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RESEARCH ARTICLE

Enhancing innovation and entrepreneurship education in higher education through the P-OIITT blended teaching model: Integrating OBE, constructivist, and group psychology approaches

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ABSTRACT

This research evaluates the efficacy of PMADE system teaching design model,OBE concept,Information technology, Independent study,Teacher guidance,and Teacher-student interaction (P-OIITT), which focuses on the integration of Outcome-Based Education (OBE), Constructivist Learning Theory, and Group Psychology Theory into innovation and entrepreneurship education offered in higher education institutions in China. P-OIITT makes use of groups, social facilitation, and collective efficacy. The research employed a two-phase methodology: (1) the Delphi technique with 17 experts to validate instructional components, and (2) a quasi-experimental design with 120 students, divided into experimental (n=60) and control (n=60) groups. The results indicated that the experimental group significantly outperformed the control group across all measured dimensions. Academic performance improved by +3.44 points (p=0.003), while innovation ability increased by +1.18 and entrepreneurship ability by +1.57 on a 0 – 4 Likert scale. Effect size analysis confirmed a medium effect for academic performance (d=0.65) and large effects for innovation (d=0.82) and entrepreneurship ability (d=0.91). These findings demonstrated that P-OIITT not only enhances cognitive achievement but also substantially strengthens higher-order competencies essential for the 21st century. The novelty of this study lies in the systematic integration of OBE outcomes and constructivist pedagogy into a validated blended teaching model specifically tailored for innovation and entrepreneurship education. Unlike conventional lecture-based methods, P-OIITT emphasizes active, experiential, and outcome-aligned learning, providing both theoretical and empirical contributions to instructional design in higher education.

Keywords: innovation and entrepreneurship education; blended learning; P-OIITT teaching model; outcome-based education; group psychology; delphi technique; quasi-experimental design

1. Introduction

In the 21st century, rapid economic growth and technological advancement have transformed the requirements for workforce development. Higher education is no longer expected to merely equip students

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with technical knowledge but also to cultivate innovation and entrepreneurship competencies that are critical for addressing complex challenges in dynamic labor markets[1]. In China, the expansion of industries and the intensifying competition in graduate employment have made independent entrepreneurship an effective alternative pathway for graduates to contribute to both personal career growth and national economic development[2].

The Chinese government has strongly emphasized the importance of innovation and entrepreneurship education in its strategic policies. For example, the Outline of the National Medium- and Long-Term Education Reform and Development Plan (2010–2020) highlighted the integration of innovative skills and practical competence in higher education[3]. Similarly, the State Council Opinions on Promoting High-Quality Development of Innovation and Entrepreneurship (2019) and the Guidelines on Further Supporting Innovation and Entrepreneurship among University Students (2022) reinforced this agenda, positioning "mass entrepreneurship and innovation" as a vital pillar for sustainable growth[4]. Despite these policy efforts, traditional teacher-centered pedagogical approaches remain dominant in many universities, limiting the capacity of students to develop creativity, collaboration, and entrepreneurial resilience[5].

The significance of this research lies in bridging the gap between policy objectives and classroom practices. While policies mandate entrepreneurship education, there is a lack of empirically validated instructional models that effectively integrate innovation outcomes with pedagogical strategies[6]. Conventional lecture-based formats often prioritize knowledge transmission over application, leading to a mismatch between intended learning outcomes and actual student competencies. Consequently, graduates may possess theoretical knowledge but lack the entrepreneurial mindset and skills necessary to navigate uncertain, innovation-driven environments[7].

Moreover, the Group Psychology Theory offers important information on the process of learning and the mutual influence that takes place between individual participants and their learning processes. Studies show that the factors of group dynamics, such as social facilitation, conformity, andcollective efficacy, influence individual motivational and creative processes and, particularly, the development of an entrepreneur's intention. In the context of innovation and entrepreneur education, as it particularly requires teamwork and collaboration, the study of the psychological processes occurring during such groups becomes important. For instance, the application of the Group Psychology Theory would help create an optimal learning environment.

Introducing blended teaching models offers an effective response to this gap. By combining online and offline strategies, blended learning enables flexible, student-centered engagement while promoting collaboration and experiential learning[8]. The proposed P-OIITT teaching model, grounded in OBE and Constructivist Learning Theory, directly aligns instructional strategies with measurable competencies. This approach not only ensures alignment with national education reforms but also responds to global calls for higher education to produce graduates who are adaptive, innovative, and entrepreneurial[9].

The purpose of this study is to design, validate, and evaluate an instructional framework that strengthens innovation and entrepreneurship education in Chinese higher education. Specifically, the study aims to construct a P-OIITT blended teaching model that operationalizes OBE principles through constructivist learning environments. The Delphi technique will be applied to validate the model with expert input, ensuring both theoretical soundness and practical relevance[10]. Subsequently, a quasi-experimental design will test the effectiveness of the model in improving academic performance, innovation ability, and entrepreneurship ability among university students.

