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Article

Comparison and research for blended teaching and traditional teaching based on AHP—Using basic course of management as an example

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Abstract: With the advancement and progress of information and internet technology, blended learning has garnered increased attention from both students and teachers. By utilizing the Analytic Hierarchy Process and integrating feedback from questionnaires, this study constructs an evaluation index to compare the effectiveness of blended learning with traditional teaching methods. The relative weight or criteria of each index is calculated, enabling a comprehensive analysis of the teaching outcomes between these two approaches. The findings indicate that Blended teaching stimulates student interest and enhances learning abilities, while traditional teaching excels in fostering teacher-student interaction. Based on these results, suggestions are provided to guide instructional strategies for teachers and learning approaches for students. According to a study. This study also focuses on the moderating role of smart technologies between the Knowledge management process and employee performance in the case of the Hail health cluster.

Keywords: AHP; blended teaching; traditional teaching; comparative study; learning interest; digital literacy; learning effect

1. Introduction

The U.S. Department of Education's 2020–2023 Strategic Plan outlines that educators should integrate digital tools and internet technology to innovate teaching practices, enhance instructional methods, and improve learning outcomes (U.S. Department of Education, 2020). Maker spaces are now essential for developing innovation and entrepreneurship skills, advancing technical innovation, and fostering projects in Chinese applied universities under the innovation-driven development plan (Wang and Ali, 2024).

The plan emphasizes encouraging students to use digital resources for active and independent learning and developing problem-solving skills through technology. The integration of digital tools aims to accelerate the adoption and effectiveness of educational practices. In traditional teaching, teachers strive to enhance learning outcomes, particularly for abstract and complex content, by employing various methods to optimize teaching effectiveness (Ali et al., 2023). Currently, blended learning is increasingly popular in the education sector for its convenience and effective approach. How effective is blended learning, and will it replace traditional teaching methods? Through expert analysis, tests involving teachers and students, and comprehensive survey results, the effectiveness of blended learning is assessed and compared using a rigorous evaluation method such as the Analytic Hierarchy Process (AHP), ensuring that both the content and methodology of the evaluation are scientifically sound and rigorous (U.S. Department of Education, 2020).

2. Related concept

The Analytic Hierarchy Process (AHP), initially proposed by T.L. developed by Saaty in the 1970s, is a comprehensive evaluation method that combines qualitative and quantitative analysis to address multiple criteria, multi-element, and multi-level decision-making problems. This approach breaks down complex systems into multiple levels and factors, simplifying the research process. It utilizes simple calculations to compare and evaluate the importance of different factors, thereby determining the weight or criteria of varying degrees of significance for each alternative solution., thus providing guidance for selecting an optimal scheme (Silva and Oliveira, 2021).

For the purpose of this study, blended teaching approaches refer to instructional methods that integrate traditional face-to-face classroom instruction with online learning activities and resources. This includes models such as the flipped classroom, hybrid courses, and blended learning modules, where a portion of the course content is delivered online, complementing in-person instruction (Graham, 2019).

Literature review

Blended teaching provides multiple learning forms and channels by integrating the advantages of traditional teaching and digital learning. Students receive direct guidance from teachers in class, and can also conduct independent learning, collaborative learning and practical activities through online platforms outside of class (Pape, 2010). Common forms of blended teaching include: video courses, online quizzes, interactive platforms, virtual classrooms, etc. (Pape, 2010). The rise of blended teaching is closely related to the development of technology and the popularization of the Internet (Saad and Ali, 2022). First of all, the Internet allows students to learn anytime and anywhere, no longer relying on traditional classroom time (Sadeghi, 2019). In addition, learning management systems (LMS), video conferencing, online discussion boards, etc., allow teachers and students to interact in a more diverse manner. In addition, blended teaching can provide customized learning paths according to students' needs and rhythms to meet the learning styles of different students (Sarmento et al., 2018). First of all, blended teaching can provide students with greater flexibility and personalized learning experience (Ellis et al., 2006). By combining online learning, students can choose learning content according to their own learning progress. This flexibility is particularly suitable for students who need personalized support (Strambi and Bouvet, 2003). In addition, the application of digital technology enhances classroom interaction and learning experience. Students not only participate in class, but also study and discuss after class through online platforms to consolidate and expand their knowledge (Major et al., 2018). Blended teaching also encourages students to engage in collaborative learning. Online group discussions and activities promote knowledge sharing and teamwork (Agosto et al., 2013). However, blended teaching also faces some challenges. First, teachers need to have certain technical skills and be able to effectively design and manage online learning activities. For some teachers, mastering new digital tools and technologies may bring difficulties (McNicol, 2008). Second, blended teaching requires students to have a high degree of self-discipline, because the online learning part usually lacks face-to-face supervision, which is a challenge for students with weak self-management

