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Blended Teaching Model Optimization for Innovation and Entrepreneurship Courses through Data Analytics in Higher Education

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Abstract

This study aimed to (1) develop a blended teaching model for Innovation and Entrepreneurship courses in Chinese higher education, and (2) assess the effectiveness of the proposed model. The sample consisted of 17 Chinese experts selected through purposive sampling and 30 higher education students from China. The research employed statistical analysis techniques including mean, standard deviation, coefficient of variation, and t-test to analyze the data. Results demonstrated significant improvements in students' entrepreneurship skills. In the experimental group, the pre-test mean score increased from 2.21 to 3.78 post-intervention, while the control group showed a slight improvement from 2.32 to 2.84. The standard deviation of learning outcomes decreased from 0.884 to 0.564, indicating a more consistent student performance. A statistically significant difference was observed ($p = 0.003$), confirming the effectiveness of the blended teaching model. These findings highlight the potential of blended learning in enhancing the quality of innovation and entrepreneurship education.

Keywords: Blended Teaching, Innovation, Entrepreneurship Courses, Higher Education, China

1. Introduction

The rapid advancement of digital technology and the evolving demands of the global economy have profoundly transformed higher education, particularly in the fields of innovation and entrepreneurship. Traditional educational frameworks, which often emphasize theoretical knowledge, are increasingly unable to equip students with the practical competencies and flexibility needed in today's dynamic business environment. To address this challenge, the Blended Teaching Model, which combines online and offline learning, has emerged as a promising approach to enhance the quality of innovation and entrepreneurship education.

In the 21st century, China's rapid economic growth has led to increased societal demand for highly skilled talent. Workers are expected to possess not only technical expertise but also innovation and entrepreneurship skills. In response to growing corporate competition and the difficult employment prospects for university graduates, entrepreneurship has become a vital solution to mitigate employment pressures and stimulate societal development. As innovation is at the heart of entrepreneurship, Chinese higher education institutions have progressively prioritized innovation and entrepreneurship education as a key avenue for cultivating entrepreneurial talent. This focus has garnered significant attention from the government, educational authorities, and society at large [1].

Recent governmental initiatives, such as the Mass Entrepreneurship and Innovation Policy released in September 2018 [2] and the Education Informatization 2.0 Action Plan in April 2018 [3], have been designed to promote high-quality entrepreneurship education and integrate digital technologies into the learning process. Furthermore, the 2023 notice on promoting digital campus development emphasizes the transformation of universities through digital platforms, with the goal of fostering innovation and enhancing educational quality [4]. The growing interest in blended learning in China's higher education is a direct response to these governmental goals, as well as the need for a shift towards more flexible and engaging teaching methods. This teaching model uses digital platforms, interactive tools, and

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experiential learning to develop students' creativity, problem-solving abilities, and business acumen. By combining traditional classroom education with online resources, case studies, and real-world projects, blended learning offers a more flexible, student-centered experience.

The integration of "Internet Plus" into innovation and entrepreneurship education has provided new opportunities for teaching reforms. The rapid expansion of information technology has allowed students broader access to entrepreneurial resources and practice platforms, encouraging ongoing innovation in curriculum design. The blended learning model is particularly effective in fostering practical skills and innovative thinking by combining online and offline learning experiences, including entrepreneurial project practices on digital platforms. This approach not only allows students to grasp entrepreneurial theories but also equips them with hands-on experience. The integration of mentor guidance, team collaboration, and entrepreneurial case analysis further enhances students' problem-solving and teamwork abilities [5].

In the context of innovation and entrepreneurship education, the role of instructors is crucial. Teachers act as facilitators and supporters, using digital tools to optimize teaching strategies, encourage active participation, and employ diverse teaching methods such as interactive discussions, project-based learning, and video-based instruction [6]. By adopting these innovative teaching practices, higher education institutions can better prepare students to meet future challenges as highly capable and innovative talents [7].

Despite the promise of innovation and entrepreneurship courses, challenges remain in China's higher education system. These courses often struggle with excessive theoretical content and a lack of practical experience. Many professors lack entrepreneurial experience, hindering their ability to guide students through real-world challenges. The insufficient collaboration between academia and industry results in missed opportunities for internships, mentorship, and industry-driven projects, which are crucial for developing practical entrepreneurial skills. Furthermore, the rigid and standardized curriculum in many Chinese institutions fails to adapt to students' evolving interests and market dynamics, constraining innovation [8].

In light of these challenges, this study explores the potential of the Blended Teaching Model to optimize innovation and entrepreneurship education in China. By integrating conventional lectures with online learning, this model fosters autonomous learning, greater student involvement, and the development of critical entrepreneurial skills. It also enhances the flexibility and accessibility of learning, encouraging collaboration among students, educators, and industry professionals. As such, blended learning represents a key strategy in preparing future entrepreneurs who are equipped to thrive in a competitive global marketplace [9].

2. Literature Review

Blended teaching, which integrates traditional in-person lectures with online learning, has gained significant attention in global higher education. This methodology is especially pertinent for courses in innovation and entrepreneurship, which require both theoretical understanding and practical implementation. In China, higher education institutions are increasingly exploring blended teaching to improve student engagement, learning outcomes, and entrepreneurial skills. This literature review examines current research on the blended teaching paradigm applied to innovation and entrepreneurship courses in China, highlighting its effectiveness, limitations, and future directions.

2.1. Blended Teaching in Higher Education

Blended learning is widely regarded as an effective pedagogical strategy in higher education. Research indicates that it enhances student engagement, knowledge retention, and critical thinking skills. Utilizing digital tools such as Learning Management Systems (LMS), online discussion forums, and virtual simulations enables students to engage in flexible and participatory learning experiences. However, the success of blended learning is contingent upon well-structured course design, instructor readiness, and the technology infrastructure available to both educators and students.

Studies have shown that hybrid instruction, which incorporates significant use of technology and active student participation, can effectively engage students and improve learning outcomes. To succeed, blended learning requires careful course planning and a technological infrastructure that supports both in-person and online components.