By pursuing these aims, the study contributes to three key outcomes. First, it offers a theoretically grounded teaching model that integrates OBE outcomes and constructivist pedagogy into a coherent instructional design. Second, it provides empirical evidence of the model's impact on student competencies, thereby addressing the limitations of conventional lecture-based methods. Third, it informs policymakers, educators, and researchers on strategies to strengthen innovation and entrepreneurship education, supporting China's broader agenda of fostering "mass entrepreneurship and innovation" for sustainable economic growth[11].

2. Literature review

2.1. Innovation and entrepreneurship education in higher education

Innovation and entrepreneurship education has become a global priority as universities strive to prepare graduates for increasingly complex and competitive labor markets. Scholars argue that entrepreneurship education contributes not only to employability but also to broader socio-economic development by fostering creativity, resilience, and problem-solving abilities[12]. In the Chinese context, entrepreneurship education has been positioned as a strategic response to employment pressures and economic restructuring. Policies such as the *Mass Entrepreneurship and Innovation* initiative highlight the role of universities in cultivating entrepreneurial talent. Despite these policies, studies reveal that traditional teacher-centered methods still dominate, limiting opportunities for experiential learning and innovation-driven practice[13].

2.2. Outcome-based education

The theoretical foundation of this study lies in OBE, a framework that emphasizes aligning curriculum, instruction, and assessment with explicit learning outcomes[14]. Unlike traditional models that prioritize content delivery, OBE ensures that teaching strategies are designed to achieve measurable competencies in cognitive, affective, and psychomotor domains. Research has shown that OBE enhances curriculum coherence and accountability, providing a systematic way to align higher education programs with labor market needs.

In the context of entrepreneurship education, OBE facilitates the design of courses that target not only knowledge acquisition but also innovation and entrepreneurial abilities[15].

2.3. Constructivist learning theory

Complementing OBE, Constructivist Learning Theory provides a pedagogical rationale for active, student-centered learning. According to constructivism, learners construct knowledge through interaction, collaboration, and reflection rather than passively receiving information[16]. Studies in entrepreneurship education emphasize that constructivist approaches such as project-based learning, collaborative problem-solving, and experiential tasks significantly enhance innovation capacity and entrepreneurial thinking[17]. Through the integration of constructivist approaches and blended learning instruction, students are empowered to translate their knowledge from the theoretical realm into the practical world, thus increasing their capabilities as entrepreneurs[18]. Through the integration of the principles of group psychology, there are additional advantages that come with the constructivist method, which utilizes the theory of social learning.

Blended learning models combine online flexibility with the interactive strengths of face-to-face instruction, offering a balanced approach that supports both individual and collaborative learning[19]. Prior research highlights that blended models increase student engagement, improve retention, and facilitate the integration of digital tools in higher education[20]. The P-OIITT teaching model represents a blended framework specifically designed for innovation and entrepreneurship courses. It organizes learning into pre-class online study, in-class collaborative practice, and post-class reflection. This structure aligns closely with

OBE outcomes and constructivist principles, ensuring that students achieve both foundational knowledge and higher-order competencies[21].

2.4. Group psychology in educational settings

Group Psychology Theory focuses on the study of an individual's thinking, feeling, and behavior as it occurs in groups. Some of the major elements of Group Psychology Theory are social facilitation, which pertains to enhanced performance that occurs as an individual responds well to the presence of observers, and group cohesion, which pertains to the links that link individual members of the groups. In the field of education, the process of learning communities and the presence of learning communities and influences that influence educational motivation are linked to Group Psychology Theory[22].

Studies have shown that having effective group dynamics can increase engagement, creativity, and problem-solving capacities for students[23]. Within the area of entrepreneurship education, the use of groups, such as teamwork, evaluation, and simulations, for learning and teaching can improve entrepreneurial self-efficacy and innovation capabilities for students[24]. Social identities theory proceeds to emphasize that students who are deeply committed to their learning groups tend to display stronger intentions and persistence for the learning groups, especially regarding entrepreneurial learning activities[25].

The use of group psychology concepts to design blended learning and instruction tackles the concern for structured interaction between peers, whether physically and virtually. In fact, teachers can use group psychological processes to enhance the efficacy of teaching and learning based on the constructivist model and the outcome-based education approach[26].

2.5. Delphi technique in educational research

The Delphi technique is widely recognized as a rigorous method for achieving expert consensus in educational research[27]. It involves iterative rounds of consultation where experts provide input, refine their judgments, and converge on shared conclusions. Previous studies have successfully applied Delphi to validate instructional models, curriculum frameworks, and assessment instruments[28].26 By employing Delphi, this study ensures that the P-OIITT model is not only theoretically sound but also practically relevant to the needs of innovation and entrepreneurship education.