ability (Wang, 2024). The course design is also more complicated. Teachers need to design online and offline teaching content and activities at the same time, which puts higher requirements on the overall planning of the course (Ellis et al., 2006). Finally, the accessibility of technology is another problem. Especially in some regions or groups, the inequality of technological resources may aggravate the inequality of education (Li and He, 2022). The main characteristics of traditional teaching methods are that teachers dominate the classroom and students acquire knowledge by listening to lectures and participating in discussions. Classroom interaction is concentrated, the learning progress is controlled by teachers, and extracurricular learning mainly relies on textbooks and homework (Vernadakis et al., 2012). This method can provide instant feedback and teacher-student interaction, but lacks space for personalized learning, may not adapt to the needs of different students, and limits students' autonomous learning and flexibility (Cevikbas and Kaiser, 2022). On the other hand, blended teaching can significantly improve students' learning participation and academic performance. The key factors are technical support, enhanced autonomous learning, and provision of instant feedback (Wei et al., 2017). Blended learning increases students' learning flexibility and interactivity by combining online and offline learning, enabling them to better master knowledge in a personalized learning process. These factors work together to improve students' learning efficiency and performance (Wei et al., 2017).

3. Analytic Hierarchy Process (AHP)

3.1. The construction of a hierarchical index system

This paper assesses the pedagogical efficacy of blended learning and traditional teaching, providing an objective analysis of their respective merits. To ensure a scientific and rational evaluation of actual teaching outcomes, a questionnaire survey was conducted on instructors and students enrolled in basic management courses at a specific institution using an online survey platform. A total of 247 valid questionnaires were collected, with teachers and students serving as the primary participants, as depicted in **Figure 1** (Graham and Robison, 2023).

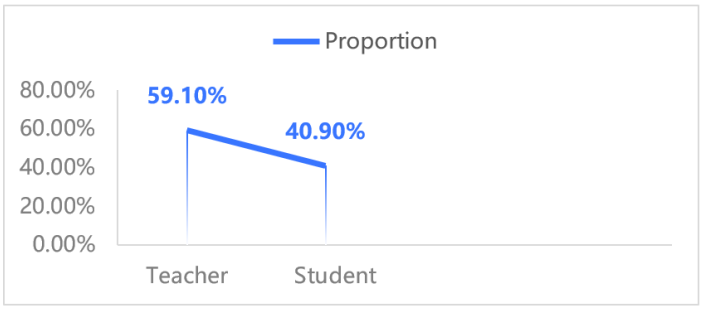

Figure 1. Questionnaire surveyed.

The proportion of teachers is 40.9% of the total respondent, and the proportion of students is 59.9% of the total respondent, which adheres to the characteristic or requirement that students should account for a higher proportion.

3.1.1. Factors influencing teachers' teaching method selection

The key factors influencing teachers' selection of teaching methods in the index evaluation system encompass knowledge comprehension, classroom discourse, difficulty explanation, and classroom practice. These four factors account for 87.85%, 5.26%, 4.05%, and 2.83% respectively in terms of proportion. It is worth noting that knowledge comprehension holds a significant share, as depicted in **Figure 2**.