Additionally, instructors need proper training to address the challenges of integrating technology into the classroom and ensuring that courses are engaging and participatory. Although some students favor hybrid classes due to their flexibility, others struggle with the lack of face-to-face interaction. Despite these challenges, hybrid learning provides opportunities to enhance accessibility, equity, and educational quality by encouraging collaboration and utilizing technology to improve learning outcomes [10].

2.2. Blended Learning Models

Blended learning aims to improve educational outcomes by integrating online and offline learning. This approach, which blends traditional classroom instruction with modern information technologies, has gained considerable support as information technology advances and the number of online education platforms increases. Blended learning successfully combines the benefits of traditional classroom teaching with the flexibility of online education, thus improving students' learning outcomes and meeting the demand for more personalized education [11].

Blended learning has gained popularity in recent years because it is both flexible and effective. Various implementation strategies, such as flipped classrooms, modular teaching, and collaborative learning, enhance student autonomy and foster a strong connection between theoretical knowledge and practical application. Furthermore, the use of digital tools and platforms allows instructors to disseminate information, assign projects, and facilitate interactive engagement, thereby increasing student involvement and fostering a more independent learning experience [12].

Although blended learning enhances student engagement and improves critical thinking, it also presents challenges such as technological difficulties, time management issues, and assessment complexities. These challenges can be mitigated by ensuring that courses are meticulously planned and that educators are well-prepared. Additionally, successful blended learning requires a reliable technological infrastructure and the active involvement of both instructors and students [13].

2.3. Teaching Design of Innovation and Entrepreneurship Courses

In recent years, innovation and entrepreneurship education has become a key focus of higher education reform, particularly in the context of the "Internet Plus" initiative. The rapid advancement of information technology has propelled reforms in this area by providing students with broader access to practical platforms and entrepreneurial resources. By combining online and offline teaching methods, universities can increase student engagement and interaction, thereby enhancing the integration of theoretical knowledge with practical applications [14].

Innovation and entrepreneurship courses aim to bridge the gap between theory and practice by allowing students to experience the entrepreneurial process through real-world projects. Blended learning has become increasingly mainstream in these courses, incorporating flipped classrooms, modular teaching, and project-based collaborative learning methods. These strategies promote autonomous learning and encourage teamwork [15]. The use of online teaching platforms has further enhanced course flexibility and enabled interdisciplinary collaboration, while also allowing for distance education [16].

Studies have shown that Outcome-Based Education (OBE) aligns learning outcomes with course objectives and ensures that students acquire core entrepreneurial skills. Constructivist teaching methods, such as interactive learning, also improve students' cognitive and practical abilities. Teachers play a crucial role in facilitating learning by offering guidance and resources. The Ministry of Education in China has emphasized the importance of integrating innovation and entrepreneurship education into higher education, and this article discusses the design and execution of blended teaching strategies for these courses [17], [18].

2.4. Innovation and Entrepreneurship Courses

Innovation and entrepreneurship courses have been widely promoted in China's higher education system to address the growing demand for innovative talent. Research in this area focuses on three main areas: course content design, the development of innovative teaching methods, and policy support. The design of course content emphasizes the integration of theoretical knowledge with practical skills, often through experiential learning, project-based education, and case discussions, all of which significantly enhance student engagement [19].

Government policies play an essential role in promoting innovation and entrepreneurship education by supporting collaboration between universities and businesses. This collaboration helps align academic courses with real-world entrepreneurial practices, providing students with opportunities for mentorship, internships, and industry-driven projects [20]. Despite the growth in innovation and entrepreneurship education, challenges remain, such as mismatched course content, insufficient teacher training, and a lack of robust evaluation mechanisms. Further research should explore collaborative course content development and the use of big data and AI to optimize teaching models and improve outcomes [21], [22].

The blended teaching paradigm combining online and offline learning has proven effective in enhancing student engagement, critical thinking, and practical skills in innovation and entrepreneurship education. While the approach offers several benefits, including increased learning flexibility and broader accessibility, it also presents challenges related to technology, assessment, and student motivation. Overcoming these challenges requires investments in digital infrastructure, the creation of interactive learning communities, and the use of AI-driven analytics for tailored feedback [23].

2.5. Delphi Technique

The Delphi Technique is a structured method for gathering expert opinions, particularly useful for addressing complex, multi-layered topics. This method facilitates consensus-building through anonymous and iterative feedback, helping to avoid conflicts among experts. It has been widely used in fields such as social sciences, medicine, and management decision-making. The core steps of the Delphi Technique include defining the research problem, selecting an expert panel, designing and distributing multiple rounds of questionnaires, collecting and analyzing data, and ultimately reaching a consensus [24], [25].

This technique is particularly beneficial in developing educational frameworks, such as the blended teaching model for innovation and entrepreneurship courses. By using a Delphi panel of experts, including academics, industry leaders, and educational technologists, this study aims to identify essential components of a blended teaching model and refine these components to create an optimal framework. The Delphi Technique ensures that the developed model is informed by expert consensus and tailored to the unique needs of higher education students in China [25].

3. Methodology

3.1. Delphi Technique for Designing the Blended Teaching Model

A comprehensive literature review led to the development of a preliminary teaching model for Chinese university students in innovation and entrepreneurship courses. The Delphi Technique was employed to design and refine the blended teaching model, involving 17 purposively selected Chinese experts. These experts, with a master's degree or associate professorship and at least five years of experience, participated through individual face-to-face or phone interviews.

First Round: Open-Ended Questions. In the first round, semi-structured interviews were conducted with the 17 experts, focusing on the impact of the blended teaching model for innovation and entrepreneurship courses. Using stakeholder theory and a development and evaluation framework, the interviews aimed to gather expert perspectives on curriculum design, program content, and implementation challenges. Open-ended questions were designed to identify essential components such as digital tools, educational methods, evaluation strategies, and engagement techniques.

The methodology for the first round included defining the research problem, identifying the key components for the hybrid teaching strategy, and selecting a diverse expert panel from academia, industry, and digital education. The experts were asked to evaluate various aspects of the teaching model, such as the effectiveness of different digital technologies, evaluation methods, and approaches for maximizing student involvement.