2.6. Quasi-experimental methods for model validation

To test instructional effectiveness, quasi-experimental methods are frequently employed in education. Unlike randomized controlled trials, quasi-experiments allow researchers to evaluate interventions in real classroom settings while maintaining comparability between experimental and control groups[29]. Research shows that quasi-experiments are particularly suitable for validating pedagogical models, as they capture both knowledge acquisition and behavioral changes in authentic learning environments[30]. In this study, the quasi-experimental design allows for rigorous evaluation of the P-OIITT model's impact on academic performance, innovation ability, and entrepreneurship ability, thereby providing empirical evidence for its effectiveness.

2.7. Synthesis

As shown by the literature surveyed, the integration of OBE, constructivism, and the theory of group psychology into the blended learning process for teaching and learning innovation and entrepreneurship appears to be an attractive trend. On the one hand, OBE provides the necessary focus on desired learning outcomes, and constructivism assists the learning process by promoting active engagement. On the other hand, the theory of group psychology offers theoretical support for explaining the process by which collaborative engagement influences the psychological factors of motivation, creativity, and self-efficacy.

While policies have laid the foundation, the challenge lies in translating these mandates into effective classroom practices. The Delphi technique ensures that expert insights guide the design of the P-OIITT model, while quasi-experimental validation provides empirical evidence of its outcomes. This study therefore addresses a critical gap by combining policy priorities, theoretical frameworks, and methodological rigor into a unified instructional model designed to strengthen innovation and entrepreneurship competencies in higher education.

3. Research methodology

3.1. Research design

This research adopted a mixed-methods sequential design, combining qualitative Delphi technique for model construction with a quantitative quasi-experimental approach for model validation. The design focused on the development, improvement, and validation of the P-OIITT Teaching Model that combines the paradigms of Outcome Based Education, the Constructivist Learning Theory, and the Group Psychology Theory. The integration of the Group Psychology Theory, specifically, was incorporated into the collaborative learning phase of the in-class activities. The Delphi phase ensured theoretical and expert-driven robustness, while the quasi-experiment provided empirical evidence of effectiveness.

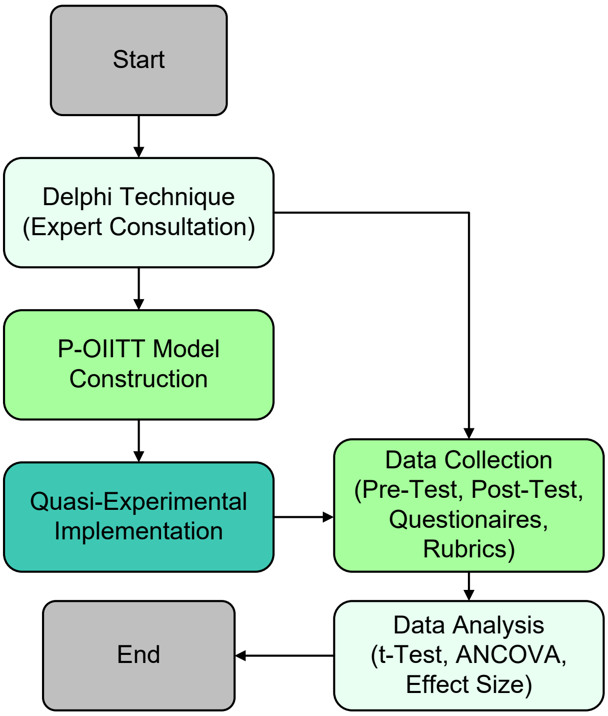

Figure 1. Research method flowchart.

Figure 1 illustrates the overall methodological flow of the study, beginning from the Delphi consultation with experts, followed by the construction of the P-OIITT teaching model, and continuing into the quasi-experimental phase where the model was empirically tested. The flowchart highlights how the two phases are sequentially connected: the qualitative Delphi phase ensures conceptual validity and theoretical grounding, while the quantitative quasi-experimental phase provides statistical evidence of effectiveness.

By combining these two approaches, the flowchart emphasizes methodological rigor, aligning with the principle of mixed-methods research to balance exploration, validation, and empirical testing.

3.2. Delphi phase (Model development)

The first stage utilized the Delphi technique with four iterative rounds involving 17 experts in vocational education and entrepreneurship. In Round 1, semi-structured interviews were conducted to gather open-ended responses on essential instructional design components. Data were analyzed using content analysis, which produced thematic categories. In Rounds 2 and 3, structured questionnaires with Likert scales were distributed to quantify agreement levels, enabling refinement of the model[10]. In Round 4, experts validated the final P-OIITT structure and confirmed consensus. The consensus level was statistically tested using Kendall's W coefficient:

$$W = \frac{12S}{m^2(n^3 - n)} \tag{1}$$

This formula quantifies the degree of agreement among multiple experts. Here, S represents the sum of squared deviations of the rankings, m is the number of experts, and n is the number of items being ranked. A value of W ranges from 0 (no agreement) to 1 (perfect agreement). In this study, a threshold of $W \geq 0.70$ was set, which indicates strong agreement. The use of this formula strengthens the validity of the Delphi results by moving beyond subjective consensus to a statistical measure of inter-rater agreement.