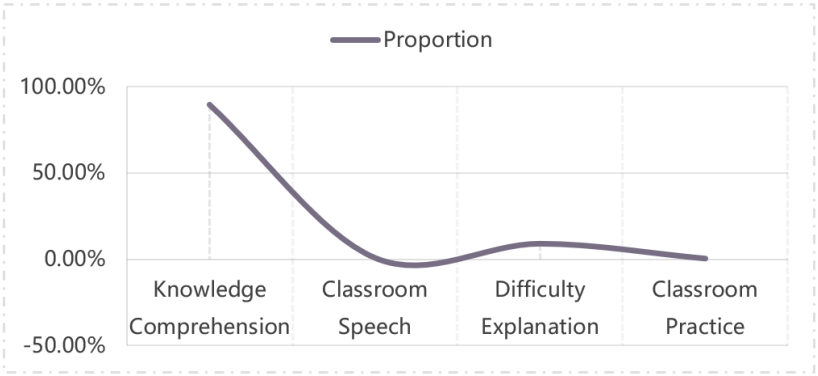

Figure 2. Factors affecting teachers' choice of teaching methods.

3.1.2. he factors influencing students' comprehension of knowledge

The questionnaire aims to enhance students' comprehension of knowledge through factors such as expanding their knowledge base, cultivating a passion for learning, providing ample opportunities for practice, and facilitating meaningful retention. The proportions of these four factors are 84.48%, 14.66%, 0.86%, and 0% respectively, as depicted in **Figure 3**. It is evident that students hold the belief that expanding existing knowledge can significantly enhance their comprehension of knowledge.

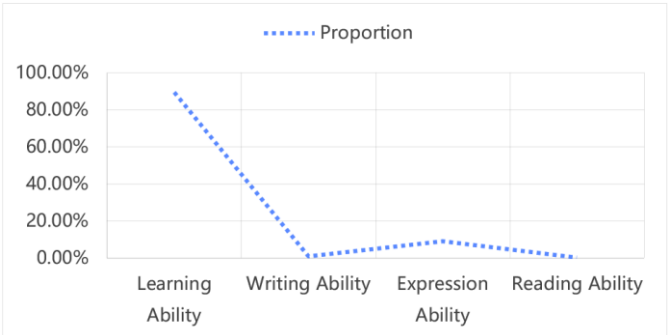

Figure 3. Factors affecting students' understanding of knowledge.

3.1.3. The determinants influencing students' inclination towards academic engagement

The design encompasses four factors that impact students' interest: effective teacher-student communication, engaging teaching through illustration and painting, the utilization of vivid language by the teacher, and the demonstration of neat writing skills. The survey results, as depicted in **Figure 4**, indicate percentages of 88.79%, 3.02%, 7.76%, and 0.43% respectively. Based on the data, despite the rapid

development of the internet era, students still perceive teacher-student communication as a pivotal factor influencing their learning interest.

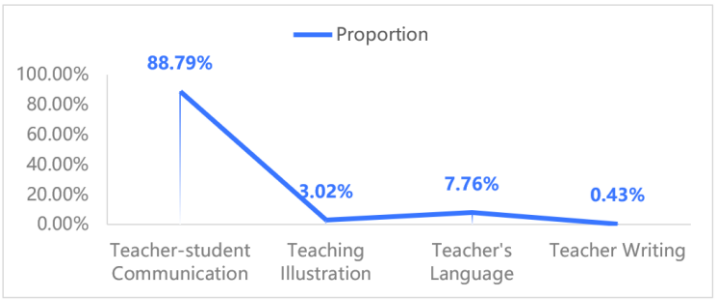

Figure 4. Factors affecting students' interest in learning.

3.1.4. Factors affecting students' digital literacy

The questionnaire survey is depicted in **Figure 5**, illustrating the distribution of factors influencing students' comprehensive ability. Notably, digital literacy constitutes a significant majority at 89.66%, while writing ability accounts for a mere 0.86%. Expression ability holds a substantial share at 9.05%, and reading ability contributes minimally with only 0.43%. It is evident that digital literacy plays a pivotal role among the various factors impacting students' overall competence.