Second Round: Prioritization and Refinement. The second round involved the development of a structured questionnaire based on responses from the first round. Experts evaluated components of the course design using a five-point Likert scale [26]. This round aimed to prioritize components based on their importance and feasibility. The key steps in this phase included summarizing the first-round results, identifying major topics and trends in expert feedback, and ranking the importance of different components. Experts also provided qualitative feedback on the feasibility of implementing these components.

Third Round: Final Consensus. The third round aimed to achieve consensus on the most effective blended teaching model for innovation and entrepreneurship courses. Experts reviewed the responses from the second round and adjusted their evaluations. The goal was to reach at least 70% agreement on the key elements of the teaching framework. Key features expected to be part of the final model included flexible digital learning tools such as MOOCs, virtual simulations, interactive case studies, student-centered teaching methods such as problem-based learning and flipped classrooms, and innovative assessment strategies like competency-based evaluations and peer assessments.

Fourth Round: Validation. In the fourth round, expert feedback was further analyzed and refined. Feasible concepts were identified, and the Delphi technique was iterated until consensus was reached. The final teaching model was validated and prepared for implementation in a quasi-experimental design.

3.2. Conceptual Framework of Blended Teaching Model on Innovation and Entrepreneurship Courses

This study examines the conceptual framework for the blended teaching model, focusing on key elements like digital tools, pedagogical approaches, and assessment strategies [27]. The framework (figure 1) aligns with the overall aim of fostering innovation and entrepreneurship skills among students. The independent variables in this framework include digital tools and platforms, pedagogical methods, evaluation strategies, and student engagement techniques. The dependent variables are student performance and innovation and entrepreneurship skills development.

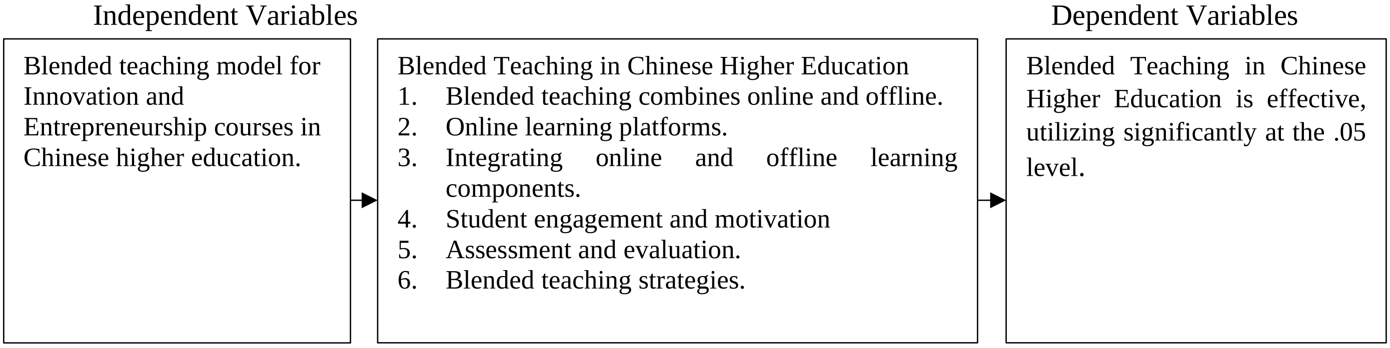

Figure 1. Innovation and Entrepreneurship Course Blended Teaching Model Conceptual Framework

3.3.Data Collection Procedures

The primary goal of data collection in this study was to evaluate the effectiveness of the blended teaching model within the innovation and entrepreneurship program. The evaluation focused on several key aspects, including the integration of online and offline learning modalities, student involvement, assessment methods, and engagement strategies. To gain a comprehensive understanding of students' learning experiences, multiple surveys were administered at various stages of the course.

At the start of the course, a pre-course survey was administered to collect demographic data, prior knowledge, learning preferences, and students' initial perceptions of blended learning. This provided a baseline for understanding students' expectations and prior exposure to blended learning environments. Additionally, mid-course and post-course surveys were conducted to evaluate changes in students' attitudes, learning experiences, and satisfaction with both the online and in-person components of the course. These surveys included Likert scale questions to assess engagement, perceived effectiveness, and overall course satisfaction, alongside open-ended questions that allowed students to provide detailed feedback on content delivery, technical usability, and the learning tools used throughout the course.

The Delphi Technique was employed to design and refine the blended teaching model. This technique involved conducting semi-structured interviews with 17 purposively selected Chinese experts, each with relevant experience and expertise in higher education. These experts played a critical role in shaping the curriculum and refining the integration of online and offline learning components within the innovation and entrepreneurship courses. Their contributions were vital for ensuring that the blended model met the educational needs of students.

To assess student engagement, Learning Management System (LMS) data was analyzed throughout the course. Key metrics included login frequency, assignment completion times, participation in online forums, and overall interaction with the course content. This data was further used to evaluate students' progress by comparing quiz results and assignment submission rates to determine if the blended learning approach enhanced student learning outcomes.

In addition to data from surveys and LMS, classroom observations were conducted to assess student interaction and involvement in both virtual and in-person sessions. These observations were aimed at measuring student engagement, interest levels, and the quality of classroom discussions. Pre- and post-tests were used to assess knowledge acquisition, while ongoing assessments through assignments, case studies, and group discussions provided insight into the application of entrepreneurial concepts.

To ensure a representative sample, students were selected from diverse academic backgrounds and demographics. Both random sampling and intentional sampling methods were employed. Random sampling ensured the generalizability of the findings, while intentional sampling allowed for a closer examination of students who demonstrated varying levels of engagement with the blended learning model.

Ethical integrity was a crucial aspect of the data collection process. Informed consent was obtained from all participants, ensuring they were fully aware of the study's objectives and how their data would be used. The study-maintained participants' confidentiality and anonymity by removing personal identifiers from the data. Participation was entirely voluntary, and students were informed they could withdraw from the study at any time without facing any negative consequences.