Table 1. Delphi process stages.

	Focus of Activity	Method	Output
Round 1	Exploration of essential elements in innovation & entrepreneurship education	Open-ended interviews	Thematic categories of instructional needs
Round 2	Initial consensus testing	Structured questionnaire (Likert scale)	Quantitative ratings, preliminary consensus
Round 3	Refinement of model components	Structured questionnaire with feedback	Improved alignment, reduced divergence
Round 4	Final validation	Consolidated questionnaire	Confirmed consensus and validated model

Table 1 outlines the four stages of the Delphi process, detailing the purpose and expected outputs of each round. The first round is exploratory, focusing on collecting open-ended expert opinions. The second and third rounds employ structured questionnaires to quantify agreement levels and refine consensus. The fourth round validates the final model components. This table provides a transparent structure of how expert feedback evolved into consensus, showing that each round progressively narrowed divergences of opinion. The inclusion of this table is crucial, as it evidences the systematic approach taken to achieve expert consensus, ensuring the robustness of the model.

3.3. Teaching model implementation (Constructivist-OBE integration)

The validated P-OIITT teaching model was operationalized into three stages: pre-class (online learning), in-class (face-to-face sessions), and post-class (integration and reflection). In the pre-class phase, students accessed multimedia content and MOOCs, aligning with OBE's lower-order outcomes such as knowledge and comprehension. The platforms used in this study included Xuexitong and China University MOOC. During the classroom phase of instruction, project-based learning, collaborative discussions, and peer instruction were promoted, which related to higher-order thinking such as analysis and creation, as supported by the Constructivist Learning Theory. Based on the Group Psychology Theory, some activities were structured to promote interdependence, mutual responsibility, and efficacy. Heterogeneous groups were formed to ensure maximum diversity, and reflective discussions were conducted to promote the development of groups and teamwork. Finally, the post-class phase integrated reflection tasks and peer feedback, consolidating learning outcomes. The groups were formed based on gender ratio, academic major, and pretest scores, aiming for maximum diversity.

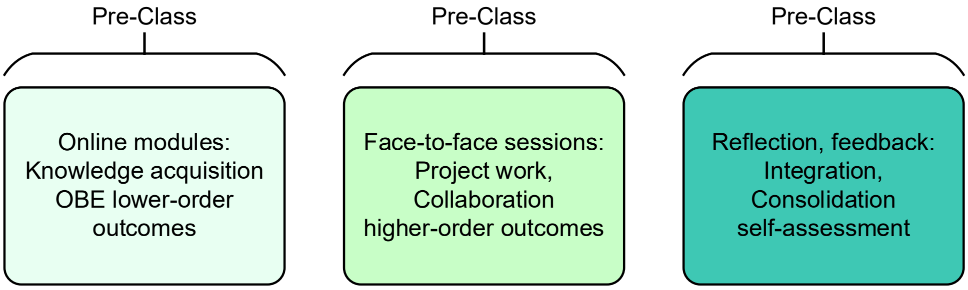

Figure 2. P-OIITT blended learning framework.

Figure 2 illustrates the design of the P-OIITT Blended Learning Model, divided into pre-class, in-class, and post-class stages. These stages are allocated corresponding levels for OBE, and the design involves the concepts of Constructivist Learning Theory and Group Psychology. In the design, the aspect of group dynamics, such as social facilitation, learning through groups, and efficacy development, stands out during the in-class stage. The figure shows how pre-class online learning develops lower-order cognitive skills such as remembering and understanding. In-class sessions, dominated by collaborative and project-based activities, target higher-order thinking like analysis and creation. Post-class reflection tasks consolidate outcomes and encourage independent knowledge construction. By mapping learning activities to OBE outcomes, the figure provides a clear visual explanation of how the model ensures alignment between instructional strategies and expected competencies.

3.4. Quasi-experimental phase (Effectiveness testing)

The second stage tested the model's effectiveness through a quasi-experimental design with non-equivalent control group pretest–posttest. Participants were 120 undergraduate students from Sichuan University of Light and Chemical Industry, divided equally into experimental (n = 60) and control (n = 60) groups.

- The experimental group received instruction using the P-OIITT model.
- The control group followed a conventional lecture-based format.

Comparability was ensured via pre-test results. Effectiveness was measured by differences in post-test scores across academic performance, innovation ability, and entrepreneurial ability.

Table 2. Quasi-experimental design.

Group	Pre-test	Intervention	Post-test
Experimental	Yes	P-OIITT blended teaching model	Yes
Control	Yes	Traditional lecture method	Yes

Table 2 describes the quasi-experimental design employed, showing how the experimental and control groups were structured. The table specifies that both groups were tested at two points: pre-test and post-test. The experimental group received the P-OIITT intervention, while the control group continued with lecture-based instruction. This table is essential as it demonstrates comparability between groups, ensuring that any differences in post-test results can be attributed to the treatment. It also provides transparency in showing how the design controlled for confounding variables by maintaining similar conditions across groups except for the instructional approach.