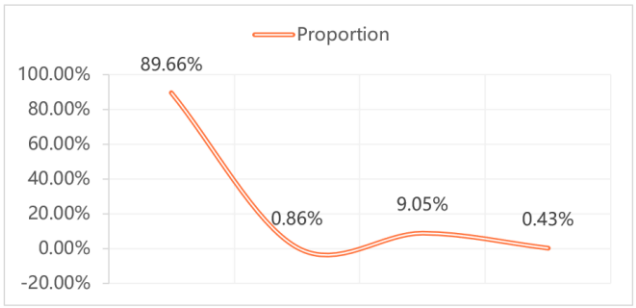

Figure 5. Factors affecting students' comprehensive ability.

3.2. Establish a hierarchical construction figure

Based on the research of questionnaire and integrated with Analytic Hierarchy Process (AHP), set teaching effect as the highest level, which is target level, and set knowledge understanding, knowledge extension, teacher-student communication and learning ability as the criterion level. Traditional teaching and blended teaching are the specific program level. A hierarchical construction model as shown in **Figure 6** is constructed.

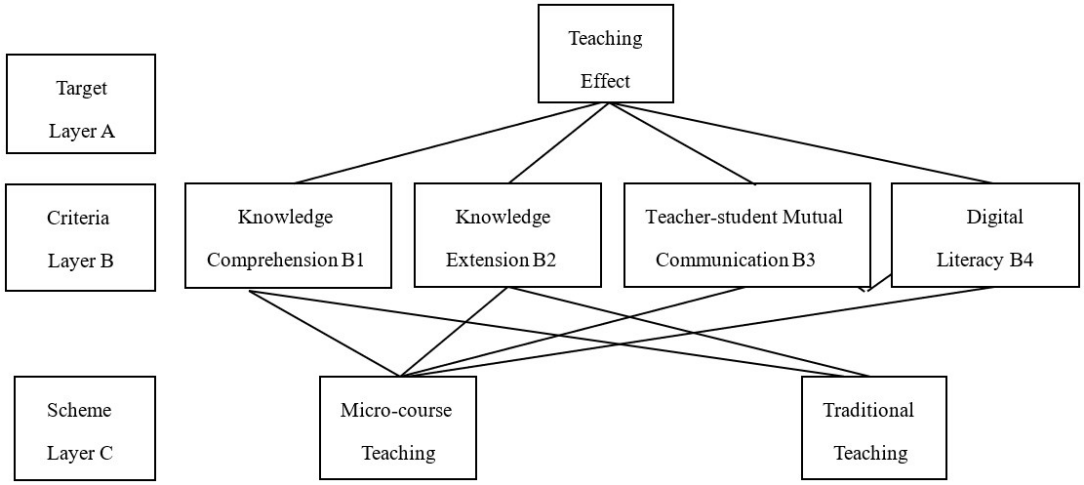

Figure 6. Hierarchical construction figure.

3.3. constructing two-to-two judgment matrix

The construction of a two-to-two judgment matrix is a pivotal step in the Analytic Hierarchy Process (AHP), and its accurate formulation directly influences the success or failure of AHP. By quantitatively constructing the matrix, it enables an objective representation of individuals' comprehension regarding the relative significance of different factors. When judging and comparing the matrix in pairs, it is determined using a scale method ranging from 1 to 9. A judgment matrix compares the relative importance of all factors in this layer to one factor in the upper layer. The elements of the judgment matrix are assigned scores based on a 1–9 scale proposed by Professor Satie from University of Pittsburgh, USA. Psychologists suggest that for paired comparisons, there should not be more than nine factors on each layer. This is illustrated in **Table 1** (Ghorbanzadeh et al., 2021).

Table 1. Scoring scale.

Scale	Meaning
1	The two factors being compared hold equal significance.
3	The relative importance of one factor is marginally higher than the other
5	The relative importance of one factor is evidently greater than that of the other.
7	The importance of one factor outweighs the other.
9	The importance of one factor outweighs the other.
2, 4, 6, 8	The middle value of the above two adjacent judgments (Such as 1/3, 3/5, 5/7, 7/9)

Notes: 1 The two factors, when compared, hold equal significance; 3 The relative importance of one factor is marginally higher than the other; 5 The relative importance of one factor is evidently greater than that of the other; 7 One of the two factors is significantly more important than the other; 9 The importance of one factor outweighs the other; 2/4/6/8 The middle value of the above two adjacent judgments (Such as 1/3, 3/5,5/7,7/9).