The data collected through the various methods was analyzed using both quantitative and qualitative approaches. Quantitative analysis included statistical methods such as mean, median, and mode to examine survey responses, pre- and post-test results, and LMS data. This analysis explored the relationship between student engagement and academic achievement within the blended learning environment. On the other hand, qualitative analysis involved categorizing and thematically examining responses from interviews, focus groups, and open-ended survey questions. This allowed for the identification of trends in students' feedback regarding their experiences with the blended learning model and their understanding of innovation and entrepreneurship.

Finally, the findings from the data collection were summarized and presented to stakeholders. These findings emphasized the benefits of the blended learning model, areas for improvement, and suggestions for course modifications. A feedback loop was established to continuously evaluate and adjust the course design based on ongoing student feedback and performance indicators. This iterative process allowed educators and course designers to refine the course to better meet students' needs and enhance learning outcomes.

4. Results and Discussion

4.1. Demographic Data

In the fourth round of expert consultations, statistical results were gathered to assess the construction dimensions of higher education teaching based on expert feedback. The table 1 shows the statistical results of expert scores on various dimensions of higher education teaching, including the mean, standard deviation, full score ratio, variable coefficient, and support level. These statistics help to evaluate the importance and consensus regarding different components, such as the OBE concept, self-directed learning, teacher guidance, teacher-student interaction, and the role of information technology in education. The response rates and support levels indicate a high degree of agreement among the experts, with full-score rates and average importance values all surpassing 3.

Table 1. Statistical results of expert scores on construction dimensions of higher education teaching

Name	Mean	standard deviation	Full score ratio	Variable Coefficient	Support level
OBE concept	3.18	0.809	41.18%	25.47%	76.47%
Self-directed learning	3.59	0.618	64.71%	17.23%	94.12%
Teacher guidance	3.41	0.795	58.82%	23.31%	82.35%

Teacher-student interaction	3.29	0.588	35.29%	17.85%	94.12%
information technology	3.29	0.686	41.18%	20.82%	88.24%

In table 2, the statistical results of expert scores on construction dimensions and pattern characteristics of higher education teaching are presented. The table provides the mean, standard deviation, full score ratio, variable coefficient, and support level for various factors such as outcome-oriented learning, teaching methods, evaluation and assessment, and student-centered learning. The data reflects expert consensus on the importance and effectiveness of these factors in shaping a well-rounded and effective higher education teaching model. Support levels and coefficients of variance further indicate that there is a strong agreement among experts, with most of the characteristics receiving high support levels.

Table 2. Statistical results of expert scores on Construction Dimensions pattern characteristics of higher education teaching.

Name	Mean	standard deviation	Full score ratio	Variable Coefficient	Support level
Outcome-oriented learning	3.24	0.664	35.29%	20.53%	88.24%
teaching method	3.35	0.702	47.06%	20.93%	88.24%
Evaluation and Assessment	3.29	0.686	41.18%	20.82%	88.24%
Student-centered learning	3.53	0.624	58.82%	17.69%	94.12%
Power and perseverance	3.29	0.588	35.29%	17.85%	94.12%
Assessment and Reflection	3.35	0.786	52.94%	23.44%	82.35%
learning strategy	3.41	0.712	52.94%	20.88%	88.24%
resource utilization	3.24	0.831	47.06%	25.70%	76.47%
feedback mechanism	3.18	0.728	35.29%	22.91%	82.35%
instructional Design	3.35	0.702	47.06%	20.93%	88.24%
Resource support	3.24	0.664	35.29%	20.53%	88.24%
Interactive style	3.18	0.728	35.29%	22.91%	82.35%
Incentive strategy	3.18	0.728	35.29%	22.91%	82.35%
Teaching support	3.24	0.752	41.18%	23.26%	82.35%
Student participation	3.47	0.717	58.82%	20.67%	88.24%
Multimedia resources	3.18	0.728	35.29%	22.91%	82.35%
Evaluation Technology	3.53	0.514	52.94%	14.58%	100.00%
Digital collaboration tools	3.29	0.772	47.06%	23.43%	82.35%
Learning Management System	3.29	0.849	47.06%	25.77%	88.24%

Table 3 presents the statistical results of expert ratings on the characteristics of dimension models in higher education teaching construction. The table illustrates how various factors, such as information technology, independent study, teacher guidance, and teacher-student interaction, influence the implementation of the Outcome-Based Education (OBE) concept, the process of teacher guidance, and the degree of teacher-student interaction.

Each row represents a specific factor, labeled from H1 to H10, with the corresponding mean, standard deviation, full score ratio, coefficient of variation, and support level. The mean values show the average ratings from the experts, while the standard deviation indicates the variability of the responses. The full score ratio reflects the percentage of experts who rated each item highly, while the coefficient of variation provides a measure of the consistency of expert opinions. Finally, the support level shows the percentage of experts who rated each characteristic as either "extremely important" or "somewhat significant," indicating the level of consensus among the experts.

Table 3. Statistical results of expert ratings on the characteristics of dimension models in higher education teaching construction

Name	Number	Mean	Standard deviation	Full score ration	Coefficient of variation	Support level
Information technology affects the implementation of the OBE concept	H1	3.24	0.752	41.18%	23.26%	82.35%
Information technology affects the effect of autonomous learning	H2	3.35	0.702	47.06%	20.93%	88.24%
Information technology affects the process of teacher guidance	H3	3.12	0.781	29.41%	25.06%	88.24%
Information technology affects the degree of teacher-student interaction	H4	3.59	0.618	64.71%	17.23%	94.12%
Independent study influences the implementation of the OBE concept	H5	3.29	0.588	35.29%	17.85%	94.12%
Independent study affects the process of teacher guidance	H6	3.47	0.717	58.82%	20.67%	88.24%
The degree to which independent learning influences teacher-student interaction	H7	3.41	0.712	52.94%	20.88%	88.24%
Teacher guidance influences the implementation of the OBE concept	H8	3.24	0.831	47.06%	25.70%	76.47%
The degree to which teacher guidance influences teacher-student interaction	H9	3.18	0.809	35.29%	25.47%	88.24%
Teacher-student interaction affects the implementation of the OBE concept	H10	3.35	0.702	47.06%	20.93%	88.24%

For instance, Information technology affects the degree of teacher-student interaction (H4) received the highest mean score of 3.59, with a low standard deviation of 0.618, suggesting strong consensus among experts on its importance. This is further supported by a high support level of 94.12%. On the other hand, Teacher guidance influences the implementation of the OBE concept (H8) received the lowest mean score of 3.24, indicating that experts rated it slightly less critical than the other factors, though it still achieved a reasonable support level of 76.47%.