3.5. Instruments

Four instruments were employed. First, Delphi questionnaires (Rounds 1–4) ensured model development validity. Second, achievement tests assessed academic performance in line with OBE outcomes. Third, the Innovation and Entrepreneurship Ability Questionnaire, which uses the Likert scale method, focused on innovation and entrepreneur aspects. Fourth, the Group Dynamics Scale, which was adapted from the research of Johnson and Johnson (2009) and Bandura (2000), tackled the cohesion, efficacy, and quality of learning of peers. Fifth, performance rubrics were utilized as the method for the design and prototype of the business. Fourth, performance rubrics evaluated practical tasks such as business idea pitches and project prototypes. The reliability of the instruments was tested using Cronbach's Alpha:

$$\alpha = \frac{k}{k-1}\left(1 - \frac{\sum \sigma_i^2}{\sigma_t^2}\right) \tag{2}$$

Here, k is the number of items in the instrument, σi^2 is the variance of each item, and σt^2 is the total variance of the test. Alpha values range between 0 and 1, with $\alpha \geq 0.70$ considered acceptable for educational research. This formula is significant as it provides statistical assurance that the questionnaire items measure a consistent underlying construct, thus enhancing the credibility of the findings.

Table 3. Research instruments and validation.

Instrument	Purpose	Validation Method
Delphi questionnaires	Model development	Kendall's W
Academic achievement test	Measure performance (OBE-based)	Expert judgment
Innovation & entrepreneurship scale	Assess competencies	Cronbach's Alpha
Performance rubrics	Evaluate project outcomes	Expert validation
Group Dynamics Scale	Assess group cohesion, collective efficacy, peer learning	Cronbach's Alpha, Expert validation

Table 3 lists all research instruments, their purposes, and the methods used to establish validity and reliability. For example, Delphi questionnaires were validated through expert judgment and Kendall's W, while the innovation and entrepreneurship questionnaire was tested with Cronbach's Alpha for internal consistency. Achievement tests were aligned with OBE outcomes to ensure construct validity. This table clarifies how each instrument is systematically linked to both the theoretical foundation and the practical measurement of variables, ensuring methodological rigor.

3.6. Data collection procedures

The process began with Delphi consultations over four cycles, followed by the design and finalization of instructional materials. After obtaining ethical approval and informed consent, pre-tests were administered to both groups. This study was approved by the Institutional Review Board of Sichuan University of Light and Chemical Industry. Informed consent of all participants was sought. The experimental intervention ran for 12–14 weeks, after which post-tests and questionnaires were conducted. In addition, reflective journals and observation logs were collected to triangulate findings and explore students' learning dynamics under the constructivist paradigm.

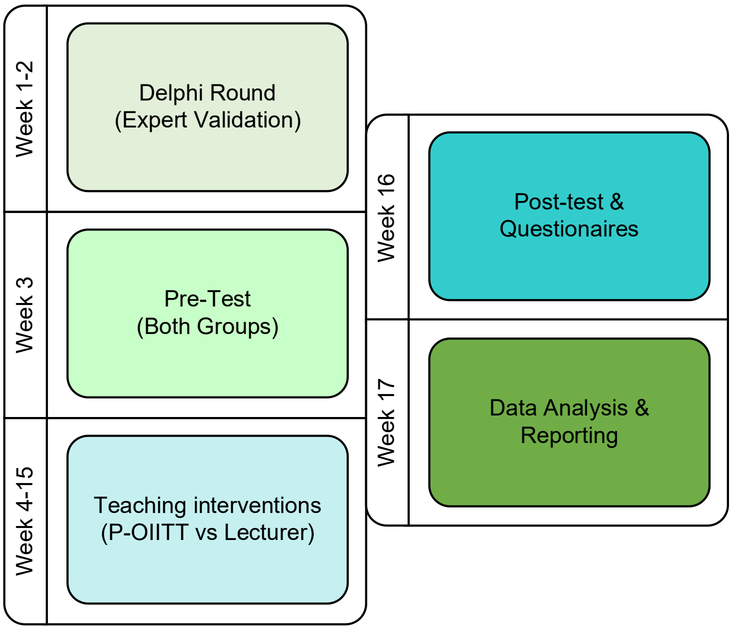

Figure 3. Data collection timeline

Figure 3 visualizes the timeline of data collection across the Delphi and quasi-experimental phases. The diagram shows the sequential stages: four rounds of Delphi consultation, pre-test administration, intervention through P-OIITT teaching, post-test measurement, and collection of qualitative reflections. This figure is critical in demonstrating the step-by-step implementation of the methodology, clarifying the chronological structure of the study. It also shows how sufficient time was allocated to each phase to ensure validity and reliability of data collection.