The components of the criterion layer encompass knowledge comprehension, learning aptitude, teacher-student interaction, and knowledge expansion. Simultaneously, constructing a two-to-two matrix serves as the prerequisite for our comprehensive ranking. By designating the goal layer as A and the criterion layer as B, we compare knowledge understanding C1 with knowledge extension B2 in the

scheme layer. To achieve our objective, the significance of knowledge understanding is amplified by seven times that of knowledge extension. Consequently, a value of 7 is assigned to it in the matrix table. Referring to the scale table in the score table reveals that knowledge understanding outweighs knowledge extension in importance. In this manner, a judgment matrix akin to **Table 2** is formulated.

Table 2. The impact of teaching.

	Knowledge comprehension	**Knowledge extension**	**Teacher-student mutual communication**	**Ability to learn**
Knowledge comprehension	1	7	5	3
Knowledge extension	1/7	1	1/3	1/5
Teacher-student mutual communication	1/5	3	1	1/3
Digital literacy	1/3	5	3	1

3.4. The task involves determining the relative importance of indicators and ensuring consistency in testing

3.4.1. Determines the relative weights among indices

The relative weight value should be initially calculated in the EXCEL table, followed by the calculation of the geometric average value, and ultimately concluding with the determination of the weight. Calculate the relative importance of the elements under a single criterion. The maximum eigenvalue λmax of the judgment matrix A and its corresponding eigenvector should be calculated $\omega = (\omega 1, \omega 2, \ldots \omega n)T$, T after normalization, and when $A\omega = \lambda max\omega$, The feature vector W obtained will be utilized as the weight vector for its corresponding evaluation unit. The maximum eigenvalue λmax and the angular frequency ω can be computed using the power method and the square root method, respectively. The table presented below is generated through the utilization of the square root method, as depicted in **Table 3**.

Table 3. The illustration of weight calculation or judgment matrix criteria.

	B1	**B2**	**B3**	**B4**	**The geometric mean value**	**Weight or criteria**
B1	1	7	5	3	$\sqrt[4]{1 \times 7 \times 5 \times 3} = 3.2011$	3.2011/5.8786 = 0.5445
B2	1/7	1	1/3	1/5	$\sqrt[4]{\frac{1}{7} \times 1 \times \frac{1}{3} \times \frac{1}{5}} = 0.3124$	0.3124/5.8786 = 0.0531
B3	1/5	3	1	1/3	$\sqrt[4]{\frac{1}{5} \times 3 \times 1 \times \frac{1}{3}} = 0.6687$	0.6687/5.8786 = 0.1138
B4	1/3	5	3	1	$\sqrt[4]{\frac{1}{3} \times 5 \times 3 \times 1} = 1.4953$	1.4953/5.8786 = 0.2544
∑					5.8786	

3.4.2. Consistency test for judgment matrix

Consistency assessment is crucial in evaluating the satisfactory consistency of the judgment matrix, wherein a comparison between the Consistency Index (CI) and the average Random Consistency Index (RI) plays a significant role. The CI serves as a measure of consistency, while the RI indicates the expected level of randomness.

Firstly, calculate the maximum eigenvalue λmax of the judgment matrix, $\lambda max = \sum_{i=1}^{n} \frac{(a\omega)i}{n\omega i}$, The value of Aω can be calculated based on the provided table, resulting in λmax = 4.12. Consequently, CI is equal to 0.04 and CR is less than 0.1, The matrix meets the consistency requirements and demonstrates satisfactory consistency. The conclusion can be inferred as follows: The relative weights assigned to B1 knowledge comprehension, B2 knowledge extension, B3 teacher-student interaction, and B4 learning ability in judgment matrix A are 0.5445, 0.0531, 0.1138, and 0.2544 respectively,as depicted in **Table 4**.

Table 4. The average random consistency index value of the matrix in 1–9 order.