After four rounds of expert consultations, 17 experts reached a high consensus on the elements and characteristics of blended teaching in higher Education. These were synthesized into the P-OIITT model, where "O" refers to the OBE philosophy, "I1" refers to Information Technology, "I2" refers to independent learning, "T1" refers to teacher guidance, and "T2" refers to teacher-student interaction. The relationships among the five elements are illustrated in figure 2.

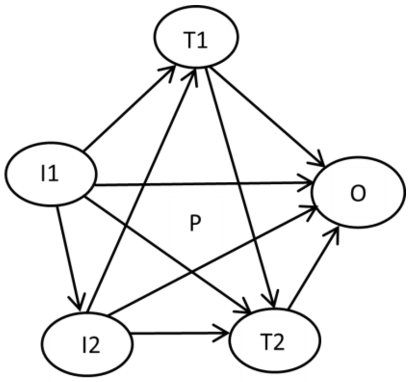

Figure 2. Blended teaching design model for Higher Education (P-OIITT).

Table 4 outlines the Blended Teaching Practice Model (P-OIITT) for higher education teaching design, emphasizing five key elements aimed at enhancing student engagement and fostering collaborative learning. Central to the model is the OBE Concept (Outcome-Based Learning), which ensures that learning outcomes are clearly defined at the beginning of each course. This approach guides students toward achieving measurable educational goals and aligns the curriculum with real-world applications. By focusing on outcomes, this model helps students track their progress and better understand the practical significance of what they are learning.

Table 4. Explanation of Elements of Blended Teaching Practice Model (P-OIITT)

Key Element	Characteristics and Description
OBE Concept (Outcome-Based Learning)	Clear learning outcomes are defined at the start of each course, guiding students toward achieving specific goals.
Teaching Method	Uses blended learning, flipped classrooms, and project-based learning. The curriculum links theory to real-world applications through practical projects.
Student-Centered Learning	Encourages collaboration, participation, and self-awareness. Students work with industry professionals on real projects.
Evaluation and Assessment	Regular assessments with timely feedback. Final assessments involve applying knowledge in practical projects.
Information Technology	Includes Learning Management System (LMS) for accessing materials and tracking engagement. Digital collaboration tools (Zoom, Teams) for discussions. Multimedia resources like e-learning modules and TED talks.
Independent Learning	Students set entrepreneurial goals, manage their learning plans, and engage in self-directed research and reflection.
Teacher Guidance	Balanced curriculum with both face-to-face and online instruction. Teachers provide real-time feedback, personalized advice, and additional resources like e-books and videos.
Teacher-Student Interaction	Active participation is encouraged with regular feedback and support through both online and offline methods.

The Teaching Method incorporates blended learning, flipped classrooms, and project-based learning. This combination allows students to engage with theoretical content at their own pace through online resources, while class time is reserved for interactive activities that promote deeper understanding. Flipped classrooms encourage students to prepare outside of class, with face-to-face sessions focusing on applying knowledge in hands-on projects. Project-based learning connects academic concepts with real entrepreneurial challenges, allowing students to develop practical problem-solving skills.

Student-Centered Learning is another core component of the model, where students are actively involved in their learning through collaboration, participation, and reflection. By working on real-world projects with industry professionals, students gain valuable experience while developing critical thinking and teamwork skills. The model also emphasizes Independent Learning, allowing students to set their own entrepreneurial goals, manage their learning, and engage in self-directed research. This autonomy fosters a sense of ownership over their education and helps cultivate skills necessary for success in the business world.

The model integrates Information Technology to support both learning and teaching processes. Learning Management Systems (LMS) provide students with access to materials, assignments, and assessments, while allowing teachers to monitor student engagement and progress. Digital collaboration tools like Zoom and Teams facilitate synchronous communication, and multimedia resources such as TED talks and interactive e-learning modules enrich students' understanding of the course material. Evaluation and Assessment strategies ensure continuous feedback, helping students improve and apply their learning in practical contexts, while Teacher Guidance offers personalized support to further enhance students' educational experience and entrepreneurial growth. Through this balanced, technology-enhanced approach, the model fosters an engaging and effective learning environment.

4.2. Results of quasi-experimental method

4.2.1. Comparative Analysis of Learning Outcomes between the Experimental and Control Groups

An independent samples t-test was conducted to examine the post-test scores of students in the experimental and Control groups, aiming to determine whether significant differences existed between the scores. As shown in table 5, the pre-test scores of the experimental group were 80.52 ± 8.38, while the control group scored 79.90 ± 7.96. The independent samples t-test results indicated no statistically significant difference between the two groups (P = 0.705), confirming the comparability of the groups. The comparative results of course performance before and after the test for both groups are illustrated in Figure 3.

Table 5. Comparison of Pre-Test Course Scores between the Experimental and Control Groups.

Grouping	quantity	$\bar{x}$±SD	T	95% confidence interval	P value
Experimental Group	60	80.52±8.38	0.379	-2.62~3.86	0.705
Control Group	60	79.90±7.96			

Note: $\bar{x}$ represents the mean, and SD represents the standard deviation.

As shown in table 6, the post-test course performance of the experimental group was significantly higher than that of the control group (83.96 ± 6.75 vs. 80.02 ± 7.68) as determined by an independent samples t-test. The difference between the two groups was statistically significant (P = 0.003). The comparison of post-test course performance between the two groups is illustrated in figure 3, indicating that the experimental group demonstrated more significant improvement in performance than the control group.

Table 6. Comparison of Post-Test Course Performance between the experimental and Control Groups.

Grouping	Quantity	$\bar{x}$±SD	T	95% confidence interval	P value
Experimental Group	60	83.96±6.75	3.000	1.48~7.24	0.003
Control Group	60	80.02±7.68			

Note: $\bar{x}$ represents the mean, and SD represents the standard deviation.