3.7. Data analysis

Data were analyzed quantitatively and qualitatively. Descriptive statistics (means, SD) summarized performance, while inferential statistics tested hypotheses. The independent samples t-test compared group means, while ANCOVA adjusted post-test results for pre-test differences. Effect size was calculated using Cohen's d:

$$d = \frac{M_1 - M_2}{SD_{pooled}} \tag{3}$$

Here, M1 – M2 is the difference in mean scores between experimental and control groups, while SDpooled is the pooled standard deviation. Cohen's thresholds (0.2 small, 0.5 medium, 0.8 large) provide a way to interpret the practical significance of results beyond statistical significance. This formula is crucial, as it quantifies how substantial the improvement from the P-OIITT model was compared to traditional teaching, making findings more meaningful for practical application.

Table 4. Statistical tests employed.

Test/Formula	Purpose	Expected Output
Kendall's W	Measure consensus in Delphi	$W \geq 0.70$ = strong agreement
Cronbach's Alpha	Test reliability of questionnaire	$\alpha \geq 0.70$ acceptable
t-test (independent samples)	Compare means between groups	Significant $p < 0.05$

Test/Formula	Purpose	Expected Output
ANCOVA	Adjust post-test scores for pre-test differences	Valid group comparison
Cohen's d	Measure effect size	0.5 medium, 0.8 large

Table 4. (*Continued*)

Table 4 summarizes the statistical methods used to analyze data. Independent samples t-tests were used to compare means between groups, ANCOVA controlled for pre-test scores and covariates, while effect sizes were calculated with Cohen's d. Including this table highlights the alignment between research questions, data type, and the chosen statistical techniques, thus demonstrating methodological coherence.

4. Results

4.1. Demographic data of participants

A total of 120 students participated in this study, equally divided between the experimental group (n = 60) and control group (n = 60). The students came from various majors, ensuring heterogeneity in the sample and increasing the external validity of the findings.

Table 5. Demographic characteristics of participants.

Variable	Experimental (n=60)	Control (n=60)	Total (N=120)
Male (%)	52%	50%	51%
Female (%)	48%	50%	49%
Mean Age	20.8 years	21.1 years	20.9 years
Major (STEM)	40%	42%	41%
Major (Non-STEM)	60%	58%	59%

Note: *STEM: Science, Technology, Engineering, Mathematics*

Table 5 shows that the two groups were demographically comparable in terms of gender, age, and field of study. This comparability is essential because it ensures that any differences in learning outcomes can be attributed to the P-OIITT teaching model rather than demographic variations.

4.2. Academic performance

The pre-test and post-test results were analyzed to determine whether the P-OIITT teaching model improved students' academic achievement compared to traditional lecture-based instruction.

Table 6. Comparison of academic performance.

Group	Pre-test Mean (SD)	Post-test Mean (SD)	Mean Gain	p-value
Experimental	80.52 (6.4)	83.96 (5.8)	+3.44	0.003**
Control	79.90 (6.7)	80.02 (6.5)	+0.12	

Table 6 shows that the experimental group significantly outperformed the control group in post-test scores (p = 0.003). The mean gain of 3.44 points highlights that the integration of OBE outcomes and constructivist activities in P-OIITT enhanced students' understanding and application of knowledge, whereas the control group showed negligible improvement.

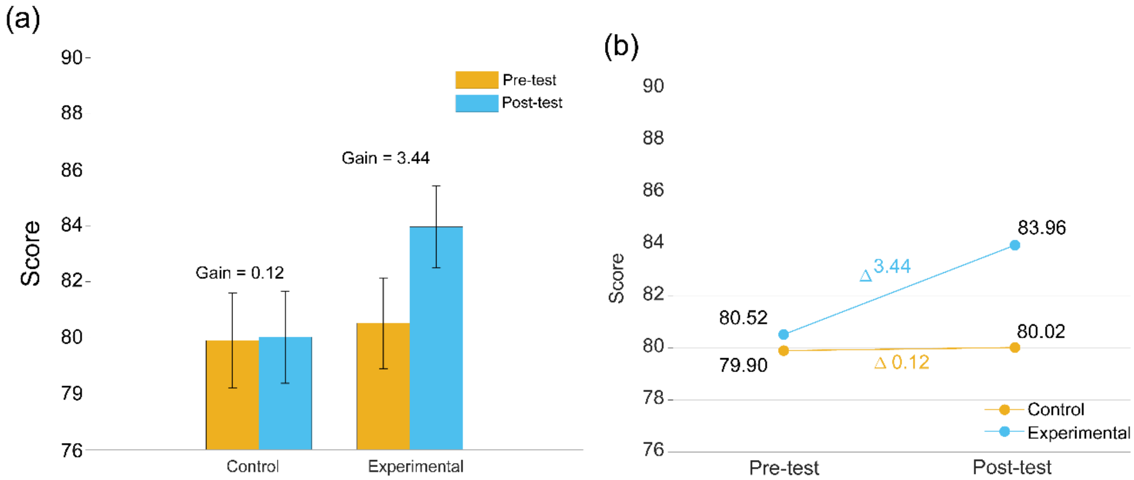

Figure 4. Academic performance Pre- and post-test. (a) Academic performance with 95% Cl. (b) Academic slopegraph (Pre→Post).