Order	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45

3.4.3. The procedure for conducting a consistency test

1) The consistency index needs to be calculated $CI = (\lambda max - n)/(n - 1)$.
2) The RI value should be determined by consulting the average table of random consistency index values for the matrix.
3) The consistency ratio needs to be calculated CR = CI/RI

The CR value below 0.1 indicates that the overall hierarchy ranking has successfully passed the consistency test. According to the aforementioned, the hierarchical importance order of the two program layers for achieving the overall goal is as follows: B1 knowledge understanding > B4 learning ability > B3 teacher-student interaction > B2 knowledge extension. Consequently, teachers' selection of teaching methods heavily relies on students' comprehension and learning capabilities. By following the aforementioned methods and procedures, the construction of analogous two-to-two judgment matrices can be carried out for each index corresponding to scheme layers C1 and C2. The specific findings are presented in **Tables 5–8**.

Table 5. Knowledge comprehension.

	Blended teaching	**Traditional teaching**
Blended teaching	1	1/3
Traditional teaching	3	1

Table 6. The expansion of knowledge.

	Blended teaching	**Traditional teaching**
Blended teaching	1	1/3
Traditional teaching	3	1

Table 7. Teacher-student mutual communication.

	Blended teaching	**Traditional teaching**
Blended teaching	1	3
Traditional teaching	1/3	1

Table 8. Digital literacy.

	Blended teaching	**Traditional teaching**
Blended teaching	1	3
Traditional teaching	1/3	1

The criterion layers (B1, B2, B3, B4) are constructed as second-order matrices rather than the judgment matrix of scheme layers (C1, C2), thereby satisfying consistency testing requirements and demonstrating satisfactory consistency.

3.5. The comprehensive weighting and hierarchical ranking of evaluation indicators for blended teaching and traditional teaching

Hierarchical general ranking refers to the process of determining how important each factor is relative to achieving higher-level goals. It follows a layered approach from highest to lowest levels. Calculation typically involves multiplying weights assigned to specific indices at one level by their corresponding higher-level indices' weights within that same layer. This results in final weight values for each index in an evaluation system, as shown in **Figure 7** (Chen and Zhang, 2022).

$$\begin{bmatrix} 0.7500 & 0.7500 & 0.2500 & 0.2500 \\ 0.2500 & 0.2500 & 0.7500 & 0.7500 \end{bmatrix} \times \begin{bmatrix} 0.5445 \\ 0.0531 \\ 0.1138 \\ 0.2544 \end{bmatrix} = \begin{bmatrix} 0.540287 \\ 0.425516 \end{bmatrix}$$

Figure 7. Hierarchy total ranking.

The hierarchical total ranking results indicate that C1, which represents blended teaching, the analysis of traditional teaching evaluation results is superior in comparison to C2. Based on AHP calculations, it is generally believed by students that blended teaching surpasses traditional teaching in terms of knowledge extension and learning ability.

4. Blended teaching and traditional teaching

The implementation of blended teaching methods in the field of education has been widely embraced, as they have significantly augmented students' interest and learning capacity, micro-teaching alone cannot suffice as the sole instructional approach for teachers. Based on the students' questionnaire, we can see that there are many reasons why traditional teaching should not be abandoned. At the same time, traditional teaching has numerous advantages. Blended teaching should keep up with the times, meet student requirements, and make continuous progress (Graham and Robison, 2023).

4.1. Blended teaching

The utilization of blended teaching is prevalent in the field of education, contributing to enhanced student interest and digital literacy. This is primarily manifested through the following four aspects:

1) Improve students' digital literacy.

The concept of blended learning integrates digital and traditional resources, enabling students to avail themselves of a plethora of materials such as instructional videos, e-books, and online courses through digital platforms. These resources not only expand students' knowledge but also enhance their ability to use digital tools. In a blended learning environment, students frequently use various educational technologies and digital tools, such as learning management systems (LMS), virtual labs, and simulation software. These practical opportunities help students continually improve their technical skills and digital literacy through hands-on application (Garg, 2020).

2) Easy to learn.

The integration of blended teaching allows teachers and students to conveniently access micro-videos on mobile devices, promoting fragmented learning. This approach greatly contributes to the academic progress and skill improvement of students while also fostering their active engagement and enthusiasm for learning.

3) Constantly improving the professional quality of teachers.