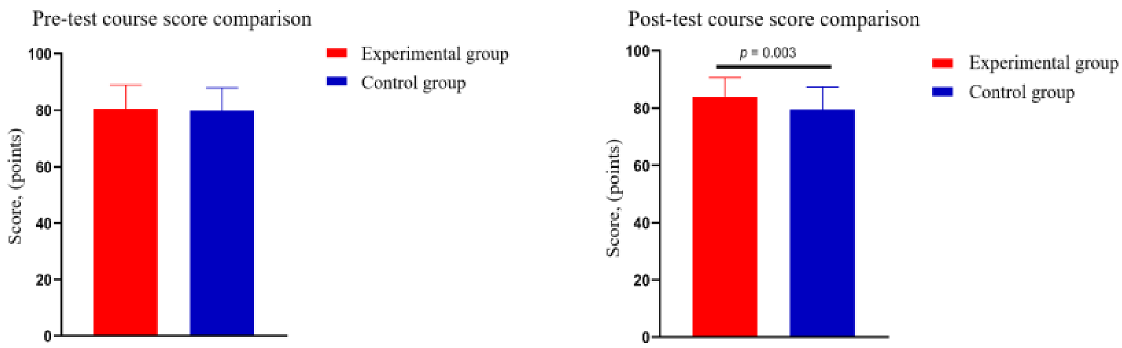

Figure 3. Comparison of Pre-Test and Post-Test Course scores between the Experimental Groups and Control Groups

4.2.2. Comparative Analysis of Innovation and Entrepreneurship Abilities between the Experimental Groups and Control Groups

As shown in table 7, there were no statistically significant differences in the levels of innovation and entrepreneurship abilities between the experimental and Control groups before the test, as determined by an independent samples t-test (all P > 0.05). This indicates that the two groups were comparable. Figure 3 compares pre-test innovation and entrepreneurship abilities between the two groups.

Table 7. Comparison of Pre-Test Innovation and Entrepreneurship Abilities between the Experimental and Control Groups

Grouping	Experimental group n=60	Control group n=60	T	P value
Innovation capability ($\bar{x}$ ± SD)	2.42±1.02	2.43±1.04	-0.053	0.958
Entrepreneurial ability ($\bar{x}$ ± SD)	2.21±1.11	2.32±1.08	-0.550	0.583

Note: $\bar{x}$ represents the mean, and SD represents the standard deviation.

After the test, as shown in table 8, the innovation ability of the experimental group was 3.60±1.23, significantly higher than that of the control group, which scored 2.96±1.16. An independent sample t-test indicated that the difference between the two groups was statistically significant (P=0.009).

Table 8. Comparison of Innovation and Entrepreneurial Abilities between the Experimental and Control Groups after the Test

Grouping	Experimental group n=60	Control group n=60	T	95% confidence interval	P value
Innovation capability ($\bar{x}$ ± SD)	3.60±1.23	2.96±1.16	2.678	0.17~1.11	0.009
Entrepreneurial ability ($\bar{x}$ ± SD)	3.78±0.97	2.84±0.99	4.766	0.55~1.33	<0.001

Note: $\bar{x}$ represents the mean, and SD represents the standard deviation.

Regarding entrepreneurial ability, the experimental group scored 3.78±0.97, while the control group scored 2.84±0.99, with a statistically significant difference between the two groups (P<0.001). In summary, the innovation and entrepreneurial abilities of the experimental group were significantly higher than those of the control group. The comparison of innovation and entrepreneurial abilities between the two groups after the test is shown in figure 4.

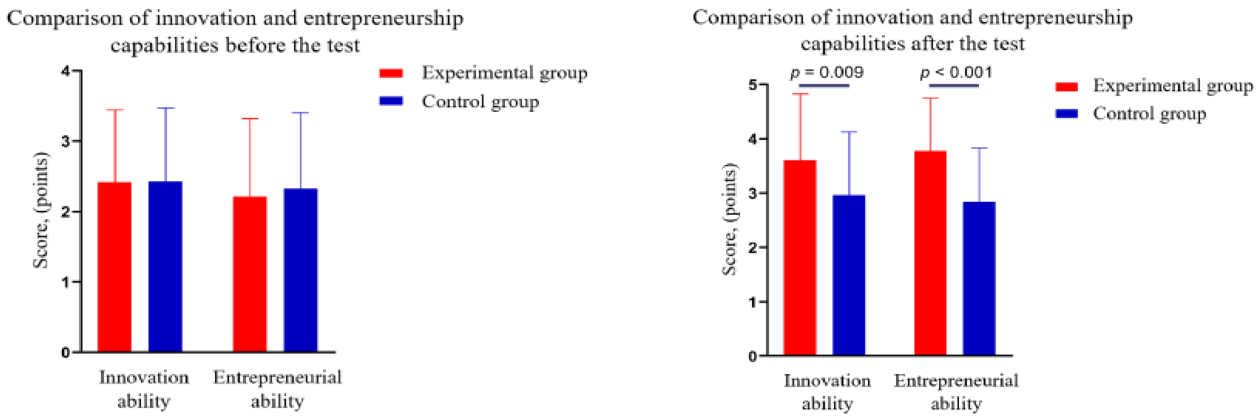

Figure 4. Comparison of Innovation and Entrepreneurial Abilities Between the Experimental and Control Groups Before and After the Test

After deriving the "Teaching Design Model for Innovation and Entrepreneurship Courses in Chinese Higher Education" using the Delphi method, 120 students were randomly selected from various Sichuan University of Science and Engineering colleges. These students were divided into a control group 60 students and an experimental group 60 students. The experimental group underwent systematic teaching based on the model. Before implementing the teaching design, the Innovation and Entrepreneurship Competency Questionnaire for College Students was employed to assess the innovative and entrepreneurial capabilities of all 120 participants. The results demonstrated that the teaching design significantly improved students' academic performance, innovative abilities, and entrepreneurial capabilities across various dimensions, confirming the model's efficacy. (1) Enhancing Academic Performance. Compared to conventional teaching models, the P-OIITT teaching practice model in higher Education proved more effective in improving learners' academic performance. A significant difference was observed between students' achievements before and after the implementation of the model and in comparison, to conventional teaching methods. (2) Promoting Innovation and Entrepreneurship Competencies. The P-OIITT model was more conducive to fostering students' innovative and entrepreneurial competencies than traditional approaches, with students in the experimental group outperforming their counterparts in the control group. (3) Integrating Blended Learning. The model deeply integrated the "blended learning" approach into classroom teaching, effectively transforming the instructional format of the "College Innovation and Entrepreneurship" course.