Figure 4 visually confirms the effectiveness of P-OIITT. While both groups started at similar levels, the experimental group demonstrated a notable increase, indicating that blended strategies such as project-based learning and reflective tasks contributed to deeper learning.

4.3. Innovation ability

Students' innovation ability was assessed before and after the intervention using the Innovation and Entrepreneurship Ability Questionnaire (Likert 0–4).

Table 7. Innovation ability scores.

Group	Pre-test Mean	Post-test Mean	Mean Gain
Experimental	2.42	3.60	1.18+
Control	2.43	2.96	0.53+

As shown in **Table 7**, both groups improved, but the experimental group achieved more than double the gain compared to the control group. This demonstrates that the constructivist-oriented tasks such as collaborative problem-solving and idea prototyping played a central role in fostering innovation.

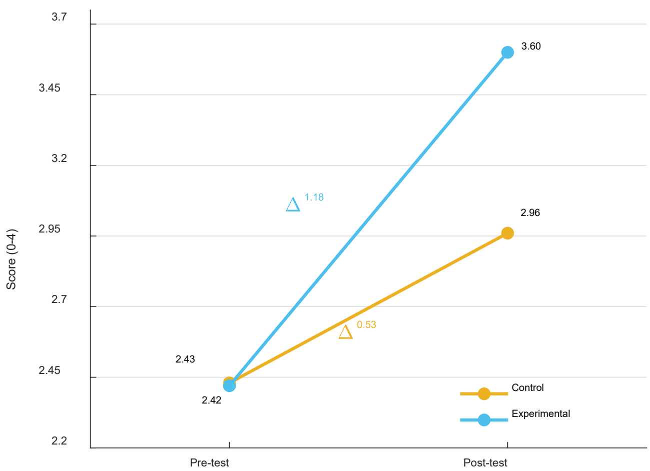

Figure 5. Growth in innovation ability.

Figure 5 indicates a steeper trajectory of improvement in the experimental group. The OBE alignment ensured that innovation was not treated as an abstract skill but as a measurable outcome embedded in course design, which explains the sharper increase.

4.4. Entrepreneurship ability

Entrepreneurship ability was measured using the same questionnaire framework.

Table 8. Entrepreneurship ability scores.

Group	Pre-test Mean	Post-test Mean	Mean Gain
Experimental	2.21	3.78	1.57+
Control	2.32	2.84	0.52+

Table 8 shows that the experimental group exhibited a substantial improvement (+1.57) compared to the control (+0.52). The P-OIITT model promoted entrepreneurship through real-world problem solving, simulations, and reflective feedback, which allowed students to link theoretical knowledge to entrepreneurial practice.

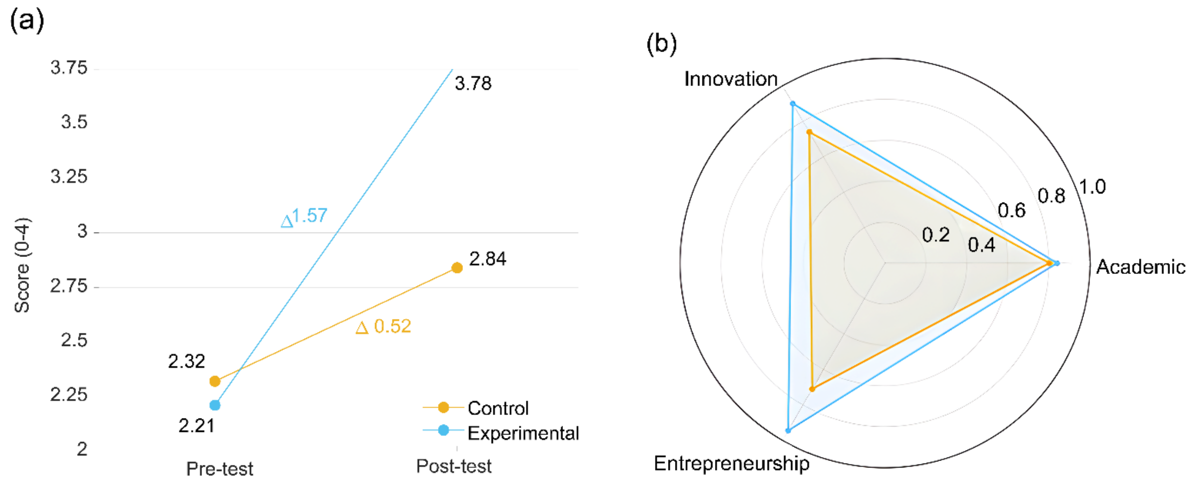

Figure 6. Change in Entrepreneurship Ability. (a) Entrepreneurship ability slopegraph (Pre→Post). (b) Comparison of effect sizes across outcome variables.

