarization and Induction Ability	4.47	.514	.115
Self-test and Rhetorical Questions	4.41	.870	.197
Identity	4.35	.606	.139
Sense of Belonging	4.35	.862	.198
Sense of Accomplishment	4.29	.772	.180
Interest	4.65	.493	.106
Cognitive Reappraisal	4.41	.618	.140
Emotional Transfer	4.47	.514	.115

The average score of Coefficient of Variation was .146, α =.911, indicating strong reliability. The indicators demonstrate a high level of consensus and concentration among the experts. All indicators have mean scores above 4, and their standard deviations are below 1, indicating that the expert opinions are concentrated. Furthermore, all coefficients of variation are below .25, reflecting the consistency and convergence of the indicator system. Therefore, this evaluation indicator system can be considered effective and reliable. In the fourth round, Based on the assessment indicators obtained from the third rounds, we formulated Questionare III,it covers 17 experts'opinions of selected evaluating indicator.There were a total of 40 indicator items. The yes response percentage was 90.4%, the no response percentage was 8.0% , the unsure response percentage was1.4%.This procedure culminated in the establishment of the ultimate and all-encompassing assessment framework for evaluating the degree of blended learning engagement within Chinese universities.

Calculating Weights Using the Analytic Hierarchy Process (AHP)

Ensuring the accuracy and comprehensiveness of evaluation results necessitates assigning appropriate weights to each indicator within their respective dimensions.

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Firstly, establish a hierarchical structure by dividing the evaluation system for the degree of participation in university blended learning into four levels: "A" as the evaluation system, "B" as 3 first-level indicators, "C" as 10 scond-level indicators, and finally, "D" as 27 third-level indicators.This step is crucial for establishing a robust and viable assessment indicator framework.The judgment matrices of the indicator items were compiled into Questionare IV,17 experts assigned scores based on the relative importance of pairwise indicators (refer to Table 1).The research utilized SPSSPRO software to compute weights for indicators at each level and conducted consistency testing. Notably, second-order matrices did not require consistency testing. Once the weights were derived, the weights of second-level indicators were multiplied by the weights of first-level indicators to determine the comprehensive weights of the second-level indicators. Likewise, the weights of third-level indicators were multiplied by the comprehensive weights of second-level indicators to establish the comprehensive weights of the third-level indicators. The results are presented as follows:

Table 8. Weight of Evaluation Indicators

	Indicator	**Weight**	**CR**	**Consistency Test**	**Combination Weight**
First-level indicators	Behavioral Engagement	.5680	.022	Congruence	.5680
	Cognitive Engagement	.1914			.1914
	Emotional Engagement	.2407			.2407
Second-level indicators	Participate	.1386	/	/	.0787
	Focus	.3431			.1949
	Interaction	.1476			.0838
	Persistence	.1205			.0684
	Self-monitoring	.2503			.1422
	Depth of Thinking	.3269			.0626
	Learning Strategies	.6731			.1288
	Self Worth	.5279			.1270
	Emotional Experience	.3426	.088	Congruence	.0825
	Emotion Regulation	.1295			.0312
Third-level indicators	Number of Online Platform Logins	.3903	.020	Congruence	.0308
	Online Platform Task Completion	.2922			.0231
	Frequency of Answering Questions In Class	.1944	0	Congruence	.0154
	classroom attendance	.1231			.0097
	The amount of video played per unit time	.1353			.0264
	Amount of classroom tasks completed	.5007			.0976
	Classroom Attendance	.3640	.003	Congruence	.0710
	Discussion Popularity on Online Platforms	.4664			.0391

Peer Reviews and Feedback	.3136			.0263
Teacher-student Interaction	.2200			.0185
Overcome Difficulties	.1676			.0115
Online Task Persistence	.5292	.003	Congruence	.0363
Maintaining a High Level of Engagement In the Classroom	.3032			.0208
Clarify Goals and Requirements	.2736			.0389
Self-evaluation and Reflection	.1508	.030	Congruence	.0215
Learning Environment Adjustment	.5756			.0819
Logic and Critical Thinking	.3366			.0211
Creative Thinking and Problem Solving	.4822	.010	Congruence	.0302
Interdisciplinary Thinking and Associations	.1812			.0114
Summarization and Induction Ability	.5143	/	/	.0663
Self-test and Rhetorical Questions	.4857			.0626
Identity	.6197	/	/	.0788
Sense of Belonging	.2394			.0305
Sense of Accomplishment	.2329	/	/	.0193
Interest	.7671			.0633
Cognitive Reappraisal	.2125	/	/	.0067
Emotional Transfer	.7875			.0246

The Importance of Assessment Criteria Regarding Blended Learning in Higher Education Engagement among the first-level indicators as follows: "Behavioral Engagement,""Cognitive Engagement," and "Emotional Engagement." Among the secondary indicators, the top five in descending order are "Learning Strategies" "Self Worth" "Interaction," "Engagement," and "Persistence." Among the third-level indicators, the top five are “Use of learning tools,” “Video learning time,” “Self-identity,” “Amount of class tasks completed,” and “Cognitive strategies.” Furthermore, the weights assigned to “Learning motivation adjustment,” “Sense of accomplishment,” “Overcoming difficulties,” and “Class attendance rate” are relatively low, signifying that these four third-level indicators carry less significance. Consequently, the evaluation system for blended learning engagement in universities can be summarized as depicted in the figure:

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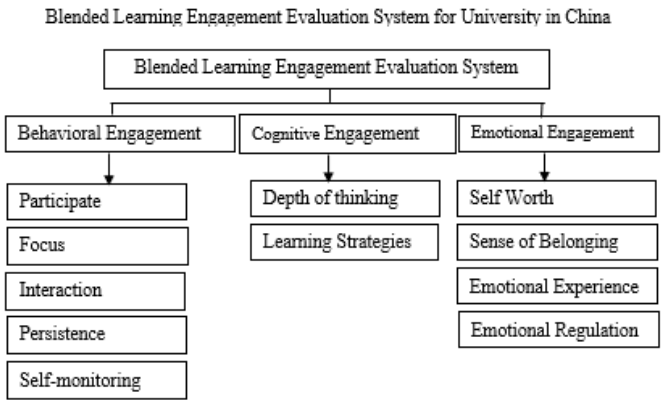

Figure 1: The Delphi method was used to analyze the literature on factors influencing online learning engagement for Universities in China

Blended Learning Engagement Evaluation System: An evaluation system for blended learning offers a comprehensive method for gauging and improving student involvement in these types of settings. It offers insightful information for ongoing enhancements to the planning and execution of blended learning programs, assisting educators, organizations, and learners in reaching their learning goals. A Blended Learning Engagement Evaluation System is a comprehensive framework designed to assess and enhance student and instructor engagement in blended learning environments. The system uses various data collection tools, engagement metrics, and data analysis to gather information on student and instructor engagement. It also incorporates feedback mechanisms, benchmarking, and learning analytics to track individual and group progress. The system aims to achieve several objectives, which include increasing student engagement, enhancing instructional design, aiding instructor development, ensuring quality assurance, personalizing learning experiences, and utilizing predictive analytics to identify students who may be at risk of dropping out or underperforming. The system aims to improve student satisfaction and help them achieve their educational goals through a culture of continuous improvement. Furthermore, the system provides data-driven insights that enable institutions to make informed decisions regarding course design, content delivery, and technology adoption, all of which are crucial to promoting student success.

Overall, a Blended Learning Engagement Evaluation System is a valuable tool for ensuring the effectiveness and quality of blended learning programs. The following weight values show the first-level indicators' relative importance: "Behavioral Engagement," Cognitive Engagement," and"Emotional Engagement." The top five secondary indications are "Persistence," "Focus," "Self-monitoring," "Interaction," and "Engagement," listed in descending order. The top five third-level indicators are "Cognitive techniques," "Amount of completed class activities," "Self-identity," "Video learning time," and "Use of learning resources." Additionally, the weights given to "Overcoming challenges," "Learning motivation adjustment," "Sense of success," and "Class attendance rate" are very low, indicating that these four third-level variables are less significant. As a result, the figure below summarizes the university's blended learning engagement assessment system.

5. CONCLUSION

This study aims to comprehensively analyze students' engagement and characteristics in blended learning at universities. A corresponding evaluation indicator system will be constructed and rigorously validated using statistical methods. The development of this evaluation indicator system holds significant importance in providing a deeper understanding of students' levels of learning engagement within blended learning environments. It equips educators and education policymakers with a scientifically robust assessment tool to enhance the learning environment and teaching methodologies, ultimately fostering students' learning and growth. Initially, the research team designed an evaluation framework for students' learning engagement in blended learning, grounded in three key dimensions: "Behavior," "Cognition," and "Emotion."

This multi-dimensional framework was carefully crafted through a blend of literature analysis and relevant theories on blended learning, thoughtfully encompassing various facets of learning engagement. This theoretical underpinning served as a solid groundwork for the subsequent development of evaluation indicators,ensuring precision and comprehensiveness in the assessment system. Blended education is a promising approach to improve education quality, offering opportunities for students to learn through various methods. A qualitative study conducted at Urmia University of Medical Sciences in Iran revealed that the most significant strengths of blended learning include lecturer-student interactions, focus on self-learning, and problem-solving skills. Opportunities include university support, alignment with national health education plans, and shared infrastructures. However, challenges include technical, organizational, and human resource bottlenecks, lack of culture readiness, dependency on the education transformation plan, and inadequate virtual activity supervision (Zhang, Y., Sangsawang, T., & Vipahasna, P. (2023).

The Delphi method was employed to conduct semi-structured interviews with experts, thereby integrating and incorporating viewpoints from experts representing diverse fields. This approach not only bolsters the objectivity and scientific rigor of the evaluation system but also capitalizes on the collective experiences and knowledge of experts across various domains, resulting in a more holistic and tailored set of

evaluation indicators. Furthermore, the indicators underwent meticulous refinement, and survey questionnaires were tailored for both students and teachers, alongside the creation of a student learning engagement scale. The data collected from different stakeholders offered a multi-dimensional comprehension of students' learning engagement. Statistical tools like SPSS were adeptly utilized to analyze and process this data, ensuring the practicality and usability of the evaluation indicator system. Policy Delphi, a survey of stakeholders, gathered expert opinions on technical issues (Li, Y., Sangsawang, T., & Vipahasna, K., 2023).

Finally, the Analytic Hierarchy Process (AHP) was harnessed to construct pairwise comparison judgment matrices, facilitating data normalization and consistency tests. This bolstered the persuasiveness and reliability of the evaluation results. In summation, the evaluation indicator system for students' learning engagement in blended learning, as developed in this study, empowers educators to gain profound insights into students' learning engagement within blended learning environments. It equips them to fine-tune their teaching approaches, optimize the learning milieu, and bolster students' motivation and learning outcomes. Moreover, the application of this evaluation indicator system provides empirical evidence for informed educational decision-making, furthering the continuous advancement and enhancement of blended learning in higher education. Altogether, the outcomes of this study hold substantial implications for the advancement of the education sector.

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