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5. Conclusion

This study provides an in-depth analysis of the current state of innovation and entrepreneurship education in higher education, utilizing the Delphi technique for expert input and thorough model design, implementation, and validation. The findings confirmed that the proposed teaching design significantly improved instructional efficiency and cultivated critical learning skills. The study emphasized the importance of systematic learning and the deep integration of teaching practices, particularly the pivotal role those online technologies play in providing flexibility in education.

The Blended Teaching Model (P-OIITT) in higher education is built around five core elements: the Outcome-Based Education (OBE) approach, information technology, autonomous learning, teacher guidance, and effective student-teacher interaction. These five elements were identified as essential for fostering an effective learning environment. The OBE approach was found to be crucial in curriculum design, while information technology serves as a cornerstone of blended teaching. Autonomy in learning was emphasized as a critical element in innovation and entrepreneurship education, with teacher guidance facilitating the understanding of complex entrepreneurial concepts. Effective student-teacher interaction was identified as vital in maintaining engagement and promoting deeper learning. These elements collectively form a cohesive and interrelated framework that enhances both teaching and learning processes in higher education.

The effectiveness of the P-OIITT model was validated using quasi-experimental methods. The design and implementation of educational practices were systematically evaluated, encouraging educators to adjust their instructional strategies and incorporate more collaborative learning activities. The P-OIITT model helped transform the teaching paradigm from being teacher-centered to a more student-centered approach, ultimately leading to improved learning outcomes. This model contributed to the development of students' knowledge structures, their ability to collaborate and communicate, and the fostering of critical and innovative thinking. In doing so, it enhanced students' competencies in innovation and entrepreneurship, preparing them to meet the challenges of an evolving global economy.

Innovation and entrepreneurship education has become a central focus in higher education, particularly in China, where there is an increasing demand for entrepreneurial talent to drive economic growth. The blended teaching model offers an ideal pedagogical framework for this purpose by combining online and offline teaching methodologies. This hybrid model increases student engagement, promotes educational performance, and cultivates an entrepreneurial mindset. As technological advancements and the demand for innovation in the global economy continue to accelerate, educational institutions must adapt their teaching strategies. The Ministry of Education in China has recognized the importance of innovation and entrepreneurship education, urging institutions to explore dynamic and effective pedagogical models that foster the next generation of entrepreneurial leaders.

However, despite the advantages, there are challenges associated with the blended teaching model, such as technological barriers, student engagement issues, and evaluation difficulties. Ensuring reliable access to digital infrastructure and equipping educators with the necessary online teaching skills are key areas that need attention. Additionally, sustaining student motivation in virtual learning environments and creating effective assessment rubrics for entrepreneurial competencies remain significant challenges. To overcome these obstacles, recommendations include investing in digital infrastructure, fostering interactive learning communities, and utilizing AI-driven analytics for personalized feedback. The blended teaching paradigm offers a promising framework for innovation and entrepreneurship education, but continuous refinement and adaptation are essential to ensure its long-term success. Future studies should focus on evaluating the sustained effects of blended learning on students' entrepreneurial achievements and assess the effectiveness of various digital tools and curriculum improvement strategies.

In conclusion, the blended teaching model represents an effective approach to enhance innovation and entrepreneurship education in China. By integrating online and offline learning, institutions can promote self-learning, improve student creativity, and develop practical entrepreneurial skills. The model not only enhances learning flexibility and accessibility but also fosters an entrepreneurial spirit through experiential learning. As technology continues to evolve, universities can better equip students to face entrepreneurial challenges, ensuring that they are well-prepared for success in a rapidly changing world. The study suggests that future research should further explore how blended learning can be continuously optimized to maximize its impact on student learning outcomes and entrepreneurial success.

6. Declarations

6.1. Author Contributions

Conceptualization: L.Y., T.S., N.T., N.C., and T.K.; Methodology: T.S.; Software: L.Y.; Validation: L.Y., T.S., and T.K.; Formal Analysis: L.Y., T.S., and T.K.; Investigation: L.Y.; Resources: T.S.; Data Curation: T.S.; Writing Original Draft Preparation: L.Y., T.S., and T.K.; Writing Review and Editing: T.S., L.Y., and T.K.; Visualization: L.Y. 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.

References

[1] L. Yang, N. Zhou, N. Wang, D. Li, and X. Wang, "Research on innovation and entrepreneurship education for college students in chemical vocational colleges," *Journal of International Education and Development*, vol. 4, no. 4, pp. 58-63, 2020, doi: 10.47297/wspiedwsp2516-250009.20200404.

[2] J. Li, S. Huang, K. Y. Chau, and L. Yu, "The influence of undergraduate entrepreneurship education on entrepreneurial intention: Evidence from universities in China's Pearl River Delta," *Frontiers in Psychology*, vol. 12, 2021, doi: 10.3389/fpsyg.2021.732659.

[3] *Education Informatization 2.0 Action plan*, Ministry of Education of the People's Republic of China, 2018.

[4] H. Liu and C. Yang, "Exploration of the new mode of college students' innovation and entrepreneurship education under the 'Innovation and entrepreneurship' education background," *Journal of International Education and Development*, vol. 4, no. 9, pp. 54-69, 2020, doi: 10.47297/wspiedwsp2516-250009.20200411.

[5] P. Wu, "Interactive teaching mode activates entrepreneurship education: Research and practice," *Open Access Library Journal*, vol. 7, no. Nov., pp. 1-9, 2020.