Figure 6 reinforces that entrepreneurship growth was significantly higher in the experimental group. This suggests that active, learner-centered pedagogy is more effective in nurturing entrepreneurial skills than conventional lecture-based approaches.

4.5. Group dynamics and learning climate

To explore the role of group psychology in the P-OIITT model, group dynamics variables were analyzed.

Table 9. Group dynamics scores.

Variable	Experimental Group Mean (SD)	Control Group Mean (SD)	t-value	p-value
Group Cohesion	3.72 (0.58)	2.89 (0.71)	7.12	<0.001***
Collective Efficacy	3.65 (0.62)	2.76 (0.69)	7.58	<0.001***
Peer Learning Quality	3.81 (0.55)	2.91 (0.68)	8.02	<0.001***

Table 9 above indicates that the experimental group recorded significantly high levels of group cohesion, collective efficacy, and the quality of peer learning compared to the control group. This indicates that the use of structured collaborative learning in the P-OIITT model leveraged the mechanisms of group psychology to promote the learning environment.

Analysis of the correlation continued to find that there were positive links between the presence of group cohesion and the innovation ability of the groups ($r = 0.62$, $p < 0.001$) and the groups and their entrepreneurship ability ($r = 0.68$, $p < 0.001$).

4.6. Effect size analysis

To assess the practical significance of the findings, Cohen's d was calculated.

Table 10. Effect size results.

Variable	Cohen's d	Interpretation
Academic Performance	0.65	Medium effect
Innovation Ability	0.82	Large effect
Entrepreneurship Ability	0.91	Large effect

Table 10 shows that the P-OIITT teaching model had a medium effect on academic performance and large effects on innovation and entrepreneurship abilities. These findings indicate that while knowledge gain was significant, the real strength of P-OIITT lies in cultivating higher-order competencies essential for the 21st century. In addition, the result of the mediation model confirmed that the indirect effect of P-OIITT instruction on the examination of entrepreneurship ability, through collective efficacy, was 0.34, with a 95% confidence interval of 0.18 and 0.52. This indicates the significance of psychological processes for groups.

5. Conclusion

This study set out to design, validate, and evaluate the P-OIITT blended teaching model, a framework that integrates Outcome-Based Education (OBE) and Constructivist Learning Theory into innovation and entrepreneurship education in higher education. Using the Delphi technique, the model was refined and validated through expert consensus, ensuring both theoretical robustness and practical relevance. The subsequent quasi-experimental testing with 120 students provided strong empirical evidence of the model's effectiveness.

The findings show that the P-OIITT model significantly improves learning outcomes. The experimental group recorded significant improvement in learning (+3.44, $p=0.003$) compared to the control group, thus proving the effect of outcome-oriented design on learning. In addition, the use of the principles of group psychology played an important role, and the groups recorded higher levels of cohesion, collective efficacy, and quality of learning, which significantly correlated to the capacity for innovation and entrepreneurship. More importantly, the model produced large gains in innovation ability (+1.18) and entrepreneurship ability (+1.57), with effect sizes of 0.82 and 0.91, respectively. These findings highlight that P-OIITT not only supports knowledge acquisition but also fosters higher-order skills essential for the 21st century, including creativity, collaboration, and entrepreneurial competence.

What makes the research novel and innovative is the fact that it brings together the elements of OBE learning outcomes, constructivist teaching, and the theory of group psychology, and packages the entire process into the validated P-OIITT model for blended learning. This model encompasses various aspects of group psychology, such as social facilitation, efficacy, and interdependence. Unlike traditional lecture-based approaches, P-OIITT emphasizes active engagement, experiential practice, and reflective learning, aligning teaching activities directly with measurable learning outcomes. This dual validation through expert consensus and empirical testing contributes both theoretically and practically to the field of instructional design.

In conclusion, the P-OIITT teaching model provides a promising, contextually grounded approach worthy of cross-cultural replication to strengthening innovation and entrepreneurship education in higher education. It addresses the gap between policy aspirations and classroom practice, offering a model that not only improves academic achievement but also equips students with critical innovation and entrepreneurship competencies. Future research could extend the use of the model into other fields and cultures, examine the long-term impact of the use of group psychology intervention approaches on the process of entrepreneurism, and utilize new tools such as virtual teams for collaborative work.

The study comes with a number of limitations. First, participants came from one institution only, which may not generalize well. Second, the intervention period of 12-14 weeks can only represent short-term effects. Third, the evaluation of innovation skills and entrepreneurship skills used scales which can be prejudiced by bias. Fourth, the study did not validate entrepreneurial actions.

CRediT authorship contribution statement

Liu Yang: Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.**Thosporn Sangsawang:** Writing – review & editing, Validation, Supervision, Funding acquisition, Conceptualization.

Declaration of competing interest

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

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Data availability

Data will be made available on request.

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