The blended teaching model requires teachers to combine online teaching methods with traditional classroom teaching. This encourages teachers to continuously explore and innovate their teaching methods to improve teaching effectiveness. In this way, teachers can better meet the diverse learning needs of students. Blended teaching emphasizes interaction and collaboration between teachers and students. Teachers need to communicate and engage with students through various digital platforms. This not only improves teachers' communication skills but also helps them become proficient in using various digital tools and collaboration platforms. According to Ali and Jing (2024), the theories of management science are applied to teaching management by educational management researchers, continuously improving the field of educational management. An important theory in management principles, incentive theory has a significant impact on our teaching management. This paper examines the findings of prior research on incentive theory in teaching management using both qualitative and quantitative methods, as well as through the use of questionnaires.

4) The approaches to blended teaching exhibit variations.

Personalized learning pathways: Through blended teaching, students can choose learning paths that suit their progress and needs. Teachers can provide various learning resources and activities, such as video tutorials, online quizzes, and virtual labs, to help students identify and solve problems during self-directed learning. Blended teaching encourages students to collaborate through online platforms. Students can discuss, share resources, and work on projects together in a virtual learning environment. This not only enhances their teamwork skills but also deepens their understanding of the content through interaction.

4.2. Traditional teaching

Despite the rapid advancements in information technology and network technology, traditional teaching still retains substantial value, as delineated below:

1) Knowledge is widely taught.

The traditional teaching approach is characterized by a teacher-led and textbook-centered methodology, placing significant emphasis on the instructor's guidance (Kim, 2018). In this setting, teachers impart knowledge to a large number of students in the classroom, thereby facilitating extensive knowledge dissemination. Through well-organized, purposeful, and planned instructional activities led by teachers, the efficacy of students' knowledge acquisition can be optimized. Moreover, traditional teaching incurs relatively low investment costs while remaining economically viable.

2) Clear teaching objectives.

Teachers strive to meticulously prepare teaching content and deliver new knowledge on a daily basis, ensuring a progressive learning experience (Stronge, 2018). Simultaneously, students can effectively integrate listening and memorization techniques, captivating their attention while enhancing their cognitive abilities and facilitating the acquisition of comprehensive, systematic, and robust knowledge.

3) Interaction between teachers and students.

Face-to-face instruction and learning foster continuous communication within the classroom, thereby enhancing the emotional rapport between educators and students (Solimeno et al., 2008). Moreover, traditional teaching methods ensure that teachers maintain their authoritative role in delivering instructions. Effective teacher-student communication contributes to cultivating students' interest in learning and mobilizing their enthusiasm, underscoring the pivotal role of students as active participants in education.

4) Promoting the all-round development of students.

Traditional teaching, through the fulfillment of instructional tasks, enables face-to-face education and communication with students to foster their moral, intellectual, and physical development. Moreover, class activities can be orchestrated to facilitate comprehensive growth among students.

5. Conclusion

The consistency ratios CR of all judgment matrices in the Analytic Hierarchy Process were calculated, and they all satisfied the criterion $CR < 0.1$, and all pass the consistency test. The order of relative weight or criteria in the overall ranking from high to low is as follows: Blended Learning is the first, and then is the traditional classroom. Compared to traditional teaching, blended learning offers significant advantages. By combining online and offline methods, blended learning provides greater flexibility and convenience, supports personalized learning, and utilizes a rich array of digital resources, enhancing both interaction and engagement. However, it requires teachers to have more technological skills and dedicate additional time to manage online instruction. Traditional teaching, with its fixed classroom schedules and face-to-face interactions, offers a stable learning environment but may have limitations in resource availability and personalization. Overall, blended learning effectively addresses some of the shortcomings of traditional teaching, serving as a valuable complement. Teachers should choose the appropriate teaching methods based on specific goals and student needs or effectively integrate both approaches to maximize their respective benefits.

Therefore, the application of blended learning in management fundamentals courses is feasible. It not only enhances student engagement but also improves their digital literacy. By combining online and face-to-face learning methods, blended learning provides students with a more flexible, interactive, and personalized learning experience, while also fostering the development of their technological skills and practical application abilities.

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