[6] F. Liu, "Design of a multimodal teaching method for business innovation: A systematic study," *Hindawi Advances in Education*, vol. 2022, no. July, pp. 1-10, 2022, doi: 10.1155/2022/5882921.

[7] K. C. Kaiyanan, "Integrating entrepreneurship into education," *Journal of Education and Learning Science*, vol. 1, no. 4, pp. 49–62, 2024.

[8] Z. Liu, C. Xiong, and D. Xie, "Application of the online and offline blended learning mode in innovation and entrepreneurship education," *2020 IEEE International Conference on Teaching, Assessment, and Learning for Engineering (TALE)*, vol. 2020, no. 1, pp. 803-806, 2020, doi: 10.1109/TALE48869.2020.9368408.

[9] D. Gudoniene, E. Staneviciene, I. Huet, J. Dickel, D. Dieng, J. Degroote, V. Rocio, R. Butkiene, and D. Casanova, "Hybrid teaching and learning in Higher education: A systematic literature review," *Sustainability*, vol. 17, no.2, pp. 1-27, 2025, doi: 10.3390/su17020756.

[10] A. Daskan and Y. Yildiz, "Blended Learning: A Potential Approach to Promote Learning Outcomes", *IJSSES*, vol. 7, no. 4, pp. 103–108, Dec. 2020, doi: 10.23918/ijsses.v7i4p103.

[11] A. Zuhairi, N. Karthikeyan, and S. T. Priyadarshana, "Supporting students to succeed in open and distance learning in the Open University of Sri Lanka and Universitas Terbuka Indonesia," *Asian Association of Open Universities Journal*, vol. 15, no. 1, pp. 13–35, 2020. Doi:10.1108/AAOUJ-09-2019-0038

[12] L. Chen, D. Ifenthaler, and J. Y. K. Yau, "Online and blended entrepreneurship education: a systematic review of applied educational technologies," *Entrepreneurship Education*, vol. 4, pp. 191–232, 2021. Doi:10.1007/s41959-021-00047-7

[13] X. Chen and S. Chan, "Implementing digital pedagogy in TVET: A Connectivist perspective", *Vocat Tech Edu*, vol. 1, no. 2, pp. 32-47, 2024.

[14] D. Kexin and N. A. Buang, "Integrating Innovative Teaching Strategies: Assessing the Effectiveness of Flipped Classrooms, Blended Learning, and Task-Oriented Methods in Enhancing Academic Performance in Vocational IT Education", *DREAM*, vol. 3, no. 05, pp. 94–108, May 2024.

[15] P. Kongchuay, "The development of learning innovation on digital platforms: The case of computational education," *Educational Innovation Journal*, vol. 10, no. 4, pp. 281–292, 2024.

[16] J. A. Alokluk, "The effectiveness of the Blackboard system uses, and limitations in information management: A literature review," Journal of Educational Systems, vol. 25, no. 1, pp. 12–29, 2018.

[17] X. H. Wen, "College students' innovation and entrepreneurship capacity construction in the era of meteorological big data," *Open Access Library Journal*, vol. 9, pp. 1–13, 2022. Doi: 10.4236/oalib.1109638

[18] R. Zhou, "Entrepreneurship education in Chinese higher institutions: Policy, practice, and pathways," *Cogent Education*, vol. 11, no. 1, pp. 1-15, 2024, doi: 10.1080/2331186X.2024.2375080.

[19] Y. Zeng and Y. Xie, "Constraints of innovation and entrepreneurship education for university students," *Journal of Educational Management and Policy Research*, vol. 21, no. 3, pp. 8-21, 2024, doi: 10.1007/s10734-024-00112-5.

[20] H. Luan, "Challenges and future directions of big data and artificial intelligence in education," *Journal of Educational Technology Development and Exchange*, vol. 12, no. 1, pp. 15-28, 2020, doi: 10.1016/j.compedu.2020.103876.

[21] M. Dai, D. Liu, M. Liu, F. Zhou, G. Li, Z. Chen, Z. Zhang, H. You, M. Wu, Q. Zheng, Y. Xiong, H. Xiong, C. Wang, C. Chen, F. Xiong, Y. Zhang, Y. Peng, S. Ge, B. Zhen, T. Yu, L. Wang, H. Wang, Y. Liu, Y. Chen, J. Mei, X. Gao, Z. Li, L. Gan, C. He, Z. Li, Y. Shi, Y. Qi, J. Yang, D. G. Tenen, L. Chai, L. A. Mucci, M. Santillana, and H. Cai, "Patients with cancer appear more vulnerable to SARS-CoV-2: A multicenter study during the COVID-19 outbreak," *Cancer Discovery*, vol. 10, no. 6, pp. 783–791, Jun. 2020. Doi:10.1158/2159-8290.CD-20-0422

[22] T. Grisham, "The Delphi technique: a method for testing complex and multifaceted topics," *International Journal of Managing Projects in Business*, vol. 2, no. 1, pp. 112-130, 2009.

[23] M. P. Staykova, "Rediscovering the Delphi technique: a review of the literature," *Advances in Social Sciences Research Journal*, vol. 6, no. 1, pp. 218-229, 2019.

[24] P. Nasa, R. Jain, and D. Juneja, "Delphi methodology in healthcare research: how to decide its appropriateness," *World Journal of Methodology*, vol. 11, no. 4, pp. 116-129, 2021.

[25] Y. Fu, T. Sangsawang, M. Pigultong, and W. Watkraw, "Utilizing systematic digital platforms and instructional design in Health communication: A Data-driven approach in China's curriculum," *Journal of Applied Data Sciences*, vol. 6, no. 1, pp. 695-713, 2025.

[26] A. Joshi, S. Kale, S. Chandel, and D. K. Pal, "Likert scale: Explored and explained," *British Journal of Applied Science and Technology*, vol. 7, no. 4, pp. 396-403, 2015.

[27] C. J. Hellín, F. Calles-Esteban, A. Valledor, J. Gómez, S. Otón-Tortosa, and A. Tayebi, "Enhancing student motivation and engagement through a gamified learning environment," *Sustainability*, vol. 15, no. 19, pp. 1-20, 2023. Doi:10.3390/su151914119